To Main Proceedings Document

"Firms as Resource Accumulation Systems: A Synthesis of Resource-Based and Evolutionary Models of Strategy-Making"

by

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[1] The author gratefully acknowledges financial support received by the Italian Ministry of Scientific and Technological Research within the research programme of national interest

Abstract

The article presents a model which integrates resource building decisions and intra-organisational ecological process model of corporate strategy-making. Firms are investigated as complex dynamic systems and the emerging dynamics of such systems are explored looking at the properties of the structure of feedback loops between resource allocation and accumulation.

The first section develops the conceptualisation of firms as resource accumulation systems. The second section briefly illustrates some evolutionary theorising on strategy-making. The third section merges the two approaches and develops a feedback model of corporate strategy-making and resource position evolution. Finally, a few simulation runs are presented and further lines of research are indicated.

1. CONTENT-ORIENTED RESOURCE-BASED VIEW OF THE FIRM

1.1 Firms as complex systems of resources and capabilities

In strategic management a vast body of literature, referred to as the resource-based view of the firm (RBV hereafter), focuses on the idiosyncratic characteristics of firms, stressing the role played by peculiar bundles of resources [Penrose, 1959; Barney, 1986, 1991], competencies [Prahalad & Hamel, 1990], capabilities [Nelson & Winter, 1982; Amit & Schoemaker, 1993] and dynamic capabilities and competencies [Teece, Pisano & Schuen, 1990; Lei, Hitt & Bettis, 1996; Helfat, 1997]. Building on these basis, firms can be investigated as very complex social systems [Sanchez & Heene, 1996; Sanchez, Heene & Thomas, 1996] and competence building and adaptation can be analysed as self-organising processes of such systems. Only few scholars, however, have focused upon the system characteristics of such bundles of resources and to the fact that firms' heterogeneity stems, rather than from a single asset, from the structure of interconnected resources.

Among these few, Dierickx and Cool [1989], in an innovative contribution, developed an interesting view of firms as complex and dynamic systems of resource accumulation whose behaviours is only partially directed and intended by decision-makers;

'System Dynamics simulation models for strategic management' coordinated by the Istituto di Economia Aziendale 'Gino Zappa' of Università 'Luigi Bocconi' of Milan.

and Sanchez & Heene [1996] and Sanchez, Heene & Thomas [1996] generated a theoretical model of the firm as a system of inter-chained gap-closing feedback loops.

Indeed, the very concept of capability has a systemic flavour. Amit and Schoemaker, suggest that capabilities are grounded in organisational processes that are *developed over time through complex interactions among firm's resources* [1993] In this sense, capabilities appear, using a chemical metaphor, as *compound assets* [Schendel, 1994].

At a higher level of abstraction, firms are *architecture[s] of organisational competencies* [Rumelt, 1995] or *hierarchies* of organisational capabilities [Nelson and Winter, 1982] and a firm's 'competence' can be seen as the '…ability to sustain the coordinated deployment of assets and capabilities in a way that promises to help a firm to achieve some desired results (goal) through specific actions.' [Sanchez, Heene & Thomas, 1996; p: 8]. The existence of a capability, for example, in marketing relies on an higher-order capability in hiring and training marketing people. The survival of the firm, however, depends on the higher-order strategic capability of deciding when and what capability in marketing ought to be developed[2]. Therefore, a firm's competence is crystallised in its ability to integrate and connect together resources and capabilities.

Yet, the relations among these different hierarchies of capabilities is complex. Not only higher-order capabilities explain lower-level capabilities, but these latter influence and direct the evolution of the former. Strategic decision-making, for example, as an ex-post rationalisation capability [Weick, 1979], is not an independent and illuminated act of creativity of a decision-maker but rather an activity strongly influenced by accumulated resources to which management is committed [Ghemawat, 1991], and by lower-level decision-making routines [Noda, 1994; Noda and Bower, 1996; Burgelman, 1983a] - in other words - by the structure of the organisation [Burgelman, 1983c].

In this light, firms are complex systems in which different hierarchies of capabilities affect and explain each other so that different layers of interpretations are inter-chained.

An analytical perspective emerges which, rather than focusing on how valuable resources generate advantageous competitive positions, emphasises how heterogeneity of a firm is shaped by the holistic properties of the system of inter-linked resources and organisational processes. Such perspective would study, rather than a particular valuable resource or capability, the whole system of firm's resources[3].

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[2] See Sanchez' levels of knowledge in Sanchez [1997b].

[3] See Sanchez, Heene & Thomas [1996] and Heene & Sanchez [1997].

Along these lines, major interest becomes the understanding of how resource accumulation systems evolve; and to what extent this evolution is intendedly directed, or spontaneously emergent.

In this respect, a number of authors [Montgomery, 1994] claim the utility of a cross-fertilisation between resource- and capability-based view of the firm and evolutionary theories. Such a marriage would certainly go a long way towards the explanation of how systems of capabilities evolve; some, for example, originating *core competencies* while others creating *core rigidities* [Leonard-Barton, 1993].

2. EVOLUTIONARY THEORISING IN THE PROCESS-ORIENTED STRATEGY STUDIES

Having conceptualised firms as a complex systems of interconnected capabilities and resources, and stated our objective of understanding how this system actually behaves, we next need a set of assumptions about the process that sets the system in motion. We need to understand which actors and decision-making processes are responsible for the aggregated behaviour of the system, and we need a system of hypotheses to address how firms decide which resources to grow and what organisational processes they want to improve. Of particular interest here is how firms decide how to allocate capital to develop and manage a portfolio of different assets and capabilities.

A major tenet of this work is that the strategy-process literature, and, in particular, recent evolutionary theorising, offers an interesting conceptual scheme to investigate how firms decide to accumulate resources, to build capabilities, and ultimately, to manage their asset portfolios.

2.1 The Bower-Burgelman model of strategy-making

In the strategy-proces literature, the Bower Burgelman (BB) process model, for example, has addressed how firms dynamically decide to allocate capital to different strategic initiatives, for building business level resources and capabilities [Bower, 1970; Burgelman, 1983 a,b,c]. According to this framework, strategy-making can be considered as *an iterated process of resource allocation* [Noda, 1994; Noda and Bower, 1996].

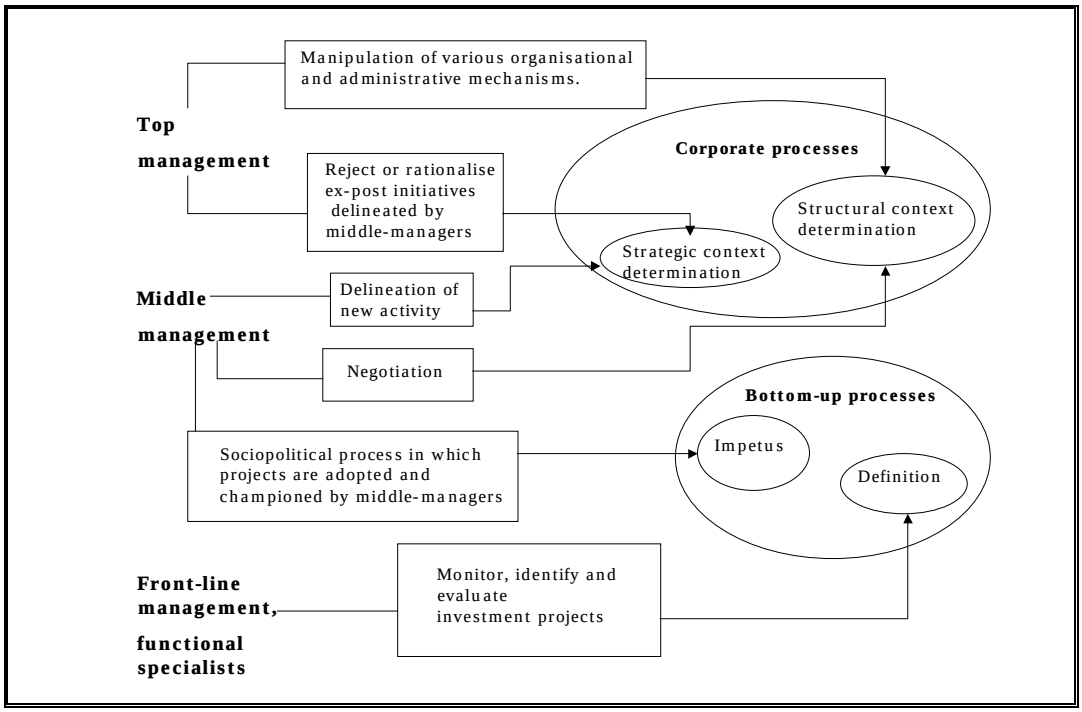
At the heart of this model is the analysis of corporate strategy-making into four sub-processes carried out by actors across three hierarchical layers.

The three groups of actors are top managers, middle managers and front-line managers. The four sub-processes are the two bottom-up processes of *definition* and *impetus*, and the two corporate level processes of *structural context determination* and *strategic context determination*. Figure 1 explain what role is played by each of the three groups of actors in the phases of the processes[4]. In the definition phase, strategic initiatives emerge from front-line managers who are closer to the market and possess specific knowledge and skills.

These initiatives may then be supported by middle-managers in the impetus phase. Top managers contribute to this process, by defining the structural context. The structural context includes the administrative mechanisms for framing bottom-up strategic initiatives in the definition phase, and for selecting initiatives in the impetus phase. In defining the structural context, top management are influenced by the current concept of corporate strategy [Noda and Bower, 1996]. Yet, middle-managers play in this process a relevant role by negotiating with top managers the configuration of administrative and organisational mechanisms. Strategic context results from top managers' *rationalisation* [Burgelman, 1983a,b; 1991], or learning, arising from the development of strategic initiatives. Strategic context is also influenced by middle managers *delineating new fields of business development* [Burgelman, 1983a and b, 1991; Noda and Bower, 1996].

Figure 1 – Key activities and processes in the B-B process model of strategy-making

[4] The diagram in figure 1 is adapted from Burgelman [1983a]. The reported diagram highlights only some among the key activities pursued by managers at different levels of the organisation.



2.2 Burgelman's intra-organisational model of strategy-making

The Bower-Burgelman model has been further developed by Burgelman [Burgelman, 1991; Burgelman and Mittman, 1994] who proposed an *intra-organisational ecological model* (IOEM) to explain organisational change and renewal. According to this perspective, an evolutionary variation-selection-retention framework underpins the process of corporate strategy-making. Variation is generated at the operational level by managers who pursue both *induced* and *autonomous* strategic initiatives. Induced initiatives are those that "*…are intended to preserve the coupling …with the organization's strategy*" [Burgelman, 1991: 245]; while autonomous initiatives are those that are *outside the scope of current strategy*. Strategic initiatives are then selected in the structural context, which works as a powerful internal selection mechanism. The structural context is influenced by values, beliefs, goals, and perceived action domain in top management's concept of strategy, which is the retained learning from implemented strategic initiatives.

This piece of work opened a promising thread of study providing a framework to interpret long-standing quandaries in organisational and management studies: (a) what the relative role is of managerial choice and environmental determinism in deciding the

trajectory of a firm's resource accumulation? And, (b) how do firms change such trajectories and adapt and what are the consequences in terms of long-term survival?

2.3 Characteristics of the Intra-Organisational Ecology Process

To explore the dynamic properties of an ecology of strategic initiatives and the consequences of these properties in terms of organisation evolution, it is important to highlight some peculiarities of the intra-organisational ecological model vis-a-vis other evolutionary models used in organisational economics studies.

A rich collection of studies has repeatedly used the ecology variation-selection-retention approach to investigate phenomena in social sciences. Such attempts range from Campbell cultural evolution, later applied to the study of organisational dynamics by Weick [1979], to Nelson and Winter's study of firms' capability evolution [1982] to, finally, Hannan and Freeman's population ecology approach to explain organisational change [1977, 1984, 1989]. In Burgelman's theory, corporate's strategy is an emergent process resulting from the evolution of an ecology of strategic initiatives that compete for scarce resources [1991].

First, in the intra-organisational ecological model, variation process is not completely random. Variation is influenced by the knowledge about the result of the selection forces of the structural context, by the knowledge of the results of the retention mechanism in the strategic context and by the content of opening business opportunities, finally, variation is constrained by extant organisational capabilities [Burgelman, 1991].

Second, whereas in other ecological perspectives the co-evolution between results of retention - new capability [Nelson and Winter, 1982] or new population [Hannan and Freeman. 1977] - and selection mechanism does not play a great role, here the results of retention - for example, emerging of a winning strategic initiative - plays a role in defining the future selection environment. In other words, according to the intra-organisational model, rather than evolution the process to be studied is the co-evolution among inter-linked processes of variation-selection-retention.

Third, in the population ecology perspective firms have not control of their evolutionary path in the sense that adaptation takes place at the population level through selection of not fitted organisations. Future path of evolution are mostly determined by characteristics of the environment, strength of selective forces and

unpredictable variation randomly generated. On the other hand, according to the intra-organisational view, the role of actors in the firms is more active.

In addition, in the intra-organisational hypothesis the role of actors is different from that played, for example, in Nelson and Winter [1982]. These authors, albeit leaving some degree of freedom for firms to adapt to evolving environments, do not consider intra-organisational dynamics. Single decision-makers in each organisation are responsible for implementing Lamarckian adaptation through imitation of successful routines. In Burgelman's IOEM, on the other hand, the role of decision-makers in the organisation is more complex to assess. In the intra-organisational theory, there are many locally and boundedly rational actors embedded in a complex structure of decision-making from which variation-selection-retention processes emerge.

Therefore, the focus of analysis becomes the co-evolution of inter-linked variation-selection-retention processes along with underpinning decision-making structures.

2.4 Intra-Organisational Ecology Process and the Feedback Approach to the Study of Complex Dynamic Systems

In Burgelman's framework, the structure of the intra-organisational ecology is composed of an interconnected web of locally and boundedly rational actors who interact through decision-making routines. The ecology can therefore be thought of as a dynamic complex system and the resource accumulation strategy of the organisation can be studied as the emergent behaviour of such system. The feedback approach suggests that behaviour can be studied by looking at the system's inner structure and, in particular, at the web of inter-linked feedback loops in which decision-makers are embedded.

Taking this perspective, the evolutionary framework could be fertilised by theories that are able to investigate the behaviour of complex dynamic systems. Three are directions along which such a cross-fertilisation could evolve.

First, the emergence of path-dependence an lock-in into resource accumulation trajectories, in response to environmental opportunities, on the one hand, and the lack of responsiveness to such stimuli, on the other hand, can be explained analysing the relative strength of, respectively, positive and negative feedback loops

in a specific corporate context. Negative feedback processes are considered variation-reducing mechanisms in their mitigating the momentum of innovative strategic behaviour in the organisation. Positive feedback processes, on the other hand, are considered variation-increasing mechanisms in their amplifying momentum of innovative strategic behaviour. For example, it has been found that selected strategic initiatives, by producing a successful track-record, may tilt internal selection in their favour thereby leading to resource allocation which facilitate further performances [Noda, 1994; Noda and Bower, 1996]. In this case, an event (initial selection and resource allocation) is endogenously amplified by a self reinforcing mechanism which breeds success to initially successful initiatives thereby originating a new trajectory of evolution.

If we consider selection mechanisms, they seem to have balancing, or negative feedback-like, dynamic properties: by eliminating strategic initiatives which dramatically deviate from a firm's accepted concept of strategy, selection mechanisms keep focus on the firm's resource accumulation trajectory. Selection mechanisms alone seem to increase the homeostasis of organisations; yet, when selection mechanisms are coupled with the retention mechanisms, which legitimate and reinforce successful innovative strategic initiatives, they might originate positive feedbacks that move the organisation away from its original resource accumulation trajectory.

Second, managerial action becomes appropriate to the extent to which is grounded upon the interpretation of the relation between feedback structure in the ecology system and emerging strategic behaviour. In the feedback view, the questions concerning determinism vs. strategic choice, and chance vs. necessity, becomes the dilemma between maintaining a rigorous homeostatic control over an ecology of strategic initiatives or saving a firm's capability to explore new trajectories riding positive feedbacks which push organisations away from their original trajectories .

Third, counterintuitive and chaotic behaviours, multiple equilibria and bifurcations are studied by highlighting the role played by non-linear relations among variables which in a dynamic system tend to alter the relative strength of feedback loops and therefore the dominant polarity of the system.

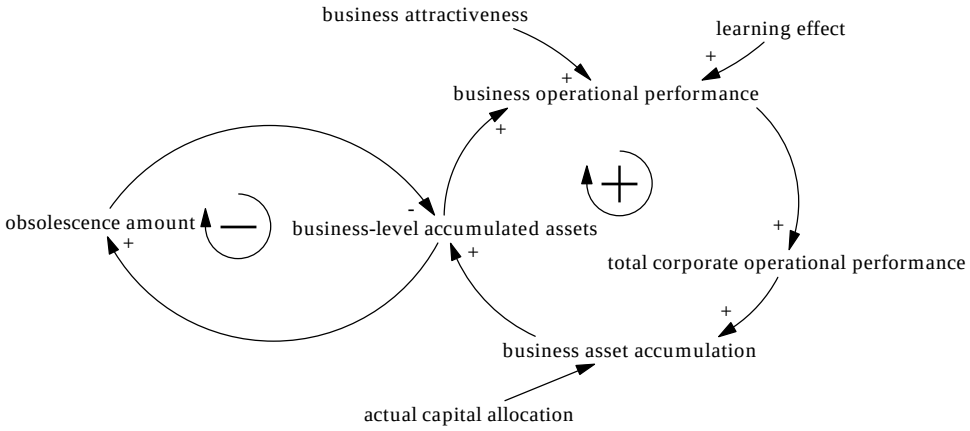
Unfortunately, this cross-fertilisation has never been accomplished. However, the potential gain from a feedback-based interpretation of evolutionary dynamics has been originally supported by Weick [1979]. Weick, in an important contribution, bridged the study of evolutionary dynamics to the feedback view developing a feedback-based interpretation to explain how a structure of inter-linked variables could generate a particular evolutionary path. However, to represent feedback structures and to study the relation between these latter and the emerging behaviour of a system requires a repertoire of conceptual and methodological tools that have often discouraged scholars in organisation and strategy literature. In Weick's study itself, for example, the hypotheses generated concerning the link between the feedback loop structure of a dynamic system and the fate of such a system is quite naive [Richardson, 1991].

3. EMERGENT FEEDBACK STRUCTURE

To speculate on the relationship between feedback structure and emergent resource accumulation behaviour, the IOEM has been translated into a feedback loop model.

Figure 2 represents a fundamental feedback structure in the organisation. On the right of the picture is the positive feedback which links business-level accumulated assets, business operational performances, total corporate performances and business asset accumulation. Such feedback crystallises a recurring dynamics in which organisation which accumulation of certain assets facilitate further accumulation. In general, Dierickx and Cool [1989] called these processes asset mass efficiencies, Arthur [1989] indicated recurring sources of self-reinforcing mechanisms and Noda [1994] explained how economies of scale and scope, and learning fuel an *economic-rational momentum*. In our model, given constant business attractiveness, as business-level accumulated assets increase, learning effects generate economies which trigger an increase in business operational performance, total corporate operational performances and therefore in the accumulation rate given a constant capital allocation.

Figure 2 - Organisation Growth and Limits to Growth



Positive feedback generally produce a characteristic behaviour which is an exponential growth. However, the negative feedback on the left of the picture give the more intuitive and immediate, though not the only one, limit to the exponential organisational growth. As accumulated asset grow exponentially, the amount of asset that each time period depreciates and needs to be restored increases. Exponential growth will take place only if asset accumulation rate is higher than the amount which each time period depreciates or becomes obsolete.

Figure 3 illustrates the main feedback structure. In the bottom right of the picture we can see the economic momentum marked as the positive feedback number 3. We can then see that other two positive feedback loops characterise the diagram. The positive feedback number 1 explains how as ROA[5] show a sustained increase in one business, reported ROA and perceived relative ROA follow. With a time delay, through the top management ex-post rationalisation process, corporate strategy will adapt to these information assigning higher weight to such a business in the business portfolio. As a consequence, the desired capital allocation in the structural context will shift in favour of such business and the pattern of selection will give precedence to induced strategic initiatives flourishing in such business thereby augmenting the proportion of capital assigned to the business. More capital assigned to the business, faster asset accumulation and therefore higher performance. Following Noda [1994], we will call such a positive feedback mechanism the cognitive-strategic momentum. In such process, results of past

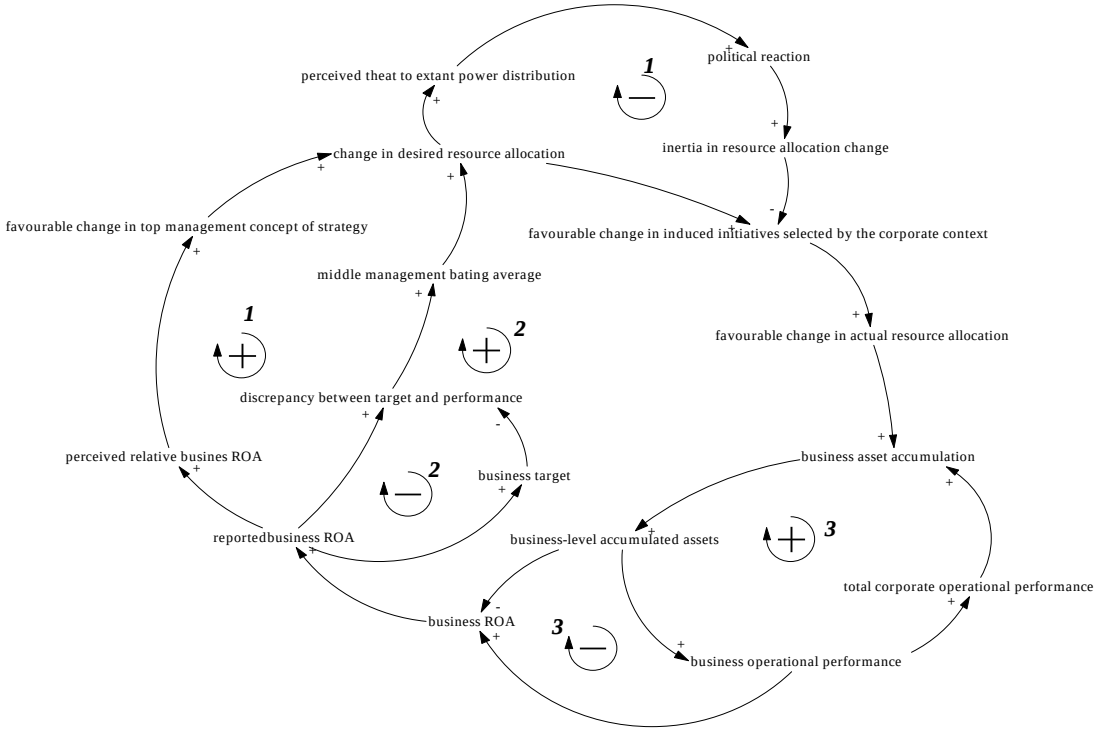
[5] Return On Assets.

action trigger a cognitive process of continuous re-assessment of business relative attractiveness. Such a cognitive process may lead to an incremental shift in the idea of corporate strategy.

The last positive feedback, the number 2, illuminates how increases of business ROA enlarge positive discrepancy between results and targets. Arising of better-than-expected results both boost middle managers reputation and gain their commitment. Increased reputation of middle managers (in the model referred to as middle management bating average) contributes to shift capital allocation in favour of the business where better-than-expected results were reported. Larger resources assigned to the business lead to higher performances and the virtuous circle starts again. Such a positive feedback is the socio-psychological momentum as reported by Noda in the study of the bell system break-up [1994].

In the main diagram in figure we also notice a number of negative feedbacks. Negative feedback number 1 depicts the political negative feedback. Such a feedback is one of the most powerful homeostatic mechanisms in organisations. The more dramatic the changes in capital allocation is, the stronger the perceived threat to the extant power structure will be felt and the more forceful the political reaction to change will be. As a consequence of increased political reaction, inertia increases and changes in capital allocation will be hindered. Negative feedback number 2 originates from the fact that, if targets are based on past experience, as past performances increase, target will also increase and therefore positive discrepancy between results and targets will reduce. Assuming a business in which results grow, reduction in such discrepancy will slower the rise in middle managers bating average and will therefore hamper further favourable shift in capital allocation.

Figure 3 - Main Feedback Structure



Finally, the negative feedback number 3 is minor loop emerging from the simple consideration that as business-level accumulated assets augment, expected operational performances must increase to obtain the same ROA. Therefore, if, for example, ROA increases in one business, and consequently capital allocation starts favouring that business, asset accumulation increases and accumulated assets follow thereby reducing the ROA.

In order to define a clear picture of the feedback structure of the ecology process model, table 4 summarises the main feedback loops which have been identified. Table 1 categorises the loops into negative and positive ones. The former loops linked to homeostatic-type processes which, given an exogenous stimulus, tend to keep the organisation away from its state, the latter generating self-reinforcing behaviour which, on the contrary, tend to amplify exogenous disturbances.

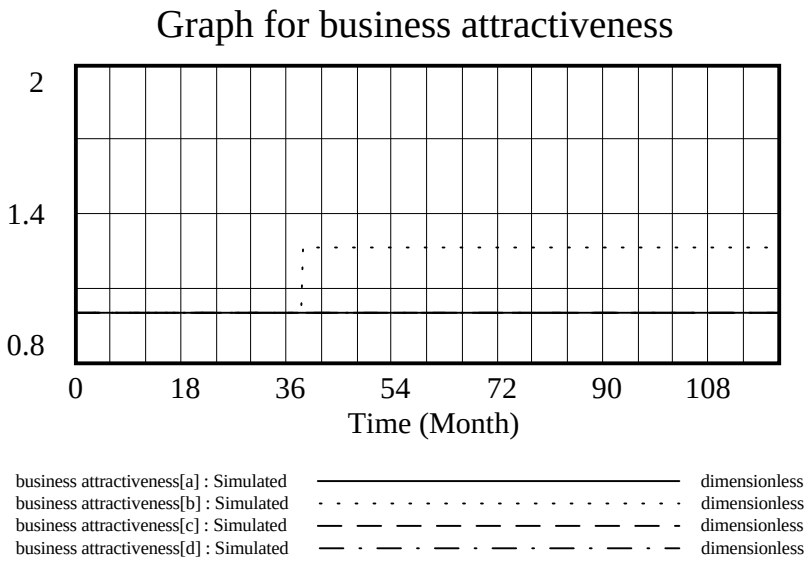
Table 1 - Mapping of the Feedback Structure

Homeostatic Processes-Negative Feedback	**Self-Reinforcing Mechanisms-Positive Feedback**
Asset depreciation and Limits to exponential Growth	Asset Self-reinforcing growth Economic Momentum
Political Structure Negative Feedback	Cognitive-Strategic Momentum
Aspiration Level Negative Feedback	Socio-Psychological Momentum
Selection Process Negative Feedback	
Minor negative feedback	

4. SIMULATION EXPERIMENTS

We tested the model by simulating a step increase in the attractiveness of one of the business in which the corporate is not operating (business [b] in graph 1). At time 0, the corporate is operating in business [a] and all the businesses have the same attractiveness (equal to 1, which is a neutral value). We assume that competing in the four businesses requires the accumulation of specific resources. Thus, entering a new business requires changes in a firm's resource accumulation pattern. In month 38, attractiveness in business [b] increases of almost 50%. This means that, it is, in general, convenient to enter business [b].

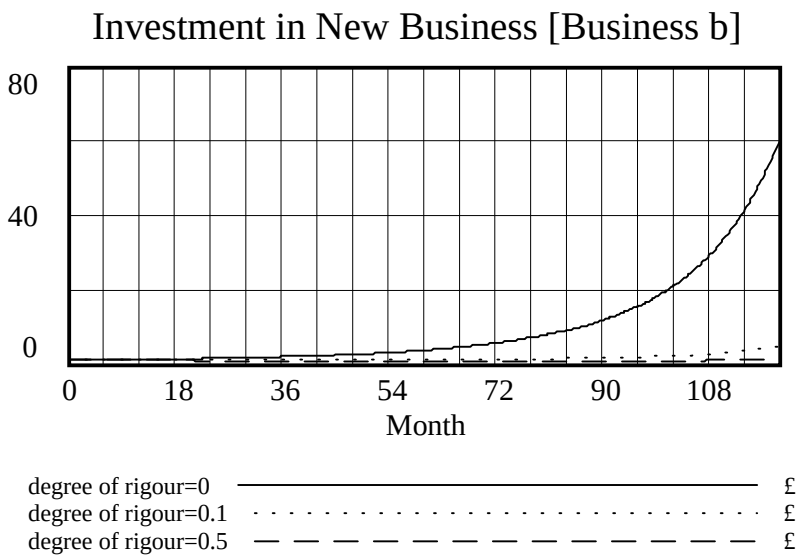
Graph 1



We analysed the behaviour of three different types of organisations. These three organisations have different degrees of rigour in selecting strategic behaviour and therefore are characterised by different level of corporate tolerance to deviant strategic behaviour. We observed their behaviours.

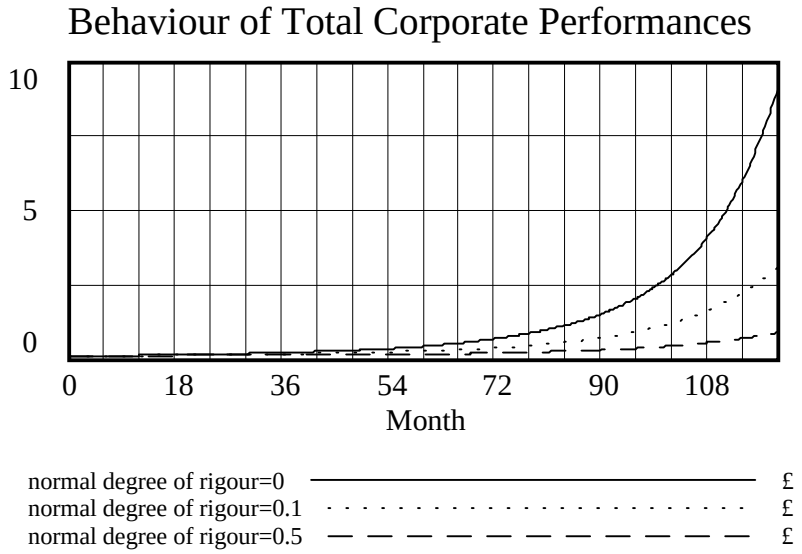
As described in graph 2, not surprisingly, the more rigid and less tolerant organisation decides not to enter the new business whereas the more tolerant organisations do enter the new business. The less tolerant organisation, driven by a number of positive feedback loops, remains locked in its traditional business. The only initiatives sponsored are those induced by existing corporate strategy and resource allocation rules. For low enough level of corporate tolerance to deviant strategic behaviour, resource allocation to business [b] is too low to fuel winning initiatives. This is so because economic momentum positive feedback pushes accumulation of assets and performances of business [a] whereas business [b] does not have a critical mass of asset to take over. Moreover, as relative performances of business [a] are boosted by the economic momentum, other two self-reinforcing mechanisms contribute to leverage such growth. As relative performances of business [a] increase, top management rationalisation over relative business performances and improvement of the bating average of middle management in business [a] rises, respectively, cognitive-strategic (positive feedback loop 1 in figure 2) and socio-psychological (positive feedback loop 2 in figure 2) momenta.

Graph 2



Interestingly, however, graph 3 shows how the more conservative organisation is the one whose total performances are the higher. This behaviour can be explained by the fact that by entering the new business, total corporate resources are dissipated among two businesses rather than focused on only one business and the economic momentum positive feedback is slowed. We can therefore say that the area below the solid curve and the other curves in graph 3 represents the cost of maintaining a strategic window over other businesses.

Graph 3



4.1 What can we learn from the simulation model of the intra-organisational ecology?

The presented simulation is useful to understand how the model contained in the article can be a way trough fertile areas of research.

First, the simulation model can be used to explore the interesting dilemma between reliability and adaptability, to address the subtle balancing of unambiguous corporate strategies and exploration and experimentation in new areas, and to investigate the choice between different postures in terms of tolerance to innovative strategic behaviours. To what extent it is worth to pay a price to maintain opened strategic windows? And, to what extent such considerations are influenced by ideas concerning the dynamic characteristics of the environment? For example, we might suppose that the choice of organisational posture is influenced by the expected variance and grain [Hannan and Freeman, 1989] of environmental changes. By simulating the model with different types of scenario, it is possible to understand if and why different organisational postures are effective in one kind of environment and not in another one.

Second, the intra-organisational ecology model is an attempt to conciliate two very different ideas concerning organisation evolution: strategic choice and determinism. Building on this base, we believe that our simulation model of the intra-organisational ecology should be used to illuminate a new concept of strategic choice as concerned with guiding the evolution of the ecology of strategic initiatives by calibrating the strength of the homeostatic processes (such as the selection process and power structure negative feedback loops) and self-reinforcing mechanisms (such as economic, socio-psychological and cognitive-strategic momenta) which characterise intra-organisational ecologies. To do so it is important to build a theoretical framework which addresses how the strength of the feedback loops are affected by decisions concerning different degrees of tolerance to deviant strategic behaviour, different levels of ambiguity with which corporate strategy should be defined, different regulations of the weight that financial criteria have in influencing resource allocation rules in the structural context and different settings of the time horizon which characterise report, control and evaluation cycles of the administrative mechanisms.

In our model all these variables have been operationalised and transformed into levers which can be manipulated. We therefore think that the model can produce a number of insights to generate a link between structures of corporate decision-making, features of intra-organisational ecology of strategic initiatives and emerging strategic behaviour.

Third, it is important to notice that in the presented simulations, we assumed that front-line managers could perfectly delineate the content of business opportunities. In future works we would like to introduce a different routines to model autonomous strategic initiatives which also considers a random element in the variation process.

5. DISCUSSION

The work aims at generating a model which could be a base for evolutionary theorising on firm strategy-making and resource position adaptation. It combines elements from intra-organisational ecological models of strategy-making with a system dynamic approach to the investigation of the feedback properties of firms as complex social systems.

Such complex social systems are characterised by a dynamic behaviour which is governed by the interaction of decision-making routines. To interpret such complex picture a feedback view is imposed upon it. The generated theoretical framework is used to address the dilemma between reliability and adaptability and between environmental determinism and managerial choice. To what extent can firms chose a position along a continuum and what are the consequences of such a positioning.

The choice between reliability and adaptability is illuminated by re-interpreting it, in the light of an intra-organisational ecological paradigm, as the choice of the relative weight of selection and variation processes and the degree of ambiguity in the definition of the corporate strategy which characterises intra-organisational selection mechanisms. Considerations about the rigour of selection mechanisms, however, lead also into the relative role of chance or luck [Barney, 1986, 1991], different initial condition, exogenous disturbances and constraints, on the one hand, and strategic choice, on the other, in forging the path of evolution of organisation.

This work investigates such questions by looking at the feedback structure that underpins the variation-selection-retention processes. According to such a view, the dynamic behaviour of an organisation is explained by the relative strength of emergent structures. Such structures are formed by the aggregation of two base type: negative feedback loops that are order maintaining, or homeostatic structures; and positive feedback loops, or disorder and homeoresis creating structures.

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