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Abstract

The benefits of strategically balancing exploitation and exploration are well documented in the literature. However, many firms tend to overemphasize exploitation efforts, even in the face of the strong need to step up their exploration activities. We draw on system dynamics modeling and a case study to address this gap in the literature, and develop a theoretical framework of ambidexterity as a capacitated delay process. This framework describes how the interplay between cognitive processes and motivational factors at the top management level severely limits the formation of ambidextrous capability. As such, this paper provides a micro-level theory of how individual and interactional processes at the managerial level inhibit the development of ambidextrous capability.

Key-words: ambidexterity, firm failure, micro-level approach, organizational capability, process theory, system dynamics modeling.

1. Introduction

In the 1990s Motorola's management failed to respond to the transition from analog to digital mobile telephony, although the rise of GSM technology had been evident since the year 1990. The Motorola case is by no means an exception (e.g. Adams and Boike, 2004; Tripsas and Gavetti, 2000). In today's economy, product life cycles are becoming increasingly shorter while product complexity continues to increase. In many industries, this has resulted in a fierce competitive landscape where business performance largely depends on the organizational ability to change and innovate, combined with a talent for generating healthy returns on the investments made (Damanpour et al., 2009; Leonard-Barton, 1992; Schumpeter, 1942; Simsek, 2009). This implies that firms should create and keep a balance between exploration and exploitation initiatives (March, 1991). In this respect, a balance between exploration and exploitation activities that fit the market and competitive conditions positively influences financial performance (He and Wong, 2004; Jansen et al., 2006; Uotila et al., 2009). Organizational ambidexterity, therefore, is a key competitive advantage (He and Wong, 2004; March, 1991; Raisch and Birkinshaw, 2008).

However, exploration and exploitation require fundamentally different and often competing strategic acts, to be conducted at the same time (Simsek et al., 2009). Firms, therefore, face a dilemma (Atuahene-Gima, 2005; He and Wong, 2004). On the one hand, they need to adapt to environmental imperatives by means of exploitation efforts, particularly in the form of incremental innovation. Although this is likely to bring short-term success, it tends to reduce the flexibility of a firm to adjust to future environmental changes since it may lead to an underinvestment in exploration (Atuahene-Gima, 2005). This compromises the long-term viability of the firm. On the other hand, too much focus on the long-term future by investing heavily in exploration (i.e. radical innovation efforts) will reduce the speed at which existing competencies are improved and refined, and thus tends to undermine short-term business success (He and Wong, 2004).

Firms often fail to achieve and maintain a balance between exploitation and exploration that is viable in the long run. To understand this phenomenon, we need to focus on individual behavior, notably that of top managers. Individuals constitute a central antecedent of organizational capabilities, and as such play an important role in strategy development (e.g. Argote, 1999; Cho and Hambrick, 2006; Felin and Foss, 2005). This paper, therefore, explores how individual and interactional processes – for example, between top management and the firm's shareholders – may inhibit the development of ambidextrous capability.

Most studies investigating this type of failure have focused on the myopic tendencies of top management that limit their ability to adapt their strategy in time (Hannan and Freeman, 1984; Porac and Thomas, 1990; Tripsas and Gavetti, 2000; Tushman et al., 2004). The key argument in these studies is that strategists often do not 'see' the upcoming exogenous change, because managerial cognitive representations tend to constrain organizational behavior and inhibit the ability to bring about strategic change in a timely fashion. However, changes in the external environment are seldom so unexpected that they cannot be foreseen at all. Top managers in these cases (cf. Motorola) are thus often aware of the shifting external context, which contradicts the hypothesis that strategists often do not see change coming (cf. Helfat et al., 2007).

This suggests a theoretical perspective implying a more complex sequence of events and behavioral (cognitive and motivational) patterns that inhibits the timely change toward an improved balance between exploitation and exploration. In this respect, Helfat et al. (2007, p. 46) argue more work needs to be done on how capabilities develop over time to understand "how strategists can sometimes hinder (…) organizational change and the development of dynamic capabilities in the organization." In this paper we, therefore, explore *why and how top managers respond to environmental changes that evidently imply the need to step up exploration activities, by enhancing their firm's exploitation focus*? As such, this paper responds to calls for researching the micro-level foundations of institutions, organizational capabilities, and strategic change (e.g. George et al. 2006; Felin and Foss, 2005).

To answer the above question, a process theory was developed by means of a simulation model that was calibrated with data gathered during an in-depth case study. Longitudinal studies of *how* organizational change occurs are rare (cf. Van de Ven, 2007). This is also the case for process studies of ambidextrous capabilities. Simulation modeling is an important research tool to address research questions that unfold over time and are non-linear in nature (e.g. Davis et al., 2007; Romme, 2004; Romme, Zollo and Berends, 2010; Sterman, 2000). This makes simulation modeling very suitable for the development of process theories.

The model developed in this paper will demonstrate how a firm can get trapped in a vicious feedback loop, in which environmental disruptions that dramatically decrease organizational performance (and thus constitute a crisis-like situation) are counteracted with exploitation efforts, resulting in a further decline of organizational performance. More specifically, the interplay between cognitive processes and motivational factors appears to distort the perceived balance needed to successfully engage the new environmental imperatives. We coin this process 'the suppression mechanism'. The main contribution of this paper to the ambidexterity literature is the definition and codification of the suppression mechanism in a (system dynamics) process theory.

The structure of this paper is as follows. The next section reviews the theoretical background of the model. Subsequently, we outline the simulation model, which is then calibrated and tested by means of a case study and historical analysis. The calibrated model serves to provide a deeper understanding of the system dynamics in this case study. Finally, in the last section we discuss the theoretical and practical implications of our findings and also explore opportunities for future research.

2. Theoretical Background

Ambidexterity refers to the organizational ability to do two different things at the same time, notably exploitation and exploration (Simsek, 2009). Exploitation refers to learning through processes of incrementally improving existing knowledge, while exploration involves the pursuit and acquisition of new knowledge (He and Wong, 2004). We assume that exploitation aims to exploit present opportunities with incremental innovation, while exploration creates adaptability by exploiting future opportunities with radical innovation (e.g. Benner and Tushman, 2003). Innovation is defined here as the successful introduction of an invention (knowledge) to the market (Roberts, 1988). This implies that, in order to become ambidextrous, top management needs to create a particular balance between exploitation and exploration in the firm that serves to create, extend, and modify its resource base in alignment with the market and competitive environment it is exposed to (Helfat et al., 2007; Winter, 2000).

The literature has treated the relation between exploitation and exploration either as a zero sum game or as two different orthogonal aspects (Gupta et al., 2006). This raises an important issue: should exploitation and exploration be treated as two ends of a continuum, implying that exploitation efforts will restrict the amount of exploration efforts possible (and vice versa); or can exploitation and exploration better be understood as two different, orthogonal aspects of organizational behavior where both are likely to be infinite? Authors in favor of the former position argue that exploitation and exploration compete for the same scarce resources within the firm, in the form of a zero-sum game (e.g. Madsen et al., 2002; March, 1991). Those in favor of the second perspective refer to the context of learning: that is, in a learning setting the opportunities for both exploratory and exploitative learning can be potentially unlimited (e.g. Rothaermel, 2001).

As such, the assumption with regard to the relationship between exploitation and exploration depends on the specific context studied. In this paper, we will focus on publically held manufacturing-oriented firms that have been emphasizing exploitation and are highly constrained in their resources (incl. financial reserves). Despite the fact that learning opportunities might be widely available, these firms have to decide in which (exploitation and/or exploration) opportunities they will actively invest. Top management therefore has to create a strategic balance between exploiting their current portfolio of products and technologies and exploring new opportunities outside the current portfolio. Since this balancing act needs to be conducted with a limited set of resources, an increase in exploitation activities will decrease resources available for exploration, and vice versa. We therefore assume that exploitation and exploration initiatives are two ends of one continuum, constrained by a shared set of resources (Gupta et al., 2006; March, 1991; Simsek et al., 2009).

Many empirical studies have observed that the alignment between the dynamics of the environment and the balance between exploitation and exploration positively influences the financial results of the firm (Gupta et al., 2006; He and Wong, 2004; Jansen et al., 2006; March, 1991; Tushman and O'Reilly III, 1999; Uotila et al., 2009). This key conclusion arises from studies that assume exploration and exploitation are orthogonal aspects (e.g. Jansen et al., 2006) as well as from studies assuming these are two ends of the same continuum (e.g. Uotila et al., 2009). The available body of evidence implies that the higher the environmental moderator, the greater the returns on exploration efforts and the smaller the returns on exploitation; and vice versa (Jansen et al., 2006; Uotila et al., 2009). In this respect, high levels of environmental instability are likely to increase the depreciation rate of existing products. In turn, this creates the need to develop new products, and organizations pursuing exploration in these settings are more likely to meet the needs arising from new competitive conditions and new emerging markets.

Environmental instability can have many sources and may, for instance, arise from competence-destroying changes (Tushman and Anderson, 1986), periodic shifts in market preferences (Christensen et al., 1998), or newly emerging dominant designs that change competitive dimensions (Henderson and Clark, 1990). In that sense even the most stable environment is bound to (somewhat) change. This implies that the optimal balance between exploitation and exploration will shift due to environmental dynamism, and top management therefore has to make decisions on how to adapt to the current environmental imperatives and anticipate future dynamics (cf. Romme et al., 2010).

The success of a company therefore resides to a large extent in the capabilities of top management to sense environmental changes and translate these into a balanced portfolio of exploitation and exploration projects (Christensen and Bower, 1996; O'Reilly III and Tushman, 2008; Zollo and Winter, 2002). Many studies have confirmed the influence of top managers on their firm's performance, reporting large and statistically significant effects of corporate decision making on the strategic direction and overall profitability. Direct effects have been observed in terms of the strategic allocation of resources (Adner and Helfat, 2003; Christensen and Bower, 1996; Osborne et al., 2001). Indirect effects have also been reported, for example, in the form of signaling value (e.g. the announcement of a long-term plan leading to favorable stock market reactions) (Higgins and Gulati, 2006; Westphal and Zajac, 1998). The impact of senior executives on firm performance has also been called a 'dynamic managerial capability' (Adner and Helfat, 2003).

To formally capture ambidexterity as a dynamic managerial capability, we adopt ideas from the seminal work of Lewin (1951). Lewin argued that the interaction of forces both within and outside an individual determine his or her actual behavior. His ‘person-situation field theory’ implies that, to understand behavior, one must understand the psychological field in which an agent is operating. A psychological field is a configuration of forces and is determined by cognition and motivation processes, which is a function of the ‘person in the situation’ (Fiske and Taylor, 2007). In this respect, cognition is a process tied to the person; it provides a personal interpretation of the world, that is, a mental model; it determines what a person would do and in which direction his/her behavior should go. Motivation is a process related to the environment; this process serves to predict whether the behavior, which would follow from individual cognition, will occur at all – and if it does, to what degree. Ever since the work of Lewin (1951), social psychologists have been considering the situation as well as the person as critical for predicting behavior (e.g. Fiske and Taylor, 2007). In that sense, strategic decisions are determined by both top managements’ cognitive structures and processes and their motivation when labeling and making sense of the environment (e.g. Daft and Weick, 1984; Cho and Hambrick, 2006). For example, top managers might sense the need to change the balance between exploitation and exploration, but may be constrained by shareholder pressure and the financial performance perceived to be acceptable to most shareholders (cf. Burgelman et al., 2004). The environment and person are thus interdependent.

From a cognitive perspective, top management acts on a shared mental model (Porac and Thomas, 1990; Sengupta et al., 2008). In general, a mental model constitutes simplified representations of the world that facilitate the processing of perceived information and serve as the basis for top management to ground decision-making (Porac and Thomas, 1990; Tripsas and Gavetti, 2000; Winter, 2000). We adopt the definition of a mental model developed by Doyle and

Ford (1998, p. 17) on the basis of a comprehensive literature review in the research domains of psychology, cognitive psychology, cognitive science, and system dynamics: “a mental model of a dynamic system is a relatively enduring and accessible, but limited, internal conceptual representation of an external system whose structure maintains the perceived structure of that system.”

Formally modeling a mental model implies creating a ‘cognitive map’, an external representation of a mental model (Doyle and Ford, 1998). The cognitive map captures a conceptual representation of the mental model, the structure that stores information. Following the definition given earlier, cognitive maps should depict a structure of how the knowledge is organized and inter-connected within the mental model. Given the sheer complexity of the human mind and brain, this is simply not feasible. However, it has been argued that a limited cognitive map, which can be as small as two variables and two causal relationships, provides a sufficient means of capturing the structure of a mental model concerning a specific external system (e.g. how to balance exploitation-exploration investments in view of certain changes in the environment) (Doyle and Ford, 1998).

An important limitation to the cognitive process arises from organizational inertia (Biyalogorsky et al., 2006; Hannan and Freeman, 1984). Inertia develops as a result of historical experience and limits the extent to which the cognitive map of top management can change (Tripsas and Gavetti, 2000). In this respect, managers publicly committed to a course of action tend to remain faithful to it even when new information implies the need to take action (Biyalogorsky et al., 2006; Schmidt and Calantone, 2002). This type of inertia thus influences the speed at which top management can respond and adjust to environmental dynamism and opportunities and therefore compromises the chances of success (Hannan and Freeman, 1984; Tripsas and Gavetti, 2000).

Regarding motivational processes, we argue that the owners of the firm constitute the main motivational factor in publicly owned manufacturing firms. Top managers of publicly held firms do typically not own a major part of the firm's equity (if any at all). Walsh and Seward (1990) argue most firm owners – such as institutional and private investors – diversify their holdings across a variety of firms in order to prevent financial losses in case a particular firm fails. Because the owners have little interest in managing the firm on a day to day basis, they hire top managers (executives) to direct and coordinate activities within the firm. Berle and Means (1932) observed, already a long time ago, that owners (who are not involved in managing the firm) have a primary interest in earning a maximum profit with a reasonable degree of risk. When top management fails to achieve acceptable financial returns, this will thus result in pressure from the owners on top management to generate short-term financial results (Judge and Zeithaml, 1992). On the contrary, when owners perceive the financial performance to be adequate, top management will have the discretion to exploit as well as explore. In that sense, owners are probably the most powerful external force affecting the firms' strategy (cf. Chaganti and Damanpour, 1991).

Helfat et al. (2007) distinguish between a firm's technical and evolutionary capability, or fitness, to anticipate and respond to changing market, competitive and other external conditions. Given the research question outlined in the previous section, we will assume that the firm in our model is 'technically fit' (cf. Helfat et al., 2007), and thus able to develop the technologies and products needed in the markets it wishes to serve. This assumption is not unreasonable in view of the findings of Christensen and Bower (1996), who observed that large established firms were highly successful at developing technologies of every sort. We will therefore focus on the 'evolutionary fitness' of the incumbent firm (Helfat et al., 2007; Winter, 2000). This implies a particular capability can only be assessed meaningfully in relation to a particular competitive context and point in time. For example, in the 1990s the value of Motorola's business proposition (i.e. focus on analog telephony) shrunk, as digital mobile telephony gradually became the new standard. Interestingly, this had little to do with its technical fitness: Motorola was the first firm in the world that introduced a working prototype of the digital cellular system using the GSM standard (in 1991). Motorola thus proved technically fit but, because its top management apparently did not have the capability to effectively manage the transition, it lacked evolutionary fitness. In this respect, Motorola did not posses organizational ambidexterity.

3. Model Description and Calibration

We draw on system dynamics modeling to build and simulate a model of the causes and consequences of the suppression mechanism. System dynamics (SD) models particularly serve to investigate multiple interacting processes, time delays, and other nonlinear effects (e.g. Davis et al., 2007; Oliva and Sterman, 2001; Van Oorschot et al., 2010; Repenning, 2001; Romme, 2004; Rudolph and Repenning, 2002). SD is therefore instrumental in understanding processes that are characterized by dynamic complexity and unfold over time (Sterman, 2000). As such, this makes system dynamics very appropriate for the development of a process theory (Repenning and Sterman, 2002; Rudolph and Repenning, 2002). Moreover, system dynamics has been successfully applied to corporate strategy issues before (Risch et al., 1995; Sterman, 2000). The model in this paper is characterized by a so-called capacitated delay structure (Sterman, 2000). This type of structure arises when the impact of a set of related stocks (e.g. exploration and exploitation) depends on the level of flows in and out of these stocks – and in turn each of these flows are influenced and constrained by external conditions as well as the levels of multiple stocks.

In this section we present the most important equations of the model. A full description of the model, including all equations and settings (and sensitivity of the settings), is given in a separate document. The main ingredients of system dynamic models are stocks and flows. In the diagramming notation, flow variables are depicted as pipes with valves. Stocks, represented by rectangles, denote a particular level of a variable (e.g. investment in exploitation). The clouds represent infinite sources or outcomes of particular flows that are beyond the scope of the model. Figure 1 provides a stylized overview of the model.

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INSERT FIGURE 1 ABOUT HERE

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The model in Figure 1 captures the essence of the suppression mechanism in three feedback loops. First, the reinforcing 'Stick to exploitation' loop denotes the situation in which top management does not perceive a need to explore. Investments in exploitation in combination with a stable environment (and hence positive financial returns) decrease the need to explore and therefore no investments will be made in exploration. In an unstable environment, however, exclusively investing in exploitation will lead to an increasing misalignment with the environment, and hence an increasing need to explore. This cognitive feedback loop thus shapes top management's mental model.

Second, the balancing loop 'Limits to change' represents the potentially limiting motivational process. This loop determines to what extent the cognitive need to explore will result in investments in exploration activities. Shareholders are mainly driven by financial returns (see previous section), and this loop therefore influences the level of investment in exploration that the shareholders would allow given the perceived trend in the operational result. A positive trend creates discretional space for both exploitation and exploration, while a negative trend will increase the pressure to exploit.

The third loop 'Attempt to explore' is reinforcing in nature and involves the motivation for and effects of investments in exploration. After a particular time delay, investments in exploration will pay off, resulting in increasing operational results. This tends to reduce the external pressure to exploit, making a higher level of investments in exploration possible.

Capabilities are often a matter of a degree (Winter, 2000), and can therefore be modeled as continuous variables. In our model, the balance between exploration and exploitation (comprising organizational ambidexterity) is determined by the distribution of the available resources (AR) over the two ends. Following our assumption described in the previous section, the amount of resources available is finite: it is calculated as a certain percentage of the operating result. The percentage of the AR invested in exploration is captured by the variable 'Resource investment in exploration' (RIE). The stock 'Investment in exploitation' (Inv_Exploit) refers to the amount of resources invested in exploitation, that is, incremental improvements. On the other end of the continuum, the stock 'Investment in exploration' (Inv_Explore) denotes the level of resources allocated to exploration, that is, radical innovation. Recent studies have shown that implementing new innovation strategies and thus routines at the business unit level takes considerable time and effort (e.g. Durmusoglu et al., 2008). The desired resource adjustment is therefore subject to an adjustment time (AT). The AT is longer for exploration, since it requires more radical changes of the routines. This implies the following equations:

Change in investment exploration:

(1) $$d\,(Inv\_Explore) / dt = (RIE * AR - Inv\_Explore) / AT\_Explore$$

Change in investment exploitation:

(2) $$d\,(Inv\_Exploit) / dt = (1 - RIE) * AR - Inv\_Exploit)) / AT\_Exploit$$

The exogenous variable ‘Environmental stability’ represents the level of volatility in the market. As outlined in the former section, the alignment between the environment and the relative investments in exploitation and exploration influence the financial results, and thus the operating result of the firm. (This reflects our assumption regarding evolutionary fitness.) This sequence of events takes place with a certain delay because initial investments have to be transformed into (money generating) innovation. This delay is smaller for returns related to exploitation than it is for exploration processes since the latter requires significantly more resources to generate market success. Nevertheless, investments in exploration, when successful, yield a higher return on investment (Burgelman et al., 2004).

The alignment between the environment and the relative investments is also the basis for both the reinforcing ‘Stick to exploitation’ and the balancing ‘Limits to change’ loop. With regard to the ‘Stick to exploitation’ loop, investments in exploitation in an increasingly dynamic environment will undermine the ‘Alignment with environment’, triggering managerial action – denoted in the variable ‘Need to explore’ (NE). This variable constitutes the cognitive aspect of the behavior of top management. In general, perceptions tend to adjust to new circumstances with a certain delay, which can be modeled in terms of the behavior of a first-order adaptive system (Sterman, 2000). Not only the perception of the environment is subject to such a delay; managerial cognition (NE) also requires a particular time to adjust mental models, due to inertial forces.

With respect to the latter, the perceived operating result determines the amount of pressure from stakeholders to generate short-term financial results. (The operating result is a function of the combined returns of both exploitation and exploration investments minus the operating costs.) Stakeholders also perceive the operating results with a certain delay, implying the use of a first-order adaptive system regarding the trend (derivative) of the operating result.

This is captured by the variable ‘External pressure to exploit’ (EP). This variable constitutes the motivational aspect of the behavior of top management.

The subsequent interaction between cognition and motivation determines the value of RIE (and reflects top managements behavior regarding the development of organizational ambidexterity). This variable can range from 0 to 1. Because this variable depends on both motivation and cognition, it is calculated by multiplying top management’s desired and the stakeholder’s allowed investment in exploration activities. In that sense RIE can be called the ‘cognition-motivation interaction’. The result of the cognitive process is an actual investment level in exploration as well as in exploitation.

(3) $RIE = NE * (1 - EP)$

Calibration of the system: Case study

In order to test and build confidence in the model, we calibrated it with data obtained during a case study. The research site is a large Dutch multi-business firm that manufactures and sells a diverse range of textile related products. This firm involves six business units that are closely monitored and controlled by the executive board of the firm. The company achieved substantial growth until 2007 by pursuing an exploitation strategy for an extended period of time under the lead of the two-headed executive board. In recent years competitive dynamics have been growing and, in order to remain competitive, the firm restructured. In an attempt to realize new growth, the executive board changed the firm’s strategy toward innovation and entrepreneurship. At the same time, however, sales were decreasing and combined with the restructuring costs, significantly negative (quarterly) operating results were obtained in early 2008 and the stock-listed firm declined in value by around 50 percent. The subsequent pressure for short-term improvements in financial results resulted in the abandonment of the new growth strategy by the end of 2008. In the same period, the value of the firm on the stock exchange continued to decline rapidly until it reached the lowest value ever, a reduction of more than 96 percent within two years. Undoubtedly, the global crisis in the financial sector, which had a dramatic impact on the industrial sector, reinforced the breakdown of the firm's stock market value. In the midst of this turbulence, the board of directors appointed a new CFO in the beginning of 2009 to enforce and facilitate a strategy with an enhanced focus on exploitation. The new strategic direction as of 2009 was announced in an official press release: 'Under the current economic circumstances, [we have] decided not to pursue the growth strategy as set earlier. The company's management will concentrate on recovery of the financial position.'

The data collected in this case study include time series for key variables (e.g. data on net income in annual reports) over the period 1994-2008 and interviews with top managers within the firm and staff within the different business units. These data were used to estimate key parameters and relationships.

The cognitive balance between exploitation and exploration (NE) was established by means of content analysis of the annual reports (cf. Uotila et al., 2009). This served to estimate the level of exploitation and exploration efforts by this firm over an extended period of time. The operational definition of these two concepts in the content analysis was based on March's (1991) original definition of the two terms. That is, exploration was captured by keywords as: 'search, variation, risk taking, experimentation, play, flexibility, discovery, innovation'; and exploitation is operationalized as: "refinement, choice, production, efficiency, selection, implementation, execution". Several additional keywords were added for exploitation after studying the annual reports, namely: "cost and process". The value for the variable 'Need to explore' was subsequently calculated as the total number of matched keywords for exploration divided by the total number of matched keywords for both exploitation and exploration (per year).

Subsequently, the central moving average was calculated over three years. As such, we sample one point in the past (*t* – 52) and one in the future (*t* + 52), plus of course the current time. This approach allows for capturing the structural trend in cognitive development of the top management team, rather than the mere state of NE at the end of each year. The biggest threat to the validity for this type of analysis arises from the accuracy of the vocabulary employed. In this respect, Uotila et al. (2009) statistically validated that the vocabularies proposed by March (1991) accurately differentiate between exploitation and exploration.

The investigated firm at large is sensitive to changes in the world economy, rather than to sectoral dynamics. In this respect, this multi-business firm includes divisions that produce fast-moving consumer products as well as divisions that produce industrial B2B products (e.g. technical textiles for OEMs); as such, sectoral dynamics other than the dynamics of the world economy tend to average out at the corporate level. Therefore, the Standard & Poor (S&P) 500 index was used as a proxy for environmental stability. The Standard & Poor (S&P) 500 index is a market-value weighted index of 500 U.S. based firms and is widely considered to effectively represent the state of the dynamic global economy. The S&P 500 index for the period 1994-2008 was scaled and adapted to fit the corresponding variable in our simulation model – a continuous variable ranging from 0 (extremely instable) till 60 (very stable). Interestingly, the resulting time series for 'Environmental stability' includes two major crises: 9/11 and the more recent financial crisis. Figure 2 gives a graphical representation of the data for environmental stability used in the model.

INSERT FIGURE 2 ABOUT HERE

Subsequently, we ran the simulation model to produce a (simulated) operating result and a (simulated) need to explore, with the environmental stability as primary input. The simulated operating result can thus be compared to the real operating results (corrected for the inflation rate). Figure 3 denotes the result of this calibration exercise for the operating result. We achieved a R^2 of 0.7169 for the correlation between the real and simulated operating result, which can be considered a good fit. Figure 4 gives the calibration results for the need to explore. Here, a R^2 was achieved of 0.7288, which can also be considered a good fit.

Another indication of model fit (by observing the source of error) is Theil's Inequality statistic, which gives a decomposition of the error by dividing the mean square error into the unequal means (bias), unequal variances, and imperfect correlation (Sterman, 2000). This statistic helps in localizing the source of error (e.g. poor model fit versus random noise in the data). In this respect, low bias and variance fractions combined with a high unequal co-variation indicates that the error is unsystematic if phasing is unimportant (Sterman, 2000). The calibrated NE variable contains more unequal variation than unequal covariation. Combined with the low bias value, however, this indicates that the variable has the same mean and trend but differs from data point by point (Sterman, 2000). As such, it will have little influence on the theory developed. This suggests that the model settings are correct and the total error is mainly due to random variation

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INSERT FIGURE 3 ABOUT HERE

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4. From process theory to case narrative

The calibrated base model of the process theory outlined in Figure 1 now serves to uncover the actual conditions and consequences of the suppression mechanism in our case study. That is, the calibrated model is used in this section to identify the generative mechanisms and temporal patterns in this case. Our case study implies that five major time periods (demarcated by t = A, B, C, D, and E) can be distinguished in how the suppression mechanism evolves: see Figure 5A, B, and C for an overview. In the remainder of this section, we provide a case narrative structured in these five periods.

INSERT FIGURE 5A, B, and C ABOUT HERE

Initially (t < A), an alignment exists between the firm's investment in exploitation and the environment resulting in positive financial returns. In this setting, the 'Stick to exploitation' feedback loop is dominant (see Figure 1). Hence, hardly any attempts to explore are undertaken (relative investment in exploitation remains 100%, see Figure 5C). This feedback loop causes successful companies to 'wisely stick to what works well', (Tushman et al., 2004, p. 586). The executive board describes this behavior also in the 1998 annual report as the cornerstone of their strategy: 'The first matter of importance concerning the expansion of our business is a healthy autonomous growth and cost control. This will increase the cost-effectiveness of our current activities.' This behavior can be explained in terms of a mental model that is shaped on the basis of prior experience (Doyle and Ford, 1998). Interestingly, during this period of increasing operating results (see Figure 5A), the perceived pressure from stakeholders to exploit is decreasing (Figure 5B) and more exploration initiatives would be supported. In that sense, the environment would very likely accept change, but the firm's top management fails to initiate it (as a result of lack of cognition, see Figure 5B).

As a result of the environment becoming more and more unstable (A < t < B), the exclusive focus on exploitation becomes increasingly suboptimal. The need to explore therefore grows. The following excerpt from the annual report of 2001 illustrates the increased awareness: 'A healthy, autonomous growth is being sought in the existing (core)-activities where product innovation will take place continuously.' Because financial performance continues to grow, the pressure to exploit remains relatively low. For that reason, some level of investment in exploration would in principle be allowed by the stakeholders. However, during the time delay needed to significantly adjust top management's mental model (this slow increase in awareness is clearly illustrated in Figure 4) and during the time (delay) needed to effectively start exploring, the financial performance of the firm starts to decline as a result of environmental dynamics. This subsequently increases the pressure from the owners, which redirects the business once more toward a short-term orientation on financial performance. The board of directors stated in both 2002 and 2003: '[…] as a result of restructuring measures, cost savings and new acquisitions, the outlook for the future is positive.' As such, top management is increasingly getting aware of the need to explore, but the firm's environment starts to severely limit the amount of change possible. In 2004, the strategy was directed to one that advocated the constant search for ways to become more cost-efficient, to work more effectively, and optimize the management of current operations.

An enhanced investment in exploitation efforts generally does not come without (some) short-term results, as is the case here ($B < t < C$). Although exploration efforts have the potential of leading to superior performance, the resulting (initial generation of) new products generally underperform at the moment of their market introduction (Burgelman et al., 2004). In addition, even if the new product is superior at the moment of market introduction, its performance increase tends to start slow – as technological progress has been shown to follow an S-curve (Burgelman et al., 2004). This implies that 'old' technologies, products and routines may (temporarily) outperform the new. The declining trend in financial performance therefore tends to come to a halt as a result of the increased focus on exploitation. The executive board wrote in their annual report over 2007: 'The results achieved during the year under review give good reason for the group as a whole to be pleased with the way the transformation process has gone.' If the expected comeback does not occur at all, the firm is likely to leap to t > D.

Subsequently, the situation arises where there is both substantial awareness of the need to explore and a decreasing pressure to exploit; after all, financial performance is increasing somewhat (C < t < D). As one of the executives said during a meeting in which the status of several innovation projects was discussed (early 2008): 'We say product innovation is important, so we better do something with it'. Moreover, later in the meeting he stated: '[We] can and want to facilitate innovation initiatives with money, FTE's and commitment.' Since these new exploration efforts require capabilities that are new to the firm, it is very likely that early trials will have unsatisfactory results (cf. Winter, 2000). The new activities have to cross the boundaries of organizational units that need to adopt and implement the new strategy, which tends to be a cumbersome process (Durmusoglu et al., 2008). This was also the case for this firm, as of the business unit managers observed halfway 2008: 'Compared with [our] meeting in January [2008], little progress has been made given the fact that support (money) has been offered by the board. Do we recognize this? Is it organization? People? Priorities?' However, as the operating result turns negative, the commitment to exploration activities drops and the pressure to (exclusively) exploit grows.

From here on (t > D), top management is aware of the need to explore, but due to strong pressures from shareholders to improve the operating result as soon as possible, the motivation and incentive to invest in exploration breaks down. The firm is now entirely locked into the suppression mechanism, and responds to the instable environment with more exploitation efforts; thereby further decreasing its financial performance (the 'Limits to change' loop in Figure 1 is now dominant). As stated by the board of directors in the beginning of 2009: 'Under the current economic circumstances, [we have] decided not to pursue the growth strategy as set earlier. The company's management will concentrate on recovery of the financial position.’ After a certain amount of time (*t* > E) this situation is likely to result in a radical turnaround (possibly as part of an acquisition by another firm) or even bankruptcy. In the summer of 2009, the board of directors replaced the CEO; the new CEO has a track record in financial control and turnaround management. At the time of writing the current version of this paper (last quarter of 2009), the incumbent firm was thus going through a major turnaround.

5. Discussion and Conclusion

This paper has explored why and how managers of firms with an established focus on exploitation activities fail to develop an ambidextrous capability, even when the market and competitive conditions are this. We studied key impediments to successful ambidexterity, by adopting a micro-level focus on how individual and interactional processes impact or hinder the development of ambidexterity. More specifically, the interplay of cognition and motivation in the context of the exploitation-exploration dilemma was modeled in a system dynamics model. The model developed in this paper incorporates the main positive and negative feedback loops with regard to the managerial decision on whether to invest in exploitation and/or exploration.

This paper contributes to the ambidexterity literature by identifying and modeling the suppression mechanism. The current literature on ambidexterity tends to adopt a macro-level perspective (e.g. He and Wong, 2004; Raisch and Birkinshaw, 2008) to explain the causal links between exploration/exploitation and firm performance. The model developed in this paper provides a process theory of the micro-level origins of (the failure to develop) ambidexterity at the level of top management. Our results suggest that firms can get seriously trapped in a reinforcing loop, in which top management counteracts environmental disruptions by mere incremental improvements of the current portfolio of routines, technologies and products, which further decreases firm performance. In this respect, the interplay between cognitive processes and motivational factors over time may severely distort top management's capability to successfully align the organization to a changing environment, particularly by suppressing (investments in) exploration. Our findings also imply that external economic shocks, like the recent financial crisis, can have long-term effects on firms which go far beyond the initial shock.

While studies investigating the effect of ambidexterity have traditionally been cross-sectional (e.g. Jansen et al., 2006; Uotila et al., 2009), we argue that a longitudinal process-oriented approach might create a more complete understanding of the dynamic interaction at the top management level that causes firms to get trapped in the suppression mechanism. Longitudinal studies of *how* organizational change occurs are rare. Our study contributes to the ambidexterity literature by adopting a systems thinking and modeling approach that focuses on the micro-level origins of ambidextrous capability. The process theory of change developed in this paper serves to facilitate an understanding of the sequence of (seemingly ad hoc) events leading to the suppression of exploration activities, even when the latter are critical to the future viability of the firm.

With respect to the above, our findings also contribute to an understanding of the importance of sustained investments in both exploitation and exploration. Exploration has been considered to be less important in low-tech industries than in high-tech environments (cf. Uotila et al., 2009). Although the financial returns on investments in exploration (e.g. new product development) might indeed be smaller in low-tech environments, the consequences of getting trapped in the suppression mechanism are nonetheless severe. Furthermore, during long periods of incremental improvements (cf. exploitation), top management generally becomes less receptive to environmental changes. This makes these firms more prone to getting trapped in the suppression mechanism. In this respect, aligning a balanced portfolio of exploration and exploitation efforts to the level of environmental dynamism is important for low-tech as well as high-tech industries.

Our findings also have important managerial implications. The suppression mechanism can be observed in many enterprises that favor incremental improvements over exploring new horizons, products and processes (Helfat et al., 2007; Teece et al., 1997). By understanding the generative processes constituting the suppression mechanism, management can attempt to avoid getting trapped. Moreover, top managers and owners of the incumbent firms should tolerate (a minimum number of) early investments in exploration and possess the stamina to carry these efforts through. As such, it is paramount that the (ambidexterity) strategies and interests of top management and external stakeholders are carefully aligned.

The use of a dynamic simulation model inherently limits the research, as the biases of the modelers might be included in the model. That is why simulations should be used to elaborate on emerging theories by deductive logic and empirical evidence, and subsequently used for other empirical studies (Davis et al., 2007). As such, the process theory presented in this paper should be subjected to further empirical analysis. We therefore hope this investigation will motivate other researchers to study *how* ambidextrous firms can be created.

Several interesting avenues for future research can be pointed out. It is well known that early investments in exploration may prevent firms from getting trapped in the suppression mechanism. However, little is known on how to escape the suppression mechanism once a firm finds itself in this situation. Previous case studies merely illustrated that drastic turnarounds were necessary to escape the suppression trap (cf. Helfat et al., 2007; Tushman et al., 2004). In that sense, future work in this area should attempt to identify key processes and tools that can help firms create ambidexterity in a proactive manner.

Second, March (1991) and more recently Gupta et al. (2006) pointed out that exploration often leads to more exploration. They argue that exploration often leads to failure because of the many underdeveloped ideas with too little distinctive competence. This subsequently increases the need to search for other ideas implying more exploration. Future research can address whether complex interactions at the top management level cause this reinforcing loop – in a similar way as we modeled the reinforcement of exploitation in this paper.

Third, future research should extend the model presented in this paper to address the question as to when to strategically pursue ambidexterity versus a punctuated equilibrium (Gupta et al., 2006). Both strategies may be viable ways to create organizational vitality by balancing exploitation with exploration. The ongoing debate on these two strategies is also referred to as the simultaneous-sequential question (Gupta et al., 2006; O'Reilly III and Tushman, 2008). Simultaneity refers to synchronous pursuit of both incremental and radical innovation via dedicated subunits or individuals. Sequentiality is about iterating between exploration and exploitation, rather than organizational differentiation. Although both approaches serve the same goal, they are radically different and likely to have different outcomes.

6. References

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7. Figures

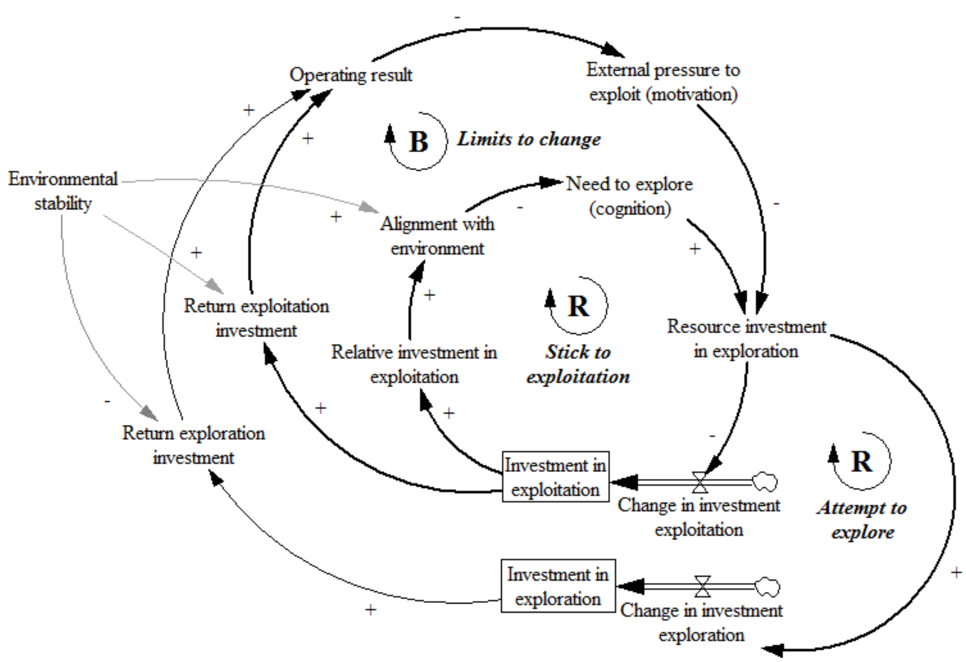


Figure 1: Stylized stock and flow diagram of the formal model.

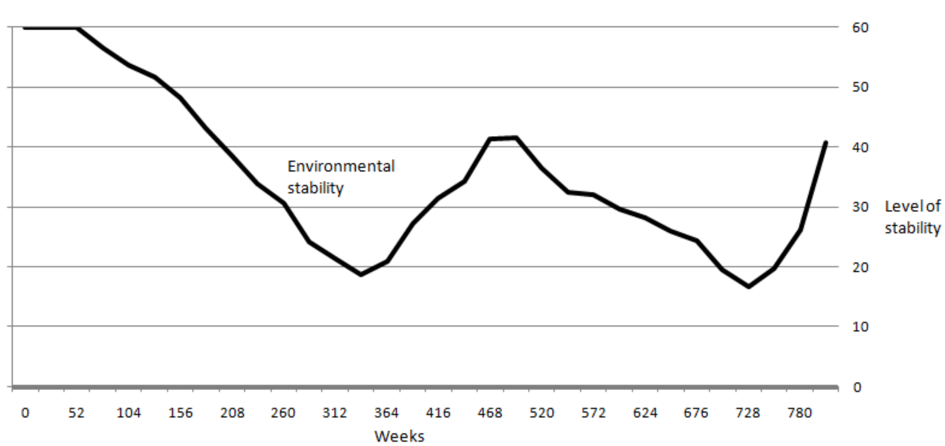
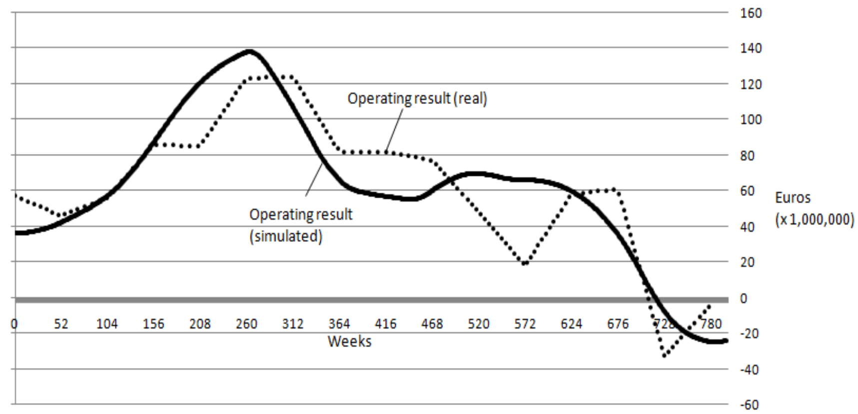
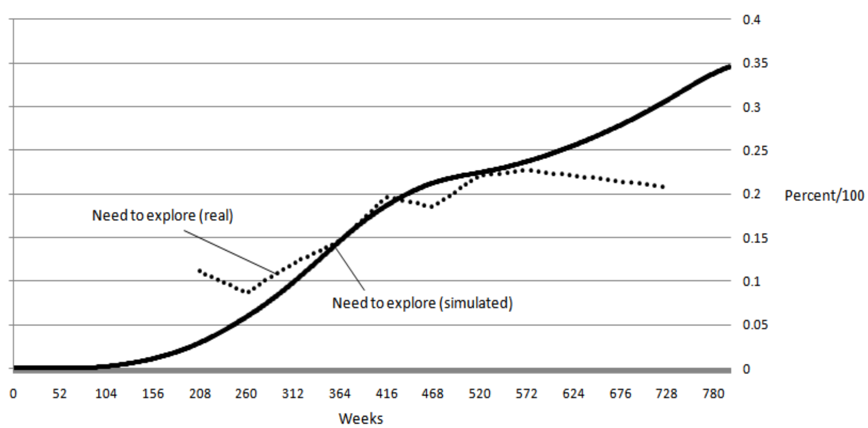


Figure 2: Graph for environmental stability (based on S&P 500).



Summary Statistics Historical Fit - Real and Simulated Operating Result	
n = 16	
R2	0.7169
Mean Absolute Percent Error	-0.0330
Root Mean Square Error	22.2385
Theil's Inequality Statistics	
Bias	0.0000
Unequal Variation	0.0004
Unequal Covariation	0.9995

Figure 3: The real versus simulated operating result.



Summary Statistics Historical Fit - Real and Simulated Need to Explore	
n = 12	
R2	0.7288
Mean Absolute Percent Error	0.2689
Root Mean Square Error	0.0622
Theil's Inequality Statistics	0.0000
Bias	0.1090
Unequal Variation	0.5636
Unequal Covariation	0.3274

Figure 4: The real versus simulated need to explore (the real NE is based on content analysis of annual reports).

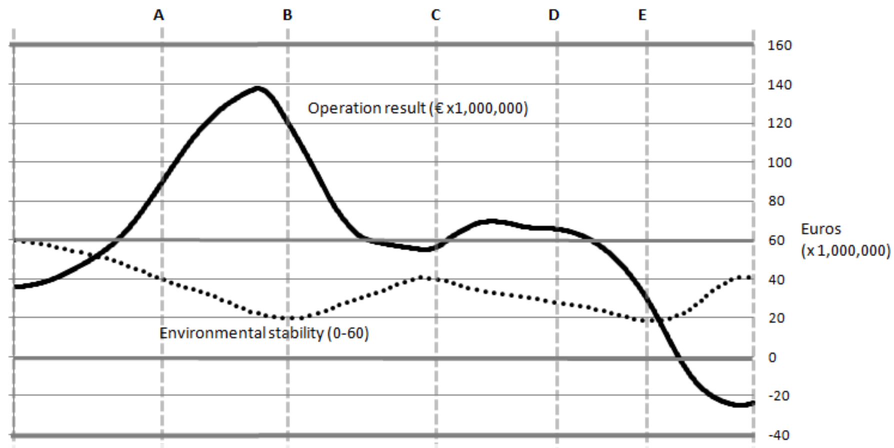


Figure 5A: Simulated operating result and environmental stability.

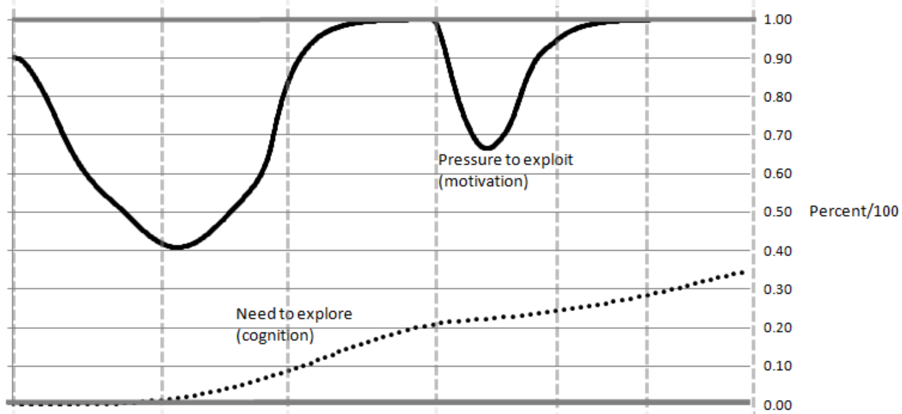


Figure 5B: Simulated need to explore and pressure to exploit.

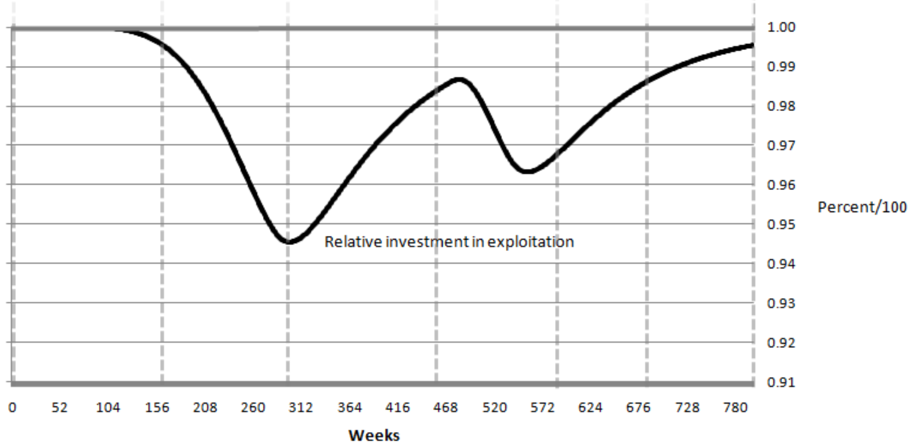


Figure 5C: Simulated relative investment in exploitation (balance).

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298	2010	An optimal approach for the joint problem of level of repair analysis and spare parts stocking	R.J.I. Basten, M.C. van der Heijden, J.M.J. Schutten
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