Untangling the origin of strategic innovation

A System Dynamics Approach

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Introduction

Innovation in strategic positioning enables companies to redefine the way to do business delivering more non-monetary value to customers with a high level of operational effectiveness; often, strategic innovators can change the competitive dynamics of industry and can influence the industry evolution processes [Baden-Fuller and Stopford, 1994; Markides, 2000]. Thanks to these flows of innovations they can remain competitive and achieve profitable growth within the current competitive environment, characterised by discontinuity, instability and uncertainty [D'Aveni, 1994].

The central problem in strategic innovation literature is to understand how it is possible to generate a constant rate of strategic initiatives that can contribute to the renewal of company strategy. To answer to this question we built a System Dynamics [Forrester 1961 and 1968; Sterman, 2000] simulation model to represent strategic innovation process integrating the results of studies on technical innovation and corporate entrepreneurship. Our main proposition is that the ability of a company to generate and implement innovation in strategic positioning is determined by three factors. Firstly it is related to the ability to govern the technical innovation process and in particular the development and diffusion of technical capabilities. Secondly strategic innovation processes occur in firms characterised by a certain degree of entrepreneurial orientation. Entrepreneurial orientation is deeply influenced by the introduction of organisational innovations that allow the release of the entrepreneurial energy embedded in the organisational structure. Thirdly, technical innovations become strategic innovations only if top managers are able to manage a process of integration through which they integrate new technical initiatives into the company's strategy.

The paper has been structured into three parts. The first step is dedicated to the exploration of the feedback relation between corporate entrepreneurship and strategy; the goal is to develop the theoretical basis for defining strategic innovation. In the second step the "stock and flow" model is presented. The third part is dedicated to simulation and results discussion.

1. A feedback interpretation of the strategic innovation process

Our model is based on the following three pillars:

- implementation of creative positioning;
- ability to generate technical innovations;
- introduction of organisational innovations.

Creative positioning. Innovative firms continuously generate creative positioning redefining the three dimensions indicated by Markides [1997]: who are the customers in terms of segments and geographical markets; what the new products are, their features and their price. Finally they how to deliver them. Creative positioning processes can involve the development of new products, new markets, new distribution channels and new strategic business areas.

Technical innovation. Creative positioning process can be sustained thanks to the integration into the strategy of the firm of technical innovations introduced in production processes and products [for a partial classification of different forms of innovation see:

Drucker, 1985; Van de Ven, 1986; Utterback, 1971; Henderson and Clark, 1990] Technical innovations are of two main kinds. Firstly, technical innovations can be introduced to improve the features of the product. This means that the innovations will contribute to increase the non-monetary value delivered by the company to customers sustaining the implementation of a differentiation strategy. Secondly, technical innovations can be introduced to increase the level of efficiency in product's production process and in the delivery of related services.

Technical innovations are *the ideal "trait d'union" between the ability to generate creative positioning, that determines the company's competitive advantage, and the diffusion of an entrepreneurial spirit at company level.* There are several ways in which the introduction of technical innovations can sustain creative positioning processes. A new production process can bring to an increase of level of product quality thanks to which the company can target a new market segment constituted by customers with a high sensibility towards quality issues. The introduction of product design innovations can simplify the number of components and the complexity of components design and can result in cost reduction. Cost reduction for a product can be the starting point for achieving strategic innovation because the possibility to achieve cost reductions can be very useful for sustaining a new position, for example with the introduction of additional service.

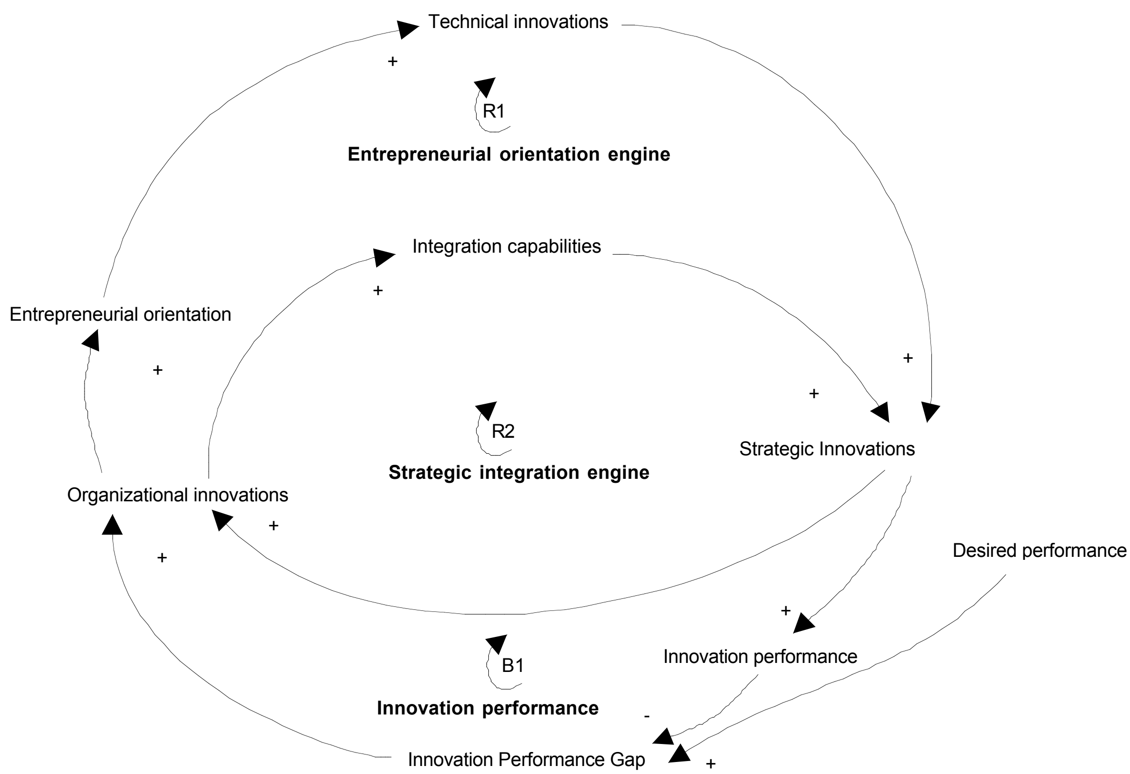
Organisational innovation. The third pillar of innovative companies is constituted by organisational innovations. Organisational innovations, which involve both soft and hard organisational variables, structure and processes, are typically finalised to instil bottom-up discipline and to release initiative capabilities in order to mould an organisational context which is entrepreneurial and disciplined at the same time. Organisational innovations have two goals.

The first goal of organisational innovation is to allow the release of the entrepreneurial energy embedded in the organisation, changing the entrepreneurial orientation of the firm. This energy is located in the middle level managers that coordinate the work of front line managers that have a direct contact with firm's operations: procurement, production, deliver, after sales service [Burgelman, 1983 a and b; Stevenson and Jarrillo, 1990]. These managers are an ideal engine for new initiatives and in particular, in our model, they are the generators of new ideas on the technical side. Organisational innovations act as a rate that regulate the emergence of new initiatives and can be activated to foster the emergence of innovative technical ideas as well as to slow it.

The second goal of organisational innovations is to integrate the "raw material" constituted by technical innovations, into new strategic positions. These innovations can also be defined as "integrative" because, thanks to their introduction, new initiatives that consist in technical innovations are integrated into the company's corporate strategy and contribute to modify company's position. These organisational innovations typically include: the creation of new business units or organisational units to deliver new products and services, the introduction of new procedures for resources allocation to sustain innovation implementation on a large scale, the redefinition of performance measurements to evaluate new initiatives. This *"integration process",* realised thanks to the introduction of specific organisational innovations, is a powerful means for balancing entrepreneurial energy, incorporated in the organisation with a certain level of strategic discipline.

New forms of positioning, technical innovations and organisational innovations constitute the main variables for interpreting in a dynamic way process of strategic innovation. Our analysis identified the existence of two main positive feedback loops and of a balancing loop among these variables (Figure 1) that represent the firm's innovative engine.

Figure 1. Feedback interpretation of strategic innovation processes



<u>*Entrepreneurial energy engine.*</u> The first feedback loop (Figure 1, R1) emerges largely from consolidated research findings on corporate entrepreneurship studies [Burgleman, 1983a and b, Baden-Fuller and Stopford, 1994]. The introduction of organisational innovations is positively related to the generation of new strategic positions via the generation of technical innovations. According to our interpretation, only a particular kind of technical innovations can be useful for strategy redefinition. Innovations in products and processes that allow the firm to reduce costs, increasing quality and no-monetary value for customers are the natural pre-requisites for implementing new forms of positioning [Porter 1996].

This clear relation is the starting point for highlighting the presence of a feedback structure. The redesign of the organisational structure and of administrative systems allows the release of entrepreneurial energy embedded in the organisation that can determine, for instance, the development of new products, processes, and the exploration of new business areas. Creative positioning has a direct impact on the behavioural context because it stimulates top managers to introduce more organisational innovations to foster entrepreneurial orientation. So there is a positive relationship between the introduction of new forms of positioning and organisational innovations.

A typical example of the dynamics of this feedback is constituted by the early history of 3M Corporation [Von Hippel, Thomke and Sonnack, 1999]. Under Mc Knight's chairmanship the company grew from a regional producer of abrasive material into an international company, a leader in the production of innovative accessories for office and industrial use based on adhesive technologies. Since the beginning, Mc Knight moulded an organisational context that allowed the emergence of bottom-up strategic initiatives which, progressively, enlarged the competitive scope of the company, introducing an increased managerial complexity that required further managerial system innovations.

The polarity of feedback loop R1 (Figure 1) is positive. The increase of the level of organisational innovations finalized to release entrepreneurial energy allows proliferation of new initiatives that, once integrated in the corporate strategy of the firm, determines the renewal of corporate strategy and the introduction of further organisational innovations. This reinforcing loop will be characterised by an exponential behaviour.

This means that the loop can have also an exponential decay if the state of a variable is affected by negative changes. The decrease of organisational innovations will determine a decrease in the flow of technical innovations and in the creative positioning processes. This is a typical situation of traditional or established competitors [Markides, 1999 a and b] that decide to preserve the status quo not renewing their strategic positioning and will undergo the "crystallisation" of the organisational situation. After a certain period of time, the less organisational innovations will be introduced to stimulate entrepreneurial orientation implemented, the less entrepreneurial orientation will emerge jeopardising the ability of the company to generate innovation.

Strategic integration engines. Feedback loop R2 is clearly regulated by the same logic that underpins the dynamic of feedback R1 (Figure 1). The introduction of organisational innovations can contribute to create the right environment in which to accommodate new strategic initiatives [Burgelman, 2002]. The polarity of this loop is positive. The increase of organisational innovations finalised at developing integration capabilities will effectively realise the strategic innovation potential of the firm. As we have seen in feedback loop R1 the more strategic innovations are implemented the more they will stimulate organisational innovations directed towards integrating technical innovations, because top managers realise that integration efforts provide positive payback.

When this feedback starts to work in a negative way the exponential decay will manifest its effects on effectiveness of strategic innovation. Technical innovations will remain isolated initiatives within the organisation, they will not receive the necessary support, in terms of organisational, physical and financial resources, to be translated into new forms of positioning.

Innovation performance balancing loop. Feedback loops R1 and R2 (Figure 1) are quite intriguing because they describe a well know dynamic in strategic management. However, alone they cannot explain why a firm decides to launch a process of strategic innovation, changing its entrepreneurial orientation to promote the emergence of technical innovations and to integrate them into competitive strategy.

The answer to the question is to be found in the traditional competitive strategy approach [Porter, 1980]. Inside an industry the level of rivalry is largely determined by firms' ability to introduce new forms of positioning. Top managers appreciate this process of new positioning development and implementation and on their observations, they set a desired level of strategic innovation. They appreciate the ability of their firms to generate new forms of positioning making a continue comparison with the average level of innovation in the industry. This is consistent also with studies on hypercompetition processes. According to D'Aveni [1994] stimuli to innovation come from the level of turbulence of the competitive environment. Such a competitive environment will stimulate top managers to appreciate the gap between the actual level of company innovation and the desired level of innovation.

This gap is the result of a process of perception of top managers that set a desired level of innovation that is a goal to be reached stimulating the spread of entrepreneurial orientation inside the firm; an increase of EO determines the development of new initiatives on the one side and the development of integration capabilities on the other.

The presence of the gap with an external target will characterise the negative feedback B1 (Figure 1) that can be called *"innovation performance loop"*. It will work until equilibrium has been reached between the desired level of innovation and the actual level of innovation. The balancing loop will also act as a limit to growth for the strategic innovation processes. The stimulus to generate organisational innovations for top managers can vary according to different level of competitive pressure within the industry. The gap will progressively reduce until the firm reaches the optimal level of strategic innovation and this will slow and subsequently stop organisational innovation and the generation of strategic innovation.

There are two considerations that must be made regarding gap dynamics. Firstly, according to the research findings of D'Aveni [1999] and Markides [2000], a company will never abandon its desire to introduce strategic innovations in current competitive environments, this will mean that every time the gap reaches its minimum value it will be opened again because the external competitive pressure sets higher goals in terms of innovation. The second consideration concerns the perception of the gap. The gap is influenced by management perception, and the perception of managers will be influenced by their mental models. Different top managers will appreciate in a different way the gap in terms of the generation of new positioning and consequently will act differently to reduce it. This point of the perception is particularly important and represents an innovative feature of our conceptual model. D'Aveni [1994, 1999] highlighted how firms react instantaneously to changes in the competitive environment by launching competitive escalation. In our model the creative positioning process and its intensity are strongly influenced by top management's perception. This means that top managers don't react instantaneously to external stimuli. For example conservative top managers, due to their mental model, can have difficulties in appreciating the necessity of innovate positioning and will be induced to respond slowly to environment modifications.

2. Stock and flow model

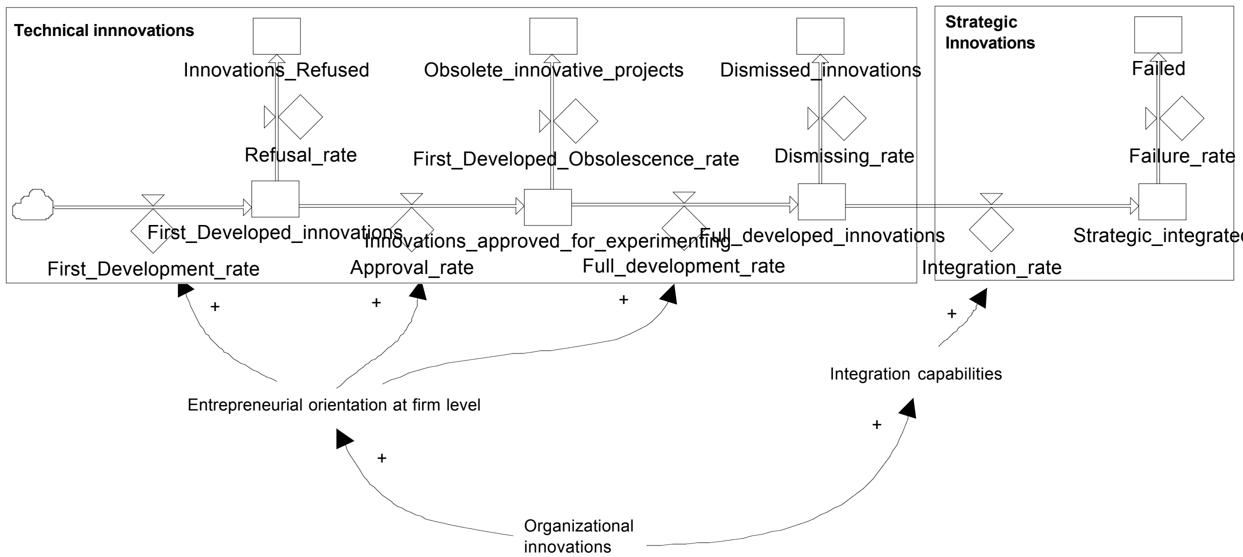
The design of the stock and flow diagram (SFD) is organised around the idea of creating a distinction between different stages of innovation[1]. The process of innovation can be articulated into different steps that represent the flow of innovative ideas inside the organisation. Each step can be modelled as a stock. The passage between different steps is regulated by rates that are activated by auxiliary variables.

The idea that the process of innovation can be modelled through different stages is widely accepted by management scholars. Quinn [1980] describes the process of corporate strategy formulation articulated into different stages. Van de Ven [1986] distinguishes four stages in the process of idea generation. Burgelman [1983a], while studying process of internal corporate venturing, points out that there are three stages in the generation of new projects. These stages require the collaboration of different actors that interact with innovators and allow the effective translation of innovations into new strategic initiatives.

According to our general construction we adopted a “pipeline of innovation” to represent the innovation process in which technical innovations flow (Figure 2). The flow is influenced by the introduction of organisational innovations. The last state of the process of innovation is constituted by strategic integration. At this stage technical innovations became strategic innovations because they are incorporated in the strategy of the firm contributing to firm’s strategic positioning modification.

[1] The mathematical model was built with the software Powersim Constructor 2.51. All equations formulation and Stock and Flow Diagrams SDF graphical representations are taken from the Powersim built model. For a complete list of equations please refer to the paper’s support material (Annex 1).

Figure 2. General view of the pipeline of innovation



The pipeline of innovation is characterised by four stocks, state variables, in which innovations accumulate and from which innovations depart for the following stage. The rates that regulate the flow of innovation are influenced by variables representing organisational innovations. These variables, that we will illustrate, represent two kinds of organisational innovations: the ones introduced to release the entrepreneurial energy and the ones introduced to integrate in the corporate strategy of the firm new technical initiatives.

2.1. The pipeline of innovation

In the following we will illustrate the main stocks that describe the pipeline of innovation.

Innovation developed. This stock represents technical innovations developed by middle level managers. Technical innovations allow the improvement of productivity or increase the ability of the firm to deliver more no-price value to customers. In our model, top managers decide that a certain level of innovation is optimal to sustain strategic regeneration. They don't define the contents of innovation, they only address middle level managers efforts to obtain technical innovations that enhance productivity and no-price value. Our conception of technical innovation at this stage is close to the concept of autonomous strategic initiatives [Burgelman, 1983c, 1985]: top managers define only broad goals that can be considered as a basic strategic orientation. Middle level managers can constantly propose innovative projects that respect the general strategic orientation of the firm coordinating front line managers. Middle level managers are agents of innovation because they formally generate new ideas basing on their knowledge.

Innovative ideas became technical innovation propositions when they are presented in a formal way to top managers according to the organisational procedures of the firm. New technical ideas must be presented to top management in a format that contains a preliminary analysis of potential benefits and cost of development. This is coherent with Van de Ven [1986], Van de Ven and Scott Pole [1990] and Burgelman [1983a] interpretation for which the formal manifestation of the new idea is the moment of starting the innovation process.

The initial value of the rate has been conventionally set at 1 to initialise the system. The analytical formulation is the following:
First_Developed_innovations = 1
*-dt*Refusal_rate*
*-dt*Approval_rate*
*+dt*First_Development_rate*
Unit of measure: innovations

Innovation approved for experimenting. This stock copes with the problem of the small scale application of innovation. Van de Ven [1986 and 1990 with Pole] while exploring new ideas generation process inside an organisation, explicitly pointed out the importance of experimenting. Experimenting is the phase during which organisation creates consensus around new ideas, that are adopted and then translated into tangible effects. The concept of experiment is recalled also by Markides [2000] when he investigates strategic innovation processes. The new strategic positioning must be implemented on a small scale before being implemented on a full scale.
For these reasons top mangers before proceeding to the full development decide to approve the small scale development that is a sort of test for the innovation before the full development process.
The initial value of the present stock as well as of the other stocks of the pipeline of innovation is set at 0, because it will be fed by the approval rate. The analytical formulation is as follow
Innovations_approved_for_experimenting= 0
*-dt*First_Developed_Obsolescence_rate*
*-dt*Full_development_rate*
*+dt*Approval_rate*
Unit of measure: innovations

Full development innovations. Once the idea of a technical innovation is approved it passes through a complex process of implementation. This is an elaborated process can has been well described into three phases by Utterback [1971]. The first is industrialisation during which the final project is developed considering problems related to its production and delivery during this phase the project can be modified and the initial idea can undergo substantial changes. After industrialisation, there is the phase of prototyping is in which the features of product are tested and also in this phase changes can be done. Only after prototyping is the new product released for production. These three phases can be easily applied also to the development of a new production process or of new service. With the introduction of this stock we aim to capture the contribution of industrialisation and prototyping to the strategic innovation process.

The initial value of the stock is 0. The analytical formulation is as follow:
Full_developed_innovations = 0
*-dt*Dismissing_rate*
*-dt*Integration_rate*
*+dt*Full_development_rate*
Unit of measure: innovations

Strategic Integrated innovations. This is the "critical" stock in which technical innovations are transformed into strategic innovations. Technical innovations are suitable to become strategic innovations only if they can contribute to redefinition of the value proposition of the firm. For example the introduction of a new innovation into the production process can contribute to the redefinition on "how" the product is delivered, but it does not necessarily influence a modification in the "what" and the targeted customer segment. Only technical innovations that can sustain strategy renewal allow the constitution of new strategic positioning. If an innovation cannot contribute to the value proposition redefinition it is not destined to become a strategic innovation.

The initial value of the stock is 0. The analytical formulation is as follows:
*Strategic_integrated = 0 -dt*Failure_rate +dt*Integration_rate*
Unit of measure: innovations

Failed strategic innovations. The last stock is built to receive failed strategic innovation. Technical innovation, once integrated, becomes new forms of positioning of the firm. New positions include the entrance into new markets, new targeted segments with new products. These new forms of positioning can be successful or can fail, in this latter case the firm will abandon them and continue to retain its previous position. At the same time when one position is obsolete, due the competitive environment evolution, it will be replaced by a new form of positioning [Markides, 2000]

The initial value of the stock is 0. The analytical formulation is as follows:
*Failed = 0+dt*Failure_rate*
Unit of measure: innovations

2.2. Rates and auxiliary related variables

To regulate the flow of innovations toward stocks we adopted the following kinds of variables.
1) the first are <u>*main rates*</u> that regulate the flows of innovations directly from the stocks;
2) the above mentioned rates are influenced by <u>*auxiliary variables*</u>. These variables essentially represent the dynamic of entrepreneurial orientation at firm level.
3) Stocks <u>*outflows*</u>. All stocks include outflows that represent failure rates, or, in other words, the rate at which innovative ideas become obsolete and are abandoned.

In the following we shall illustrate main rates and structure of auxiliary related variables.

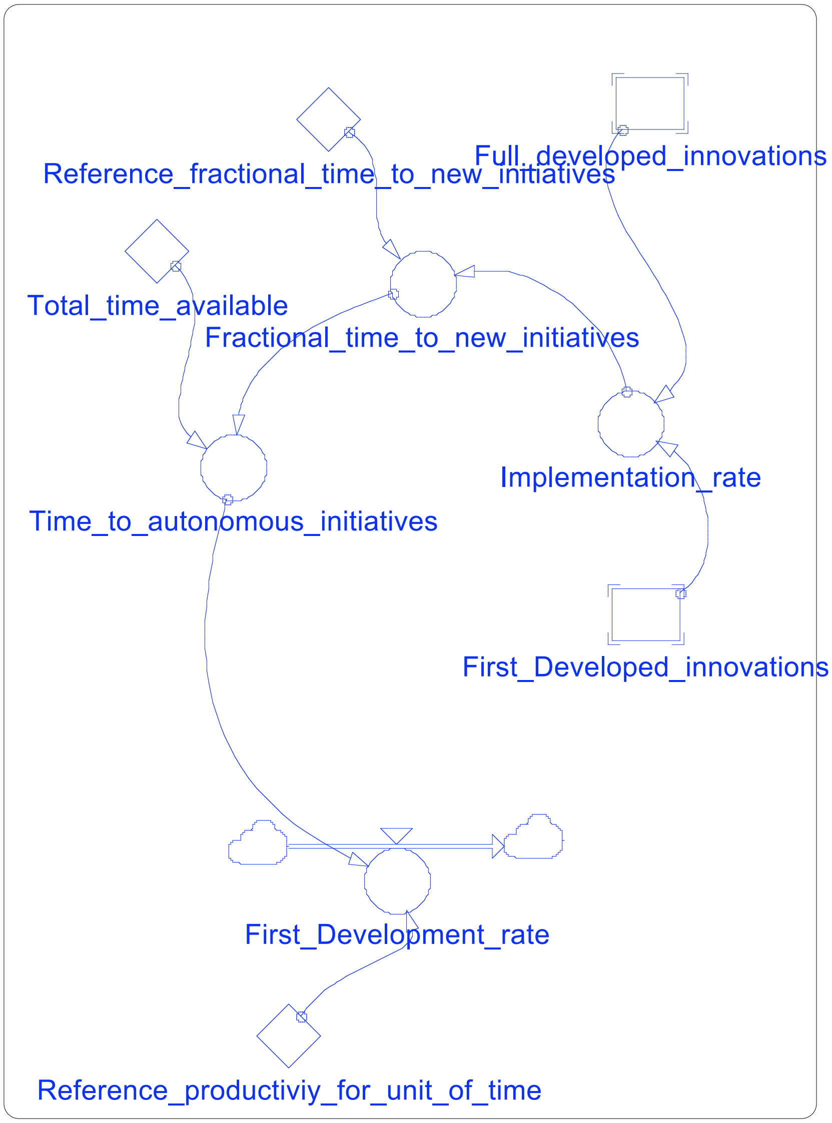
First development rate
To represent process of strategic innovation we adopted a generative model for which

innovations occur from the entrepreneurial activities of middle level managers that generate innovative ideas. Top managers want new ideas that can improve productivity and increase the no-price value delivery to be generated. For this they grant a certain level of autonomy to middle level managers

Autonomy concerns the independent action of an individual or of a group of individuals (organisational unit) in developing an idea and bringing it to completion. In this way autonomy is the result of the efforts of the individual in organising the resources that he directly control to the innovative idea. Autonomy can be intended also as freedom to act with respect to organisational constraints that can jeopardise the generation of new ideas [Lumpkin and Dess, 1996]. For this reason it is necessary to adopt a definition of autonomy that takes into account these two dimensions: the entrepreneurial ability to generate autonomously a new idea and the entrepreneurial behaviour to develop it even if there are some internal constraints. The autonomy level is set by top managers that can act to promote autonomous behaviour. For example they can change the organisational structure by flattening hierarchies and delegating authority to operational units [Pinchot, 1985]. These moves are intended to foster autonomy, but the process of organisational autonomy requires more that a design change. Autonomy is also the result of the impetus exercised by a champion who sustain the autonomous efforts to develop the ideas [Burgelman, 1985]. We choose to model the level of autonomy in the first development rate because it represents essentially the outcome of genuine efforts of middle level managers that commit their direct resources (time and managerial capabilities) to generate strategic initiatives.

We focus on managers operating in non-R&D (Research and Development) organisational units that do not perform research and development as a characteristic activity. Our idea of technical innovation is slightly more articulated. The generation of technical innovation in concrete terms is the incorporation into products, processes and services of technical knowledge accumulated into the R&D units of the firm. This formulation has been adopted for two reasons. Firstly we are not interest in the ordinary R&D activity flow, but in the strategic output of R&D that can constitute the basis of a new strategy. The generation of knowledge inside an organisational unit that has as its objective the continuous generation of technical innovation (R&D unit) is not intriguing for us and can hardly be related to the generation of strategic innovations. Secondly, the research and development activity of an R&D department is its characteristic and ordinary activity. Inversely, we are interested in understanding how middle level managers can incorporate into their ordinary activities - they can be involved in ordinary firms' tasks and functions as production, distribution, marketing and services – innovative ideas built on the top of the technical knowledge of the firm. The content of the development of technical innovations by middle level managers consists of analysing market opportunities, effecting environmental scanning, then of recognising company resources and competencies, and finally in formalisation. With formalisation of the innovative proposal all the analyses made are included in a document that is delivered to top managers for approval.

Figure 3. First development rate graphical representation



The formulation of the development rate depends on two variables: time dedicated to innovation and productivity of middle level managers. Time should be intended as the time that middle level managers can allocate - according to top managers decisions - to innovative project development. Normally middle level managers concentrated on ordinary tasks and only a small portion of time is allocated to innovative projects production. In the model we presumed that top management plan the time that can be allocated to new initiatives as a fraction of the total time available for all company tasks. This is consistent with the idea that the process of innovation is governed at the beginning from a top-down perspective [Burgelman, 1983a], that do not directly induce new initiatives, but illustrate the goals and act to introduce the right administrative mechanisms to allow the bottom upwards emergence of initiatives

Time definition in the model must not be intended as a complete informal time dedicated expressly to generate new initiatives as happened in the case of 3M Corporation [Von Hippel, Thomke and Sonnack, 1999] in which all managers have a certain amount of time to develop new initiatives. Time to generate innovation includes the following definitions of time:

- the time that middle level managers spend to get into contact with R&D departments to capture the knowledge capabilities in terms of new products and services;
- the time that middle level managers spend with customers understanding their needs;
- the time dedicated to analysing the internal process that can be improved thanks to technical innovations.

All the above mentioned ways of time allocation are the result of a disciplined organisational context characterised by the introduction of rules that push time allocation devoted to the generation of new ideas.

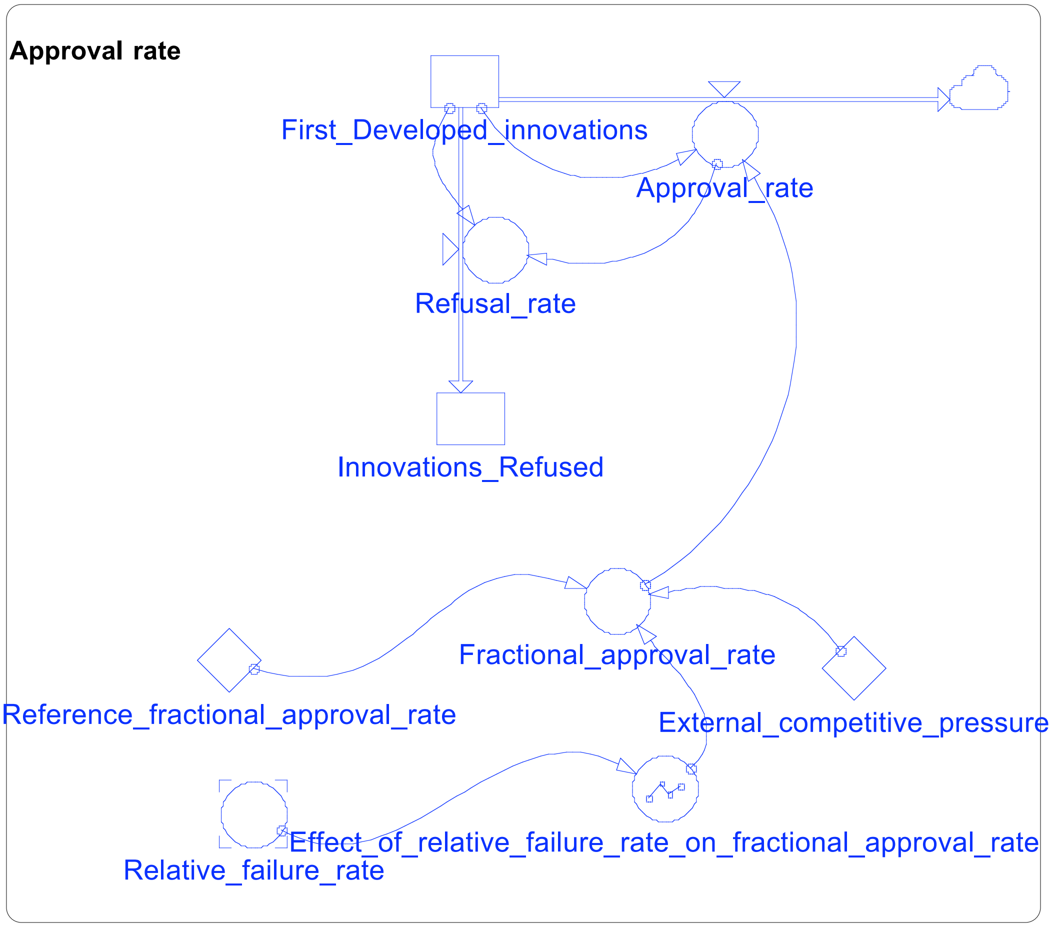
The time allocated to the development of innovative projects in conjunction with the productivity of middle level managers determine the rate at which new projects are implemented. The productivity is expressed as the number of innovative projects that middle level managers can develop per unit of time. This variable expresses the reference productivity of middle level managers in generating innovation. However the subtle interpretation of the variable shows that it can represent the effort of top managers to generate autonomous strategic initiatives in addition to the standard productivity. Of course this will require a specific structure of the model to exploit factors that stimulate productivity, for example the introduction of an articulated incentive structure. However, also if we recognise the importance of this argument, we prefer to keep the model structure as simple as possible to focus on the relationship among three forms of innovations.

We introduced the hypothesis that the fraction of time that can be dedicated to innovative initiatives can be influenced by the implementation rate. This variable is the expression of the desire of top managers to keep the innovation process in equilibrium. We adopted this hypothesis even though it is necessary to consider that scholars have emphasised that, in order to promote a certain level of chaos inside an organisation it can stimulate further innovation [Burgelman, 2002]. We interpreted chaos as a negative effect of innovation process that top managers want to govern. For this reason they have constant control over the projects that are fully developed. If the fully developed projects increase compared with first developed projects, top managers will act to increase the autonomy of time to foster the presentation of innovative projects. On the contrary if the first development rate is too high with respect to the full development rate, top managers will reduce the autonomy of time to reduce the arrival of new initiative that should be processed in the pipeline.

Approval rate
The approval rate is the rate at which first developed projects are accepted. Refused projects will enter into a specific stock with a refusal rate that is equal to the difference between the total projects in the stock of presented projects and the approval rate. The approval process consists in the analysis of the projects presented by middle level managers. Approval is based on the quality of analytical reports made by middle level managers.

The approval rate in the model was linked to a dimension of entrepreneurial orientation called innovativeness. *"Innovativeness reflects a firm's tendency to engage in and support new ideas novelty, experimentation and creative processes that may result in products, services or technological processes"* [Lumpkin and Dess, 1996: 142]. Innovativeness can be seen as the willingness to explore new technical alternatives giving the necessary authorisation to develop it. According to Lumpkin and Dess [1996] the evidence at firm level of innovativeness can take several forms. Innovativeness may occur along a continuum from simple willingness to try a new product line or experimenting with a new advertising venue to *"a passionate commitment to master with a new product"* [Lumpkin and Dess, 1996: 142]. The approval rate is mainly an expression of the dimension of innovativeness of entrepreneurial orientation. Top managers should approve presented projects only based on a report that contains a technical and market analysis. In fact projects presented are little more than a theoretical exercise by middle level managers. New ideas are not subjected to a process of prototyping, no market response was analysed, for example, with structured interviews. The projects presented are essentially the output of an internal resources analysis conducted by middle level managers combined with their "imagination" - the new idea - about the potential effects of innovation. In this condition it is evident that the approval rate is essentially a function of the willingness to *engage in and support new ideas and novelty* – the innovativeness – of top managers. Innovativeness at firm level is directly influenced by top managers that, in our model, modify procedures, introducing organisational innovations, to regulate the approval of first developed project.

Figure 4. Graphical representation of approval rate

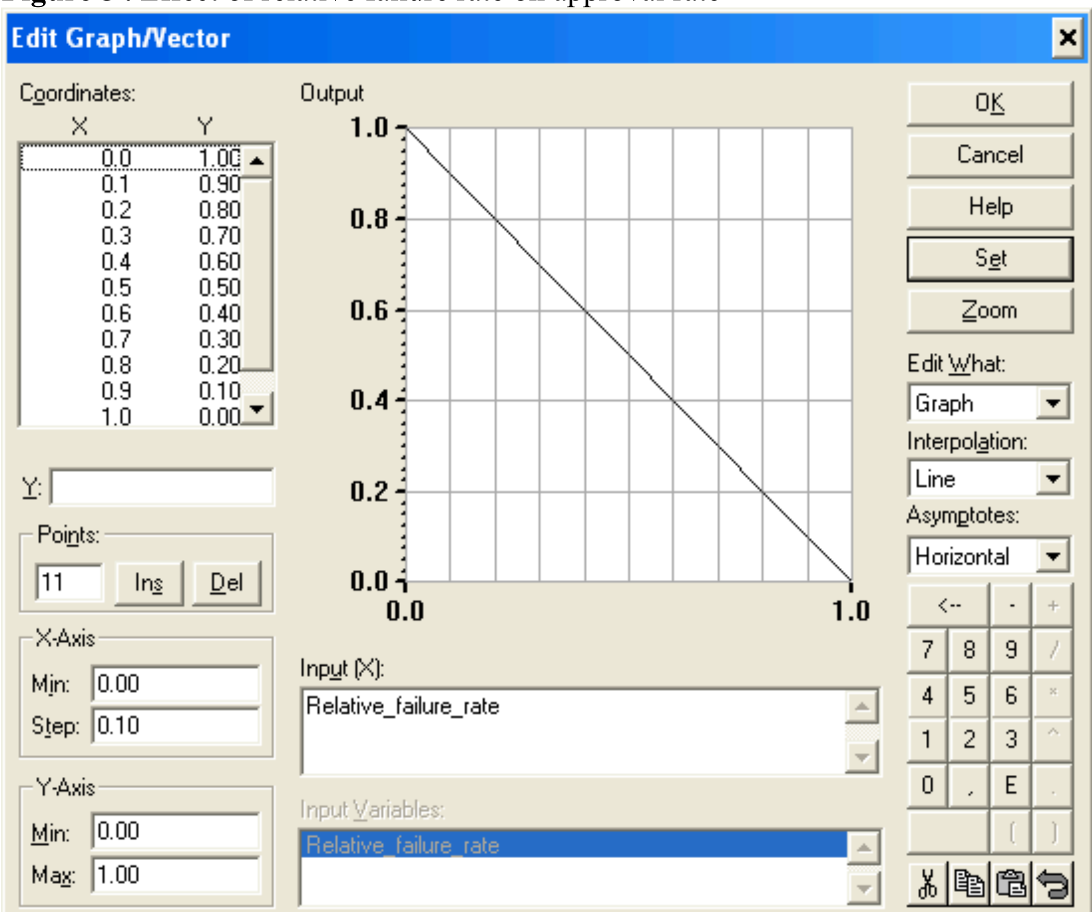


The mathematical formulation of the model's approval rate is similar to the previously analysed variable. Top managers set a standard approval rate. This represents their reference attitude towards innovativeness, because it is the expression of what percentage of innovative project they want to implement. The reference approval rate can be modified by two other variables: external competitive pressure and the effect of failure rate.

The external competitive pressure is a variable that can assume values comprised between 1 and 2. The value 1 identifies a traditional competitive environment and it has no effects (negative or positive) on approval rate, a value of over 1 identifies an increased competitive pressure determined by rivals, a value of 2 identifies a competitive environment characterised by a high competitive pressure of the kind described by D'Aveni as hypercompetitive [1994]. The external competitive pressure multiplies the reference approval rate and boosts it in the case of increased rivalry. This happens if we consider that top managers act to close the gap between desired innovation and actual innovation. If competitive pressure is high, top managers would like to have a higher innovation rate to renew their strategy, for this reason they will boost the approval rate.

The second variable affecting the approval rate is the effect of the relative failure rate (Figure 5). The relative failure rate is the result of the ratio between the failed strategic innovations and the integration rate. It expresses the constant monitoring of the strategic innovation effectiveness by top managers. Top managers appreciate the speed of strategic innovation failure comparing it with the strategic innovations that are on the way to be fully developed. The higher the failure rate, the more the approval rate will fall. No multiplying effect has been included, because the failure rate can act simply as a brake to the innovation process [Van de Ven, 1986].

Figure 5 . Effect of relative failure rate on approval rate



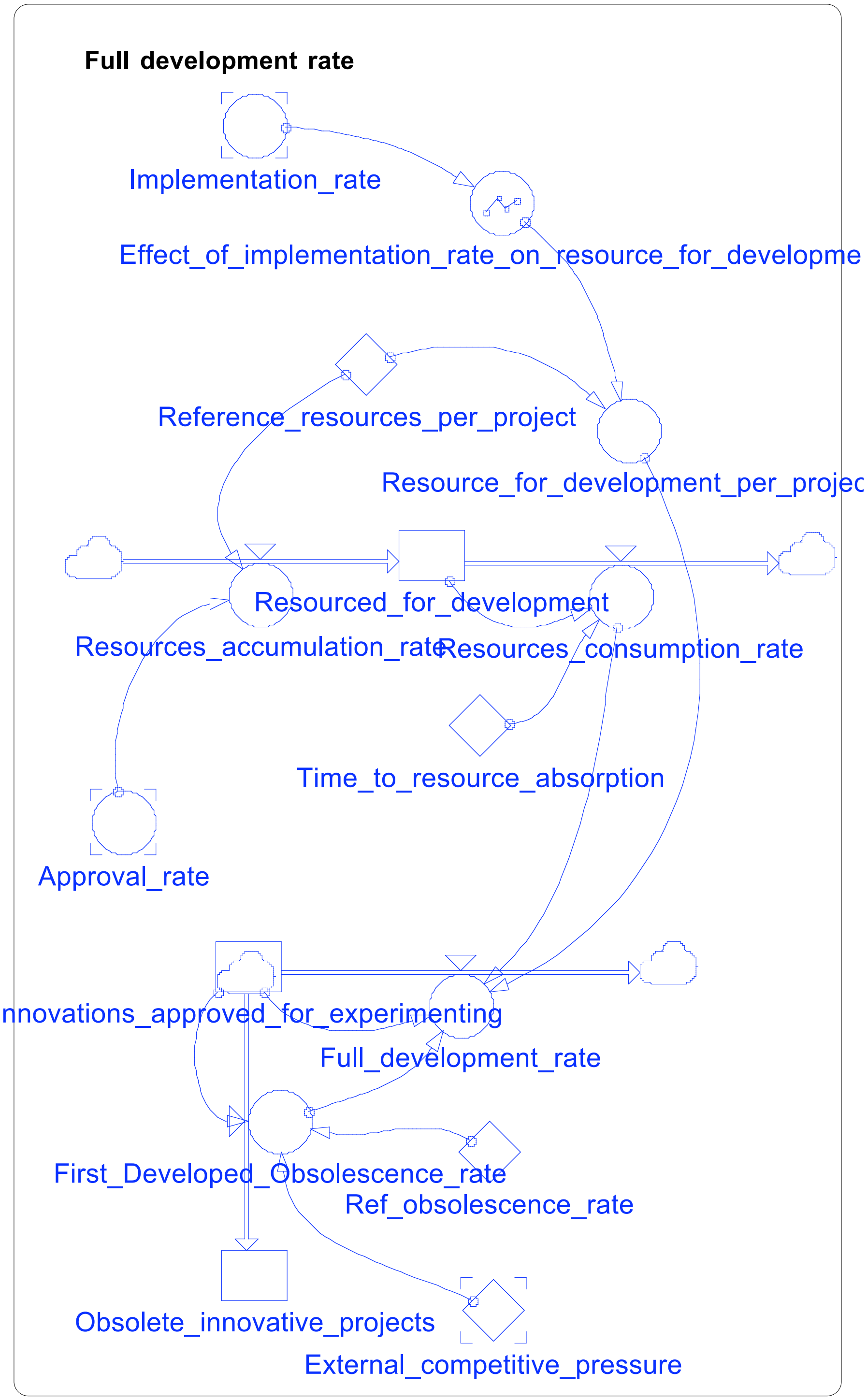
Full development rate

Full development rate is the rate at which technical innovations are fully developed. Full development means that the project has undergone a process of industrialisation, pre-production and introduction on a small scale. In the case of the introduction of a new product, it will be industrialised, tested with prototypes, produced and finally introduced on a small scale.

In our model the full development rate is linked to the *risk taking attitude* of entrepreneurial orientation. This dimension refers to the in-depth origin of entrepreneurial literature that emphasised the fact that the entrepreneur works for itself and assumes a certain level of personal risk [Lumpkin and Dess, 1996].

The assumption that entrepreneurial behaviour is linked to the self-employment dimension and the to the risk is widely accepted by the literature.
Many scholars have focused on risk propensity defined as the perceived probability of receiving rewards associated with the successful outcome of a risky situation [Brockhaus, 1980, Kogan and Wallach, 1964, Sitkin and Pablo, 1992].
A broader definition of the risk taking attitude is the one given by Miller and Freisen [1978: 923] and it is particularly suitable for internal entrepreneurship because they identify risk taking "*as the degree to which managers are willing to make large and risky resource commitments – i.e. those who have a reasonable chance of costly failures"*. The idea that risky behaviour is essentially expressed by the commitment of resources is quite intriguing. The commitment can be on organisational or physical resources and, in our innovation model, can be made by top mangers on middle level mangers as innovation proposals. The commitment of resources is a risk-taking activity because resources – and in particular resources destined to innovation - are limited. Top managers introduce certain organisational innovations that modify the allocation of resources and finally modify the entrepreneurial orientation dimension of the risk-taking attitude.

Figure 6. Graphic representation of full development rate

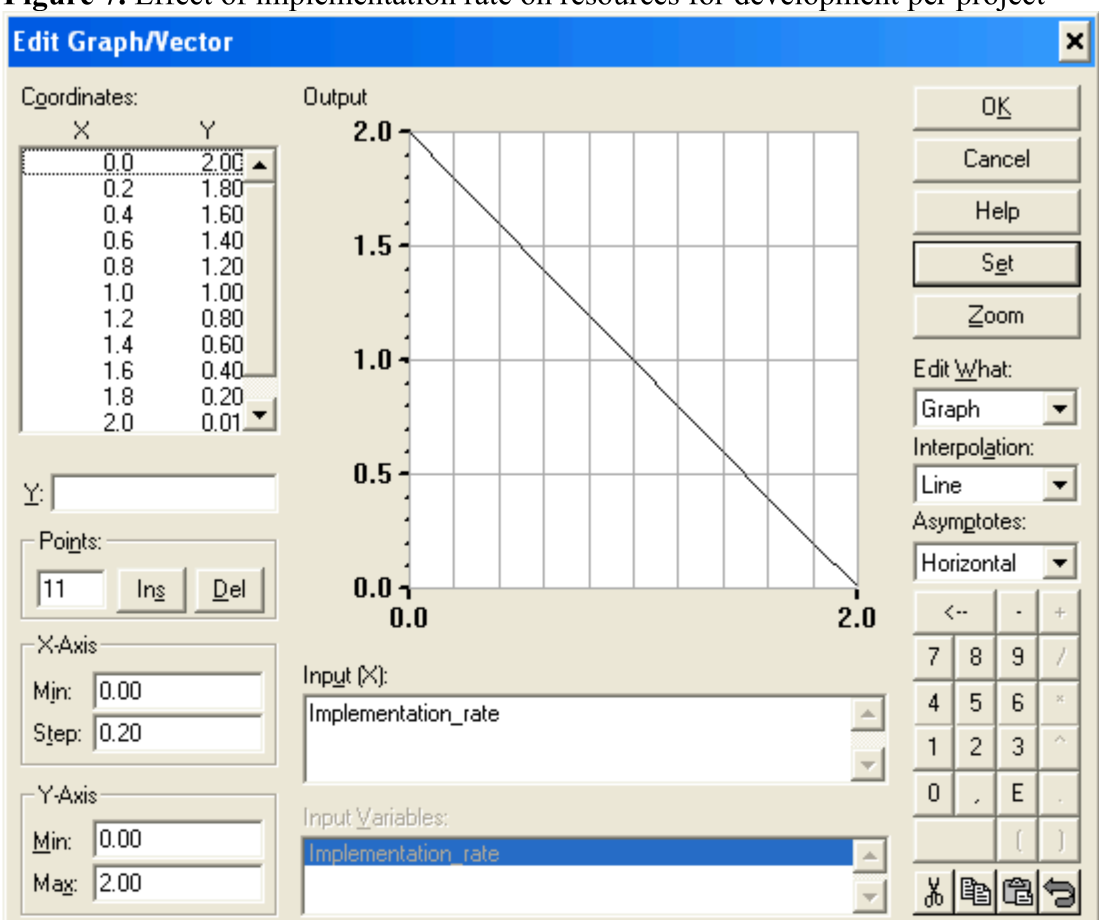


Strictly in term of mathematical formulation, the rate is constructed using two variables: the amount of resources required per project and the total resources available over time to fully develop an innovative project.

The total amount of resources to fully develop projects is the result of a commitment given by top managers on the basis of the previously approved projects. When top managers approve innovative projects they plan the allocation of a certain amount of resources to sustain the full development of innovative projects. Essentially the process of making resource commitment is influenced by reference resources per project that is the normal amount of resources destined to the development of a project multiplied for the number of approved projects.

The construction of the rate that expresses the amount of resources needed per project is more subtle (Figure 7). We again introduced the moderating effect of the implementation rate that works in an opposite way with respect to what we have observed in the dynamic of the first development rate. The higher the implementation rate the less resources top managers will devote to a single project, the lower will be the implementation rate and the more will be the resources destined to a single project to boost its development. This is consistent with the definition of a risk-taking attitude. Top managers will introduce organizational innovation modifying resources commitment rules. Increasing the amount of resources committed to a single project is clearly a way to increase the level of risk.

Figure 7. Effect of implementation rate on resources for development per project



Integration rate

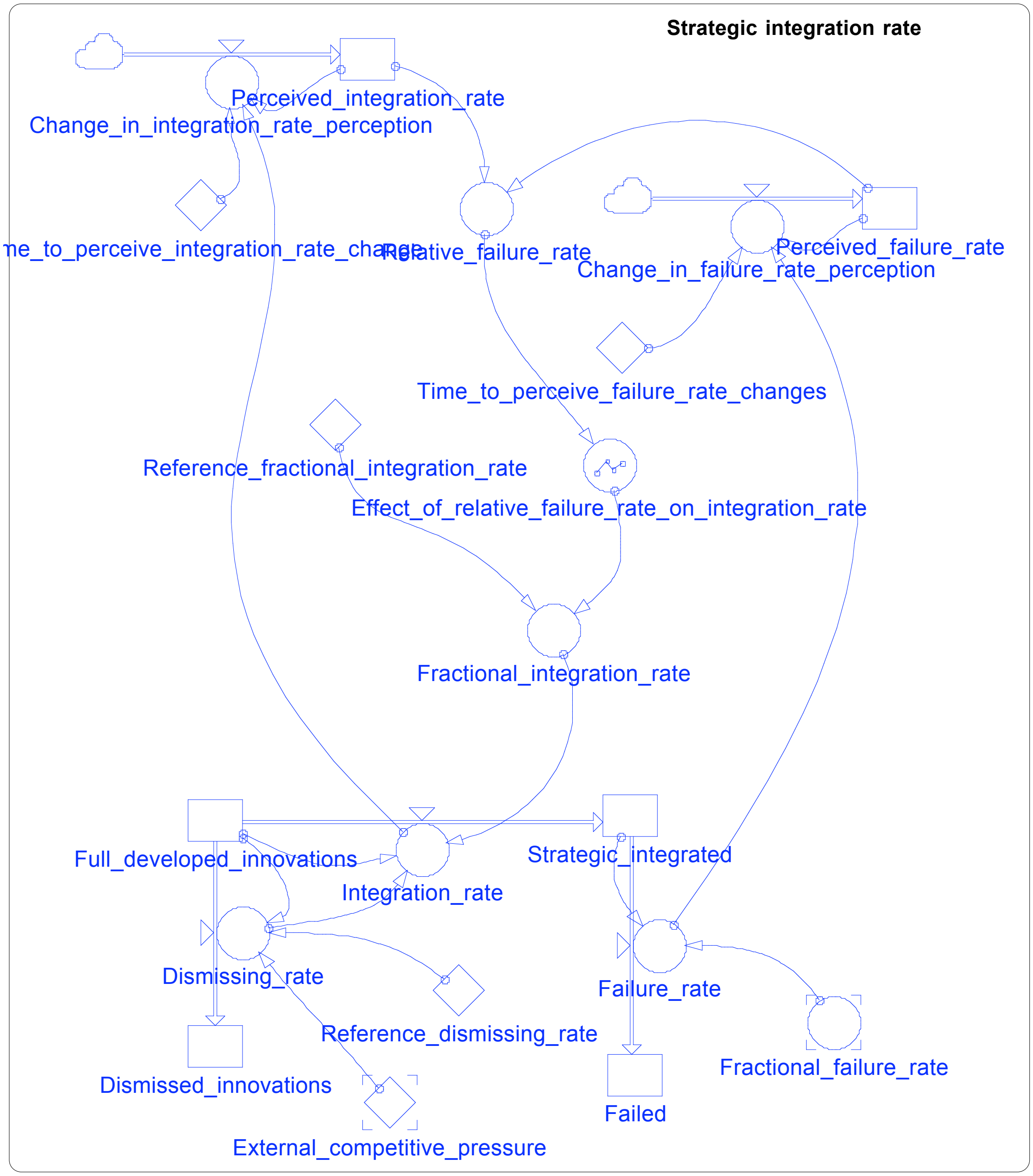
The integration rate represents the rate at which technological innovative initiatives are incorporated into the strategy of the firm. This means that fully developed technical innovations are implemented on a full scale and become part of the competitive strategy

of firm. In this view technical innovations contribute to firms' strategic positioning as defined by Porter [1985, 1996].
Typical example can be the introduction of a new product with new features that substitutes the older one and tries to deliver more value to customers in terms of more non price value. The concept of substitution is important because according to Markides [1997, 1999a and b, 2000] as well as to D'Aveni [1994] studies on competition, a strategic innovation, occur when a company is able to generate new forms of positioning that substitutes older ones. For Baden Fuller and Stopford [1994] the strategic renewal process consists of the substitution (total or partial) of the older strategy of the firm.

The need to substitute the older strategic position with the new one is evocative of a fourth dimension of entrepreneurial orientation that has been defined as *proactiveness*. Literally, proactiveness refers to how a firm relates to market opportunities in the process of new entry. According to Lumpkin and Dess [1996: 147] the firm can exploit market opportunities *"by seizing initiatives and acting opportunistically in order to shape the environment that is, to influence rends and, perhaps, even create demand"*. This description of proactive behaviour fits in with the description made by strategic innovation scholars that recognised the behaviour of the firm as the ability to influence the structure of the industry.

A proactive posture means that top managers would act to anticipate market changes through the increasing rate at which strategic innovations are implemented. The increase of this rate depends on the resource commitment that top managers can make in order to integrate full developed technical innovations. To implement on a large scale a new strategic position is fundamental for providing further resources to the innovation.

Figure 8. Graphic representation of strategic integration rate

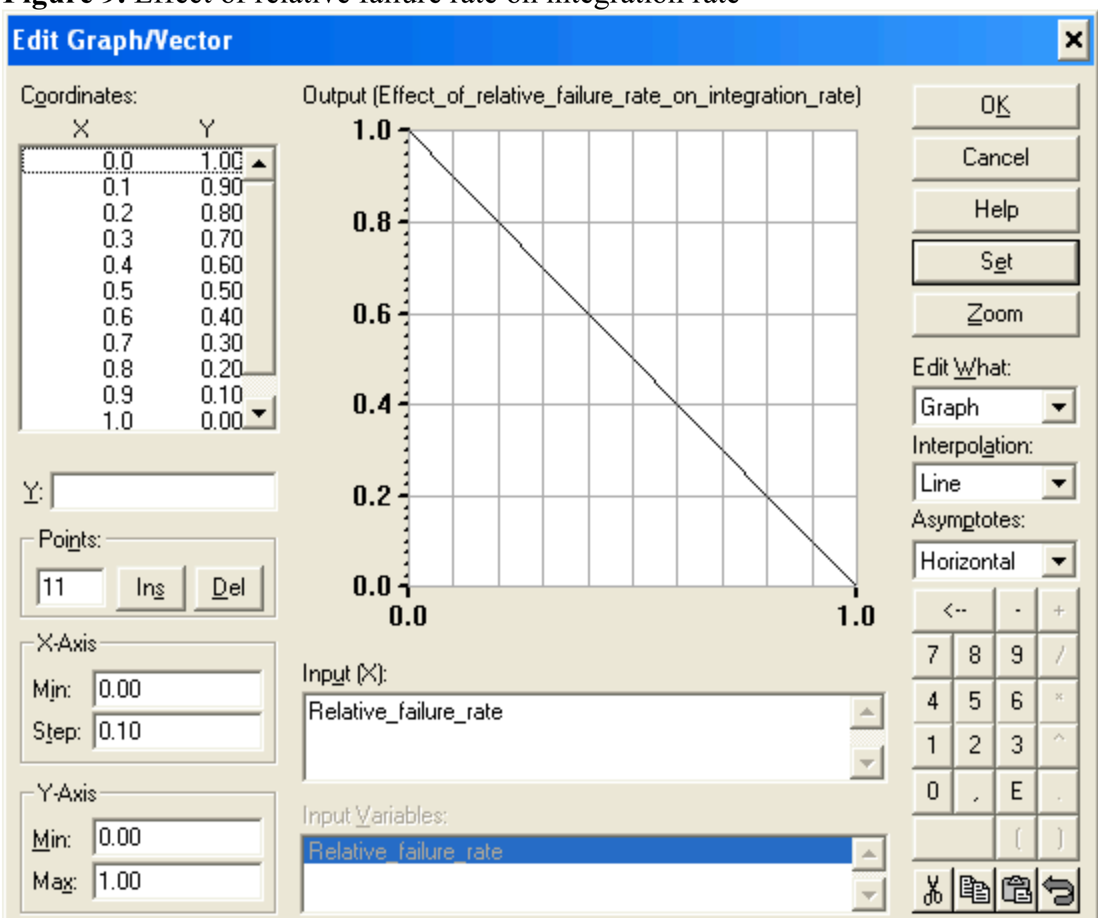


The mathematical formulation of the integration rate is quite similar to the one used for the approval rate. The integration rate can be assimilated to the approval rate. In this sense it can be considered a kind of final approval rate that occurs when technical innovations should become strategic innovations.

The reference integration rate represents managers' reference proactiveness. This rate expresses resource commitment that normally top managers make to integrate into the strategy of the firm new technical initiatives.

This reference rate is influenced by a "moderating variable" that is represented by the effect of the relative failure rate (Figure 9). An increase in the relative failure rate will influence top managers' behaviour and will impact the reference integration rate, contributing to diminishing the final integration rate. Top managers become more prudent with the increase of the failure rate and they realise that they have to change the rate at which innovative initiatives are integrated into the strategy of the firm. This decrease of the integration rate can be interpreted in different ways: firstly, top managers dedicate more time to integrate the projects, for example to understand the implication of technical initiatives for the strategy of the firm; secondly, technical initiatives require more resources to be integrated into the strategy of the firm on a large scale. This means that having a limited amount of resources, top managers have to integrate a limited number of innovative projects. Third, technical innovations continue to be subjected on an implementation on a small scale because top managers want to understand their potential effects on the strategy of the firm.

Figure 9. Effect of relative failure rate on integration rate



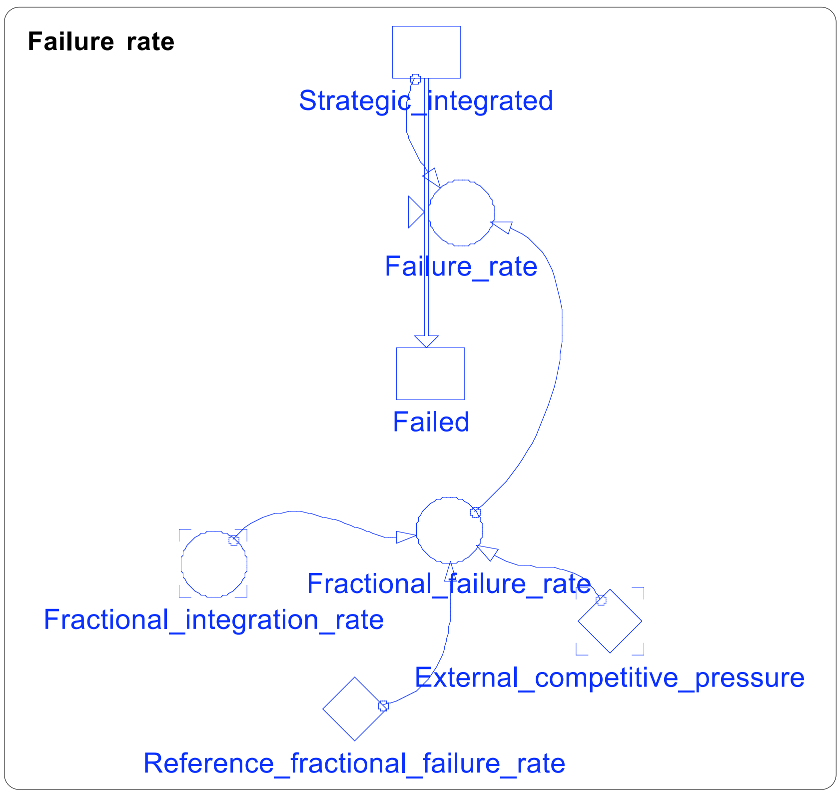
Failure rate

The failure rate expresses the rate at which innovative strategic initiatives fail. This means that for example a newly launched product or service is abandoned, or that after the entrance into a new market segment the firm will exit from it.

In our model we are not interested in modelling the dynamics of market, but we would like to insert some variables to represent structural dynamics and in particular, *competitive aggressiveness* of rival firms.

Proactiveness has also been studied in conjunction with competitive aggressiveness [Lumpkin and Dess, 1996], but when proactiveness is more related to meet demand, competitive aggressiveness is about competing for the demand. It refers to how firms relate to competitors and how firms respond to trends and demand that already exist in the marketplace. The best way to investigate competitive aggressiveness would be to include in the model a second firm that competes with the original firm for a limited amount of resources.
Our model is a one-firm model but we could not completely ignore pressure coming from the competitive environment and in particular from rivals. For this reason this we decided to adopt a failure rate of strategic integrated innovations influenced by variables representing the characteristics of industry and the level of rivalry among firms.

Figure 10. Graphic representation of failure rate



In our formulation the failure rate is a function of three variables. The reference failure rate represents the characteristics of the industry. Industries are characterised by different levels of rivalry that determine the obsolescence of strategies implemented by firms, this happens typically in technology-based industries like the IT and telecommunication industries. In this sense the reference failure rate represents the characteristics of the industry in which the innovative firm is competing.
Independently of the type of industry, the level of rivalry can decrease or increase for certain period of time influencing the characteristics of the industry [D'Aveni 1994]. This

is represented by competitive pressure. Competitive pressure can assume each value between 1 and 2. When it is 1, no effect will be evident on the reference fractional failure rate. When it assumes values of more than 1, the reference fractional rate will consequently increase.
The third variable influencing the failure rate is the fractional integration rate. We supposed that the fractional integration rate expresses the accuracy of the integration process in the strategy of the firm. The lower the rate at which new projects are integrated, the more time, the more attention and the more resources top managers will devote to them it, and the lower will be the probability that these projects will fail.

Obsolescence and dismissing rates
These two rates concern two stocks, *innovation for experimenting* and *full developed innovations*, and express that after a certain period of time innovative ideas approved for experimenting become obsolete and fully developed projects not integrated into the strategy of the firms are dismissed.
This happens for two reasons. Firstly, inside an innovative company old ideas are surpassed by new ones. Over time new ideas will emerge and new projects will substitutes the older ones.
The second reason is that the obsolescence of the projects that are in these two stages of the pipeline of innovation can be determined by rivalry. Competitors, in a turbulent environment, continuously introduce innovations that accelerate the obsolescence of rivals' innovations situated at different stages of the innovation pipeline[D'Aveni, 1999].

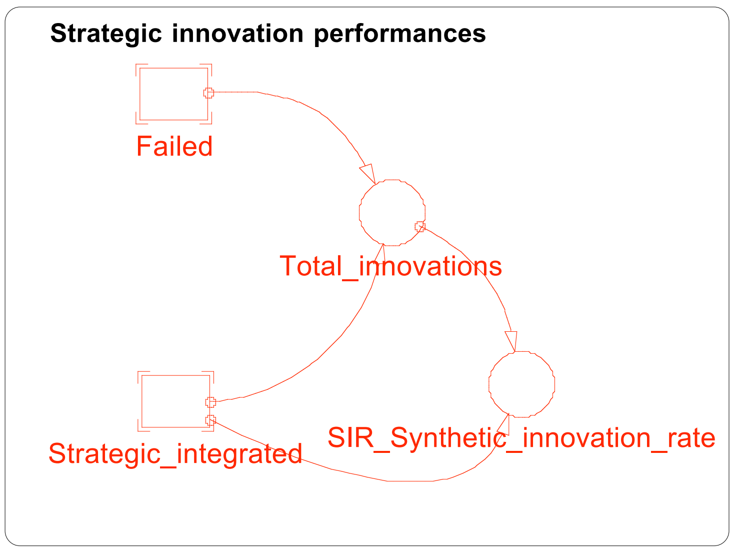
The *first developed obsolescence rate* is determined by the action of two variables: first variable is the *reference first obsolescence rate* that expresses a kind of internal selection mechanism for which each period of time (in our case each month) is eliminated from the pipeline of innovation a certain number of projects that are in the stock *innovations approved for experimenting*.
The second rate expresses *external competitive pressure*. It is neutral when it assumes the value of 1 (a traditional no-turbulence competitive environment): when it increases, it boosts the obsolescence rate reflecting the fact that in competitive environments characterised by a higher level of rivalry competitors generate innovations that determine the obsolescence of other rivals' innovations.

The *dismissing rate* expresses the rate at which fully developed innovative projects are terminated because after being implemented on a small scale they are not integrated into the strategy of the firm. This happens due the action of two variables. The first is the *fractional dismissing rate* and represents the internal selection mechanism. This rate will be smaller than the reference obsolescence rate, because the firm has heavily invested. Innovative projects have been fully developed and implemented on a small scale and top managers are not willing to lost investments. Considering these aspects, the willingness of top managers to dismiss these projects will be significantly lower than the willingness to dismiss *projects approved for experimenting* that have been developed exclusively "on paper". The second variable is the competitive pressure and it works in the same way as observed for the first obsolescence rate.

Performance measurement

The model was completed with a section dedicated to the measurement of innovation performances (Figure 11). Two variables are particularly suitable for this purpose. These measurements were inspired by early studies on internal entrepreneurship that were focused on the number of innovations developed within internal venturing programs [Bower, 1970]. The first is the total number of strategic innovations, the second is the percentage of these innovations that has been successful or that did not fail. We have called the measurement of success *SIR - Synthetic Innovation Rate*. It can assume all values between 0 and 2 and can be expressed as a percentage.

Figure 11. Performance measurement



Modelling mental models through non-linear effects

Our simulation model was built based on the contributions of literature to represent the process of strategic innovation inside a large organisation. It allows us to easily capture the relationship between different types of innovations however it cannot effectively represent top management's mental models that it was proved can play a fundamental role in the process of innovation [Burgelman, 1984; Covin and Slevin , 1991; Lumpkind and Dess, 1996]. The introduction of a specific section of the model to capture top managers' mental model modification will result in the loss of focalisation on the central research question. For this reason we decided to adopt a formulation based on the introduction of selected non-linear effects in the model to eventually represent different kinds of top managers' mental model. Those non-linear effects are: effect of relative failure rate on approval rate, effect of the implementation rate on resources for developing a single project, effect of relative failure rate on integration rate.

The shape of the curves that represents non-linear effects can be eventually modified to represent firms characterised by top managers with different mental models[2].

[2] Please refer to the paper's support material for alternative formulations of non-linear effects (Annex 2)

Neutral. The neutral profile is characterised by non-linear effects that have a linear formulation so they do not amplify or moderate the effect of certain variables.

Aggressive. The firm is characterised by top management that wants to maximise the number of innovations that are integrated. This management is typically oriented towards minimising the effect of fractional failure rate on both approval rate and integration rate. Top management does not act to allocate more resources per project in the case of a lower implementation rate because they trust in the ability of middle managers to speed up projects. The same is true in the case of the integration rate that will not be exposed to great reduction if the failure rate decreases.

Conservative. This firm is characterised by top managers that do not want to beat the market to anticipate rivals' moves. They will react to pressure exercised by failure rate and integration rate by slowing down the innovation process: their tendency is to keep the innovation process in equilibrium rather than accelerate.

In our simulation we decided to adopt the neutral profile.

2.3. Validation and sensitivity analysis

Our model is a causal descriptive model built on theoretical contributions. In this case the validation process must develop through tests for assessing the structural (internal) validity of the model (internal validation) like the structure-oriented behaviour tests [Barlas, 1996]. They asses the validity of the structure indirectly, by applying certain behavioural tests to the model-generated behaviour patterns.

Two types of structural validation tests were performed:

- *extreme conditions tests* to show the behaviour of the model under extreme conditions of certain variables;
- *behaviour sensitivity tests* to determine those variables to which the model is highly sensitive.

All validation tests were performed on a reference version of the model, that considers a firm characterised by top management with neutral mental models through innovation, standard reference rates and a standard competitive pressure. Each run was conducted to appreciate the reaction to extreme condition tests and sensitivity analysis was conducted by modifying certain variables. All tests had positive results and confirmed the internal validity of the model[3].

A sensitivity analysis was conducted on three non-linear effects that play a major influence on main rates of innovation: effect of relative failure rate on the approval rate, effect of implementation rate on resources allocation, effect of relative failure rate on integration rate. The model seems to be relatively sensible only at the modification of the last non-linear effect.

[3] Please refer to the paper's support material for a selection of validation tests performed (Annex 3).

3. Simulation and discussion

Baden-Fuller and Stopford [1994], while analyzing in a longitudinal study the strategy renewal process, choose an interval of time of 5 years to exploit the regeneration of business models of a sample of 20 European firms. In longitudinal studies [Bower, 1970, Burgelman, 1991] on internal corporate venturing processes, the interval of time of the case study is 5 years. In Burgelman's [2002] most recent works, while directing the focus of the analysis on the strategy renewal process, he enlarged the time interval up to 15 years. To capture the richness of the strategic innovation process we extended the time horizon up to 15 years. This interval of time will help us to capture the long-term interactions between the development of organisational innovations and technical and the implementation of strategic innovations, clearly showing the behavior of the feedback loop that relates the three forms of innovation. Each single interval of the simulation represents 1 month, so the entire simulation will be conducted over 180 time periods[4].

The purpose of simulation is to test two different kinds of firms in two different competitive environments.

The "proactive firm" is characterised by top managers with a clear orientation towards strategic innovation and renewal. The organisational context will be defined to foster innovation development through the pipeline.

A "traditional or conservative firm" is characterised by top managers who behave prudently throughout strategic innovation and tend to retain the current strategic position. They will be more selective regarding the innovative projects presented.

The parameters that will be used to characterise the type of firms will be:

- reference fractional time to new initiatives;
- reference approval rate;
- reference fractional integration rate.

The modification of parameters expresses a stable modification of procedures. This means that the firm's orientation toward innovation is "institutionalised" with a certain organisational design.

The competitive environment refers to the level of environmental turbulence. The level of rivalry is high when rivals introduce continuously strategic innovations and this exerts a high competitive pressure on the firm's management.

The increase of competitive pressure has two main effects: it stimulates top managers integrate more innovations and it dramatically increases the failure rate of strategic innovations. *External competitive pressure* is the parameter that will be used to characterise the competitive environment.

Performance will be measured by evaluating the effective contribution of the strategic innovation process to the renewal of the firm's strategy. This is expressed by the absolute value of technical innovations integrated into the strategy of the firm and by the relative value of the successful strategic innovations (represented by the SIR indicator).

3.1. Base run

The base run highlights the dynamics of the innovative process in large organisations

[4] Please refer to the paper's support material for simulation software settings (Annex 4).

described by the interaction between organisational, technical and strategic innovations. The reference fractional time towards new initiatives, the reference approval rate and the reference fractional integration rate have the same value of 0.30. This means that top managers allow (as reference) 30% of time for new initiatives, they plan to approve the 30% of innovative technical projects presented and to integrate the 30% of them.

The analysis of the behaviour of rates reveals the existence of temporal delays caused by the presence of an articulated stock structure (Figure 13).

The innovative firm seems to enter into a stable situation after a certain period of time (40 months), the system starts to work and proposed innovations are processed by the organisational structure. The approval rate, full development rate and integration rate start to work by bringing stocks to an asymptotical equilibrium.

Technical innovations at different stages of the pipeline tend to remain in the stocks. This is consistent with the fact that innovative firms desire to maintain a portfolio of innovative initiatives from which they benefit through time [Bower, 1970; Burgelman, 1983a].

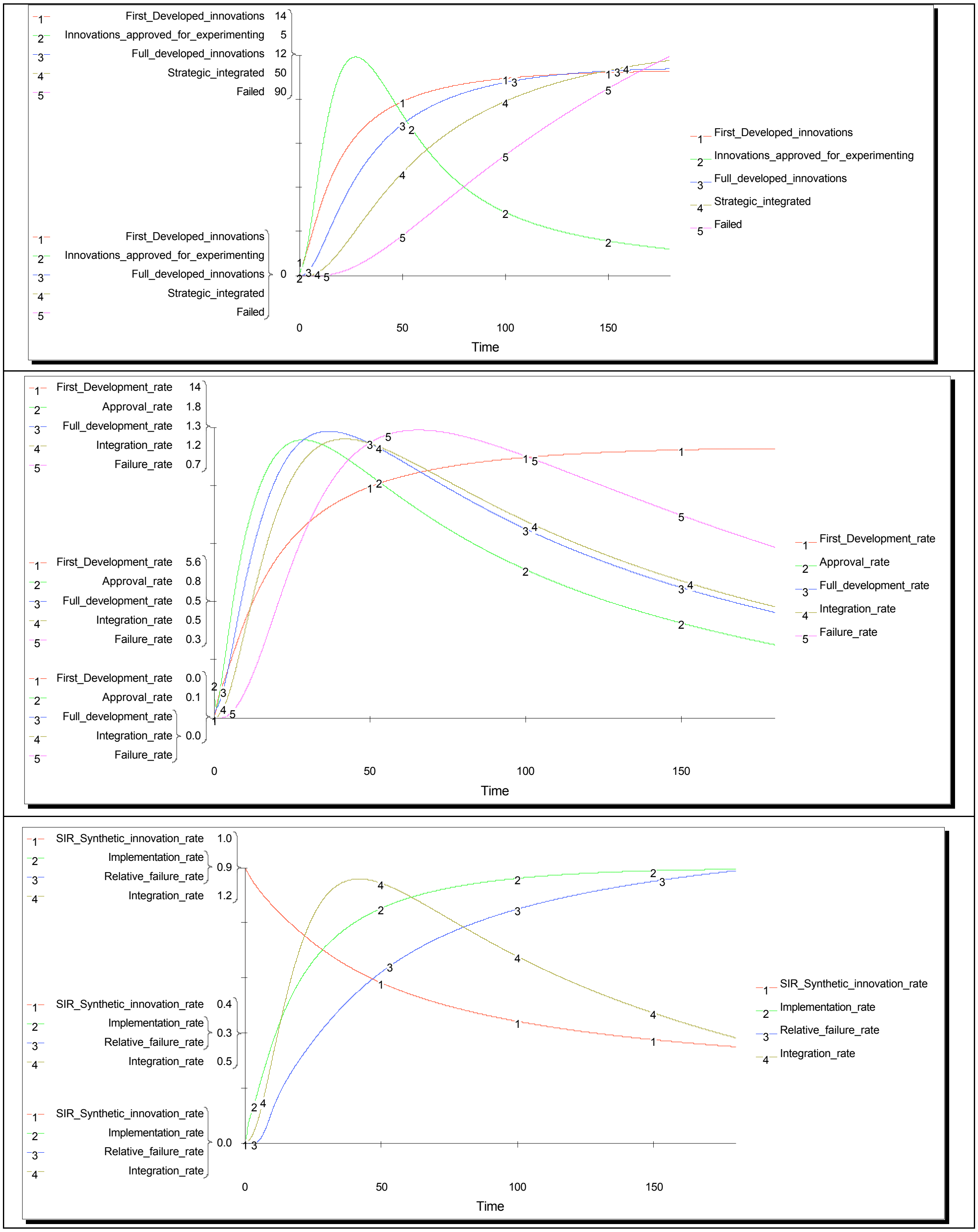
Innovation approved for experiment stock has a different behaviour because after a period of accumulation it decreases under the effect of the full development rate. Thanks to the increase in the implementation rate *the number of resources required for each project to be developed* decreases, so the full development rate increases by contributing to the transformation of the largest part of approved projects in fully developed projects. On the contrary, the approval rate reduces over the years due to the effect of an increasing failure rate. This is coherent with the general assumption of the competitive strategy paradigm for which, after a certain period of time, a new strategy can be imitated by competitors, so in the long run no competitive advantage can be guaranteed even to a company that pursues strategic innovations [Porter, 1980]. This is confirmed also from the behaviour of the SIR the Synthetic Innovation Rate that during the years tends asymptotically to 0. After 15 years it assumes the value 0.35 this means that successful integrated strategic innovations are 35% of total implemented strategic innovations. The total number of innovations produced exceeds 138.

We repeated the simulation applying stronger competitive pressure (2). The results were as we expected. The competitive pressure stimulates the firm to increase innovation activity (Figure 14). Top managers feel the gap and activate organisational innovations that stimulate the development of technical innovations. However the combined effect of the increase in the integration rate and of a high level of rivalry, increases the failure rate of strategic innovations. For these reasons, in terms of absolute value, the firm implements more innovations. However the SIR, that is a measure of the success rate, decreases to 30%.

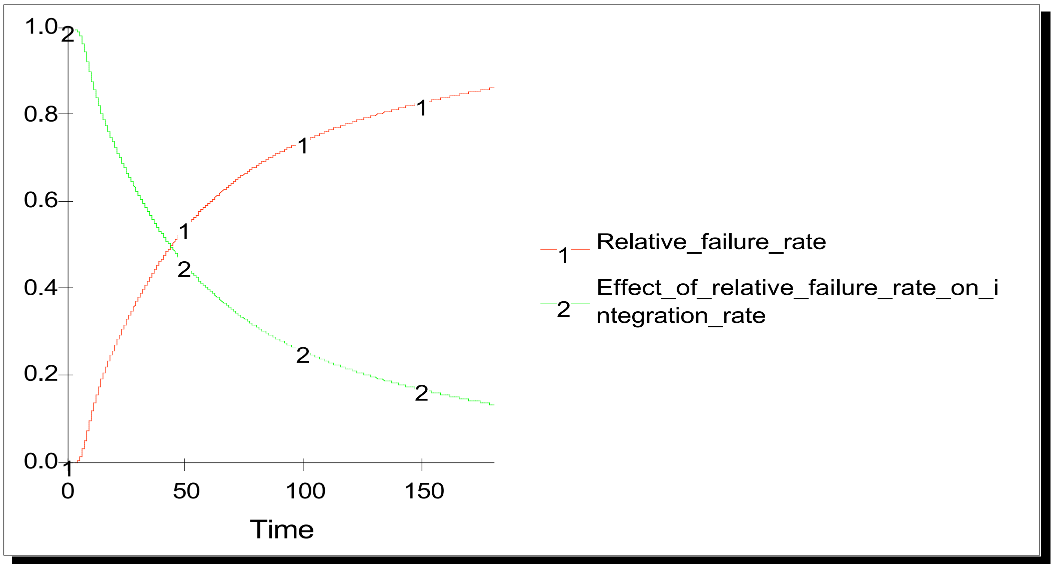
Figure 12. Model parameters for the Base Run in a traditional and in an hypercompetitive environment

Parameters	*Traditional*	*Hypercompetitive*
External competitive pressure	1	2
Reference fractional time to new initiatives	**0.3**	**0.3**
Reference fractional approval rate	**0.3**	**0.3**
Reference fractional integration rate	**0.3**	**0.3**
Reference obsolescence rate	0.1	0.1
Reference dismissal rate	0.001	0.001
First developed innovations	1	1

Figure 13. Selected results of simulation for the Base Run in a traditional competitive environment



…Figure 13


1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
Time
1 Relative_failure_rate
2 Effect_of_relative_failure_rate_on_integration_rate

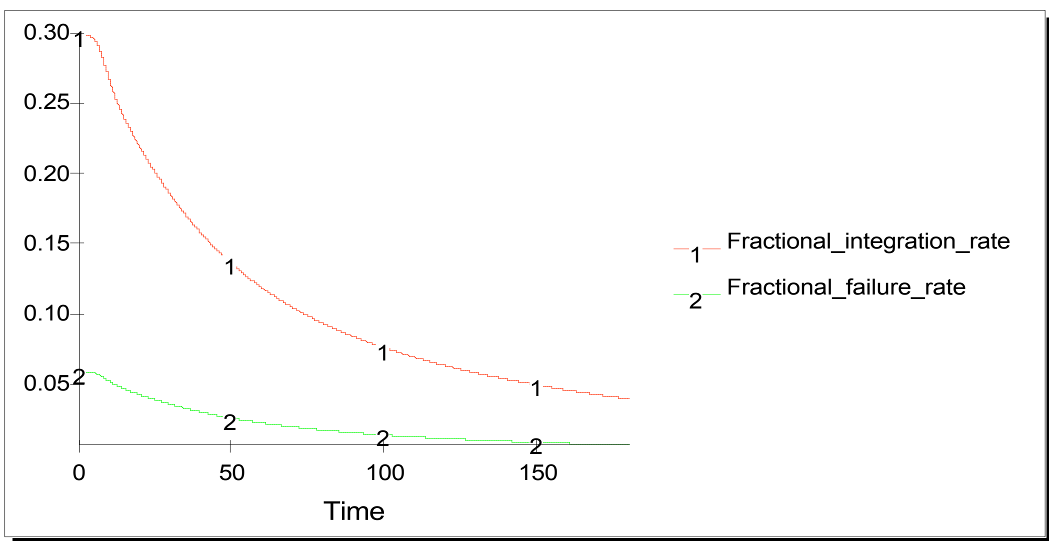
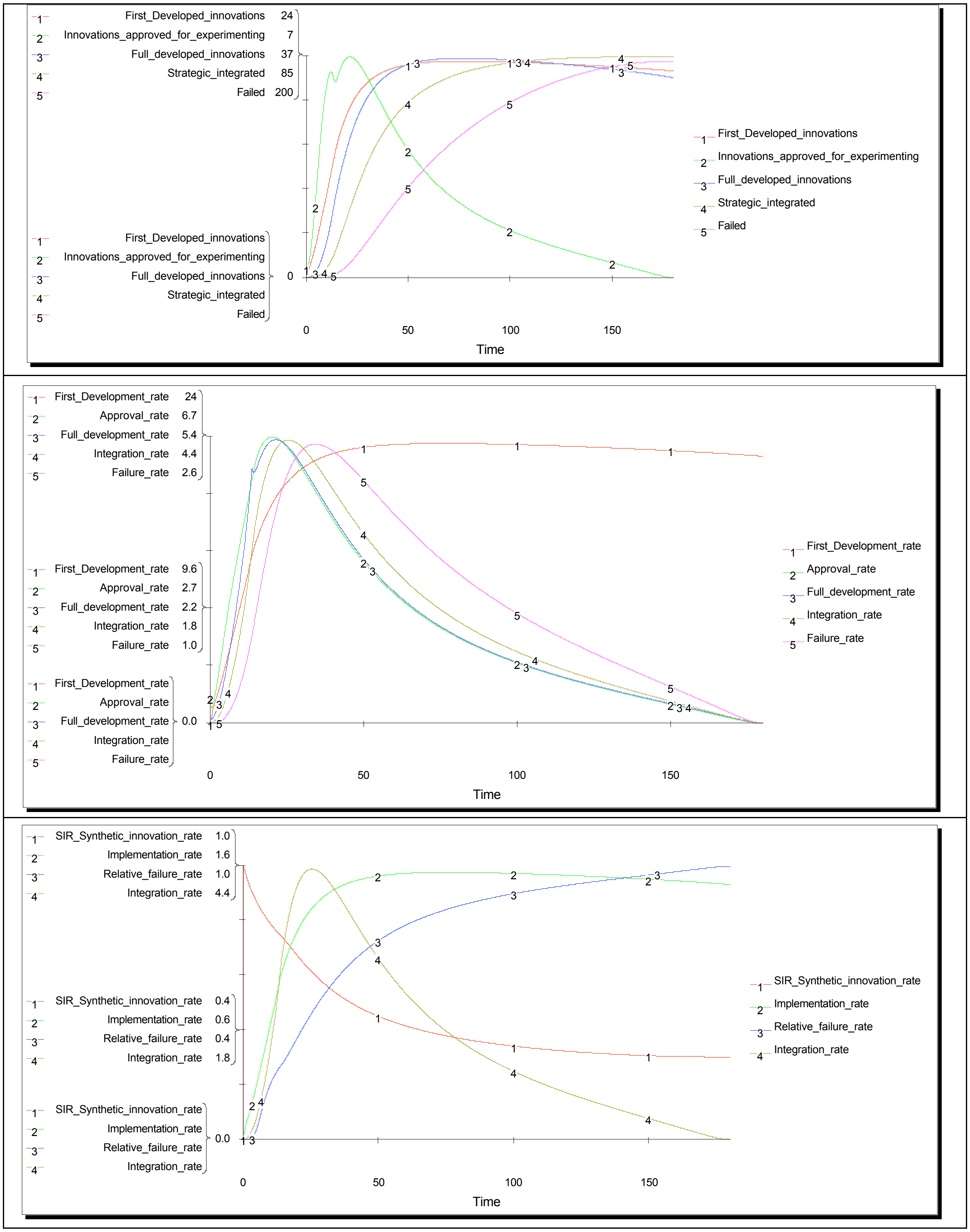

0.30
0.25
0.20
0.15
0.10
0.05
0
50
100
150
Time
1 Fractional_integration_rate
2 Fractional_failure_rate

Figure 14. Selected results of simulation for the Base Run in an hypercompetitive environment



3.2. Proactive firms

To characterise proactive firms, a precise choice of selected parameters was effected. The reference fractional time to new initiatives was set to a higher value (0.40), and that of the base run (0.30), to represent the willingness to improve innovation performance with respect to the "neutral" firm (represented in the base run). The reference approval rate was set at 0.6 this means that 60% of presented projects will be approved (this is what internal procedures determine, before the effect of other variables reduces it). The reference fractional integration rate was set at 80%, this means that 80% of fully developed projects will be integrated into the strategy of the firms (before the action of other variables reduced it). This combination of rates would express a very aggressive competitive posture of the firm for two reasons. Firstly, top managers would like to speed up the innovation process and they increase, with the advancement in the pipeline, the rates that regulate the flow of innovative projects. Secondly, top managers have a higher confidence in the quality of innovative projects in advanced stages of the pipeline of innovation. In fact they allow a very high integration rate of about 80%, compared with an approval rate (more prudent) of 40%.

In a standard competitive environment, proactive firms achieve poor performance if compared with the basic run of the model. The number of strategic innovations integrated is around 90 (Figure 16). The high integration rate determines an increase in the failure rate that stimulates an increase in the resource allocated to fully develop each project. A slow implementation rate also stimulates a decrease in the presentation rate. This determines that top managers dramatically reduce the time to autonomous initiatives for middle level managers, who are the agents of innovations. The innovation process comes progressively closer to a complete stop.

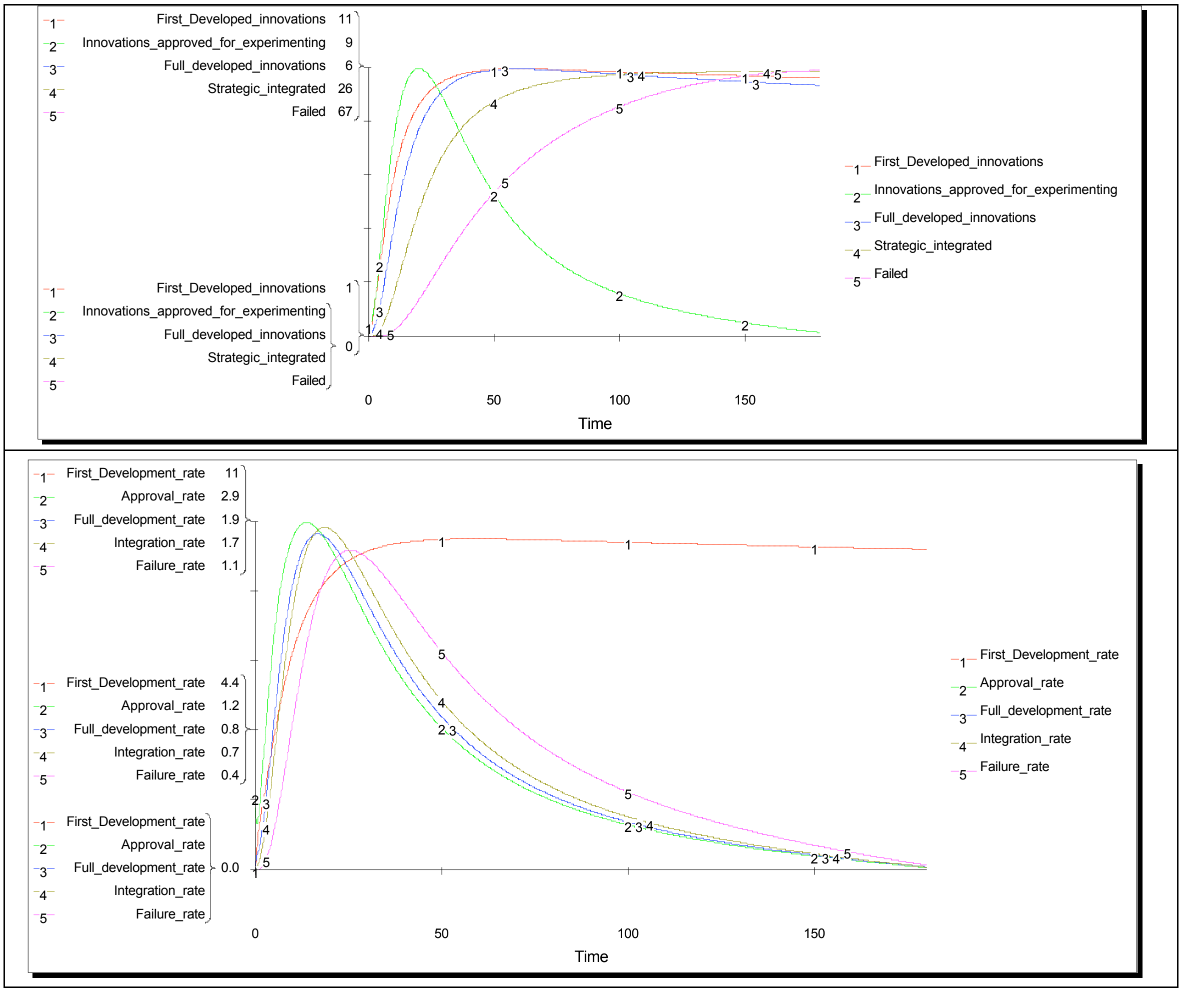
The behavior of a proactive firm within a highly competitive environment (characterised by a level of competitive pressure of 2) shows that the absolute innovative performances increase (Figure 17.). The total number of innovative projects implemented is over 280. This is due to the modification of rates that drive innovation flows inside the pipeline. The effectiveness of innovation is affected by a slight decrease compared with what we have seen previously. In fact the SIR assumes a final value of 0.25.

The relevant observation that can be made concerns the increase of the innovative pressure which speeds up the innovation process. The firm responds to "hypercompetition" increasing the degree of strategic innovation.

Figure 15. Model parameters for the Proactive firm in a traditional and in an hypercompetitive environment

Parameters	*Traditional*	*Hypercompetitive*
External competitive pressure	1	2
Reference fractional time to new initiatives	**0.4**	**0.4**
Reference fractional approval rate	**0.6**	**0.6**
Reference fractional integration rate	**0.8**	**0.8**
Reference obsolescence rate	0.1	0.1
Reference dismissal rate	0.001	0.001
First developed innovations	1	1

Figure 16. Selected results of simulation for the Proactive firm in a traditional environment



…Figure 16.

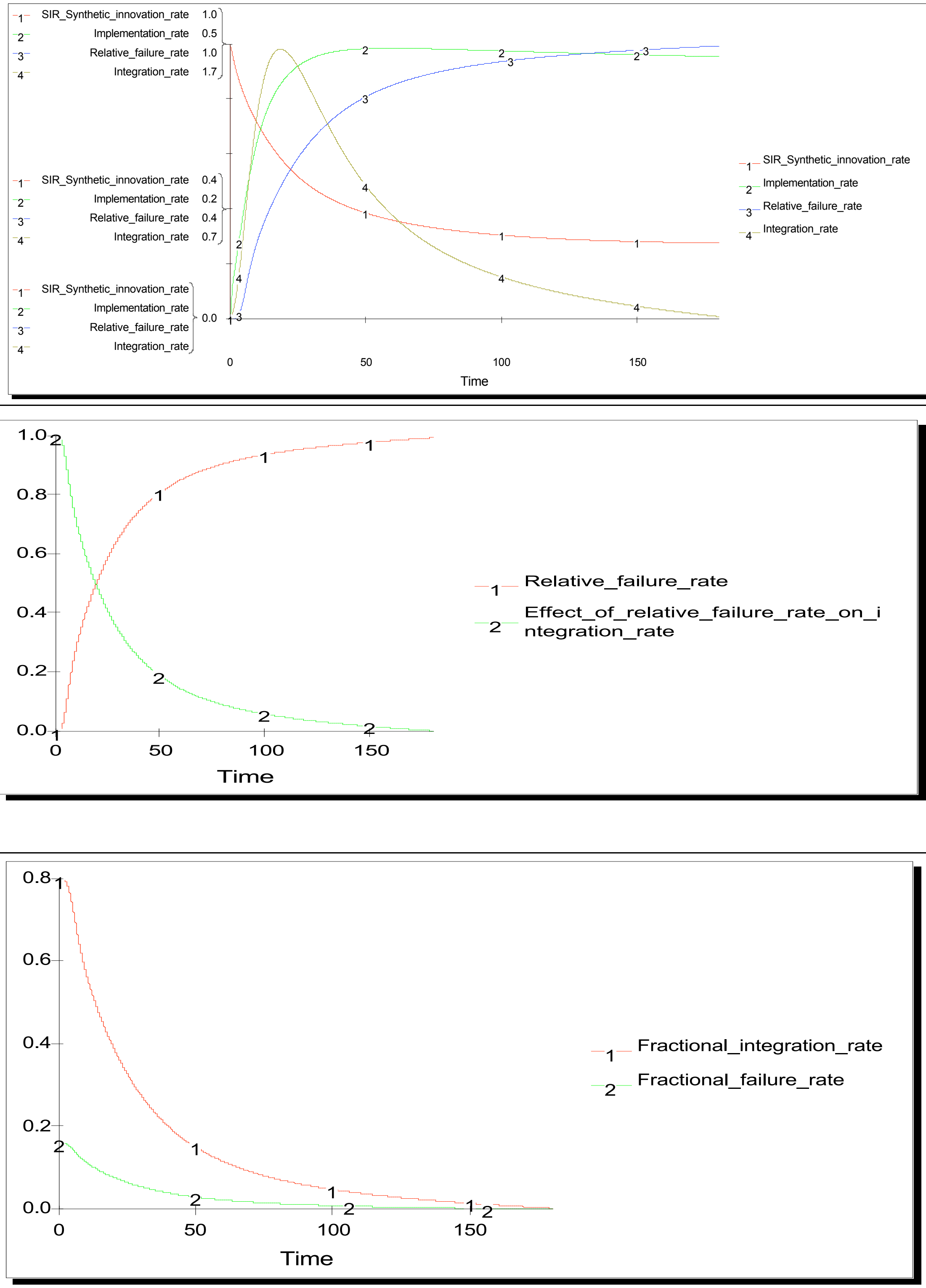
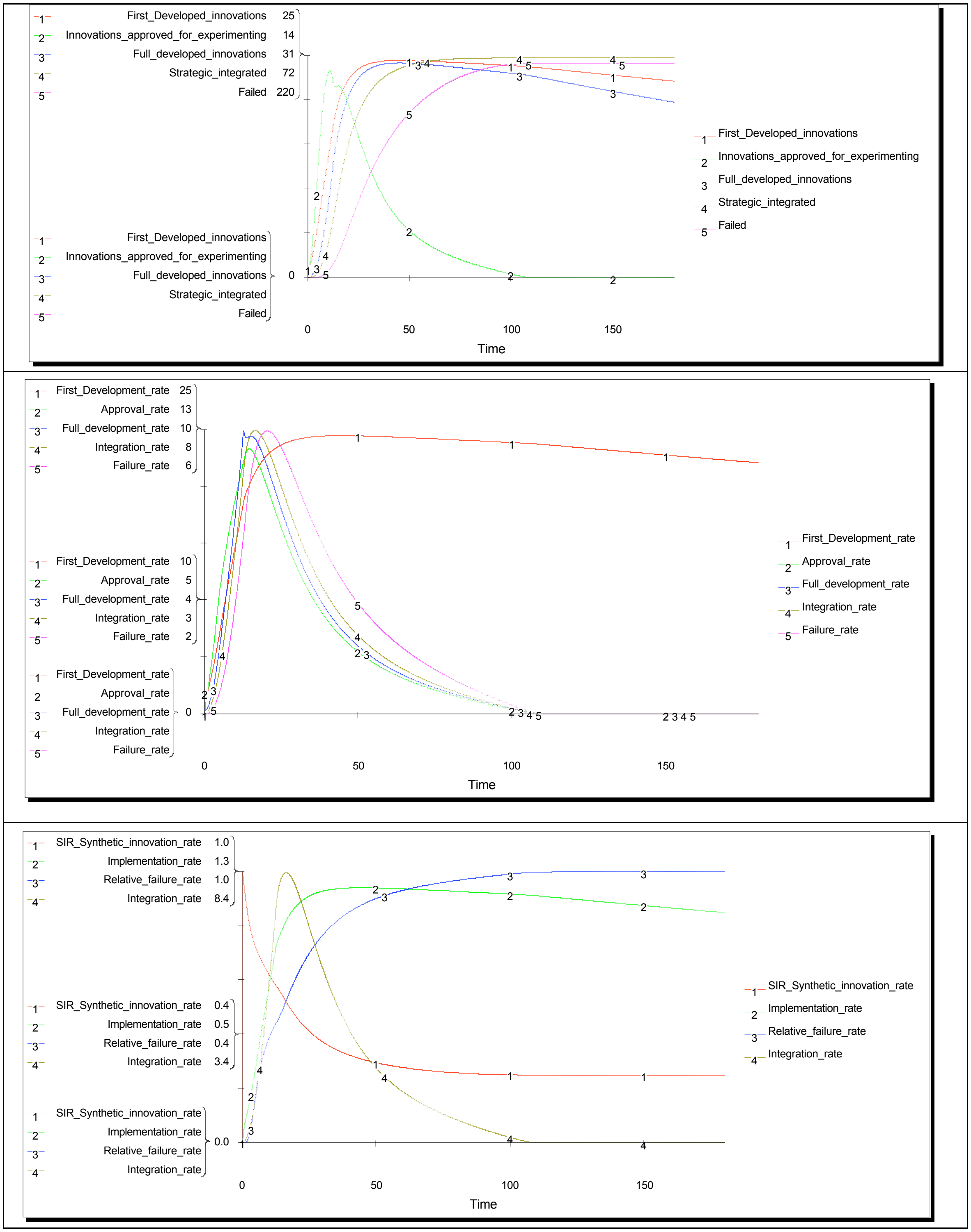

SIR_Synthetic_innovation_rate 1.0
Implementation_rate 0.5
Relative_failure_rate 1.0
Integration_rate 1.7
SIR_Synthetic_innovation_rate 0.4
Implementation_rate 0.2
Relative_failure_rate 0.4
Integration_rate 0.7
SIR_Synthetic_innovation_rate
Implementation_rate
Relative_failure_rate
Integration_rate
0.0
0
50
100
150
Time
SIR_Synthetic_innovation_rate
Implementation_rate
Relative_failure_rate
Integration_rate
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
Time
Relative_failure_rate
Effect_of_relative_failure_rate_on_integration_rate
0.8
0.6
0.4
0.2
0.0
0
50
100
150
Time
Fractional_integration_rate
Fractional_failure_rate

Figure 17. Selected results of simulation for the Proactive firm in an hypercompetitive environment



3.3. Conservative firms

To characterise conservative firms the design of reference rates was inspired by a rule based on prudence according to which top managers prefer to slow down the innovation process, so that they will be less proactive in bringing innovations to the markets. The reference fractional time to new initiatives was set to a higher value (0.40) than in the base run. The reference approval rate was set at a lower value of 0.3 to express the orientation towards making a rigorous selection. This orientation is confirmed by the extremely reduced integration rate that was set at 0.2.

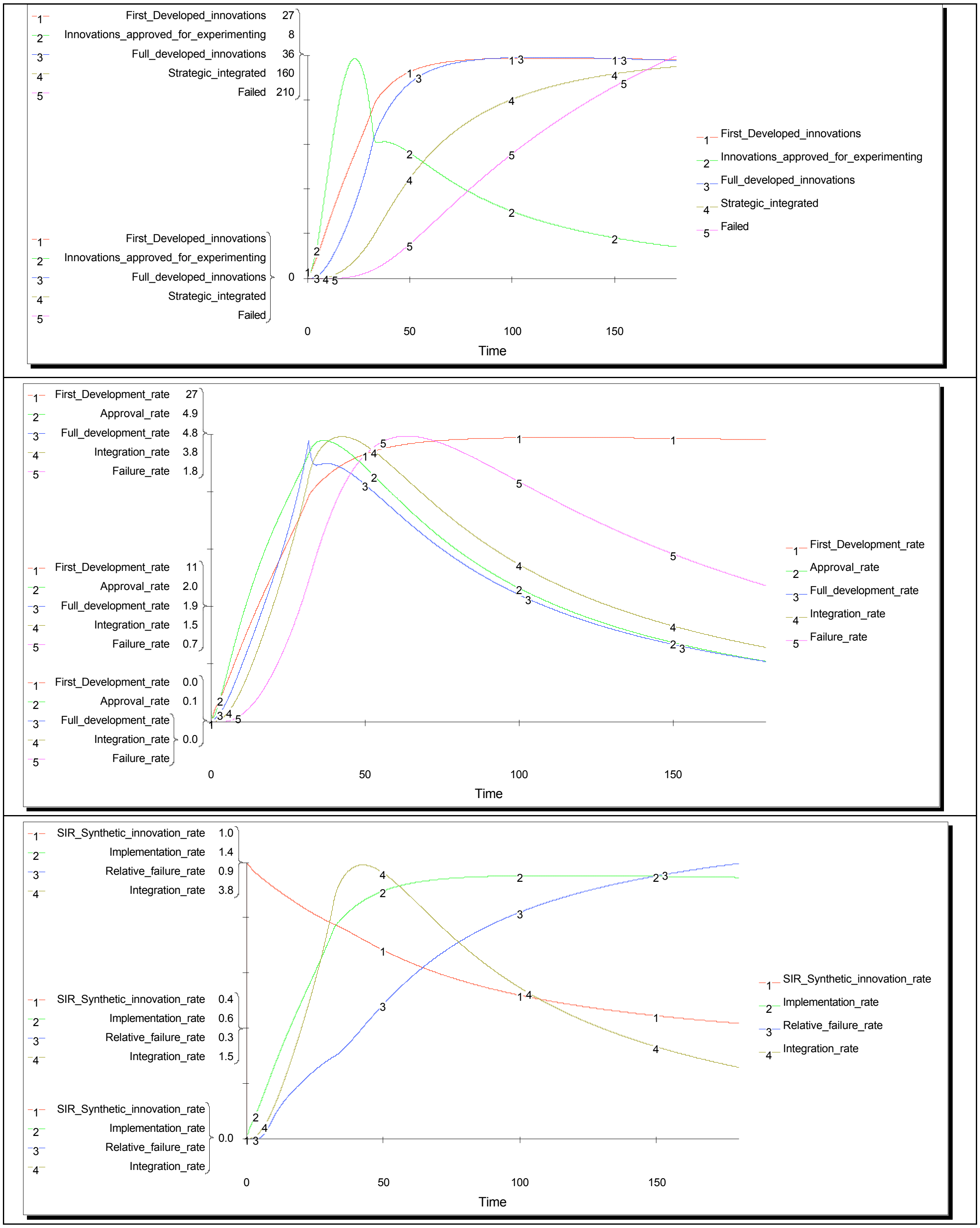
The conservative firm seems to have the most effective innovation process. Considering standard competitive pressure, the firm produces a relatively high number of strategic integrated innovations (more than 360) with a very high success rate of 0.42 (Figure 19). As the relative failure rate increases, top managers correctly slow down the integration rate to ensure a better process of strategic integration for each technical innovation.

Behavior is confirmed also assuming higher competitive pressure (Figure 20). In this case the firm produces a higher number (752) of strategic innovations compared with the conservative firms but with a good success rate of 33%.

Figure 18. Model parameters for the Conservative firm in a traditional and in an hypercompetitive environment

Parameters	*Traditional*	*Hypercompetitive*
External competitive pressure	1	2
Reference fractional time to new initiatives	**0.4**	**0.4**
Reference fractional approval rate	**0.3**	**0.3**
Reference fractional integration rate	**0.2**	**0.2**
Reference obsolescence rate	0.1	0.1
Reference dismissal rate	0.001	0.001
First developed innovations	1	1

Figure 19. Selection of simulation results for the Conservative firm in a traditional environment



….Figure 19

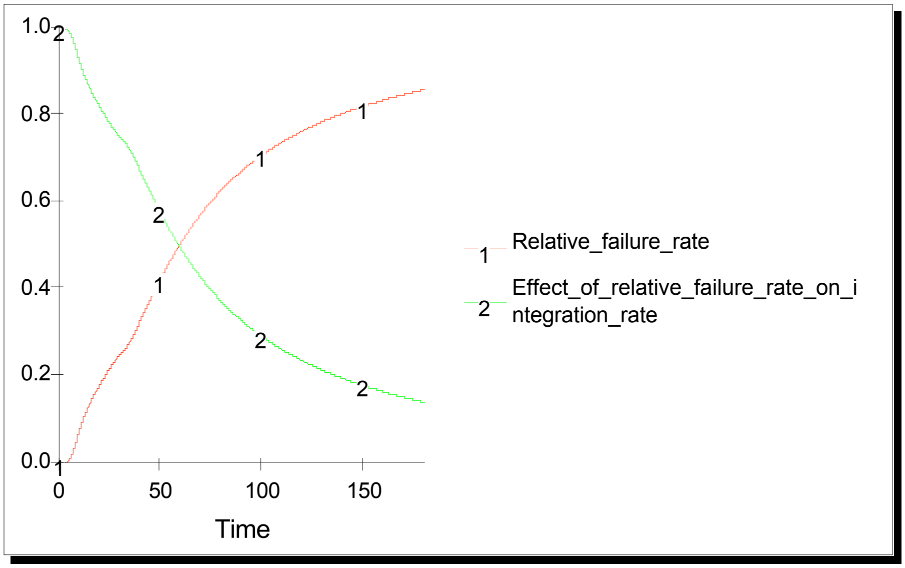
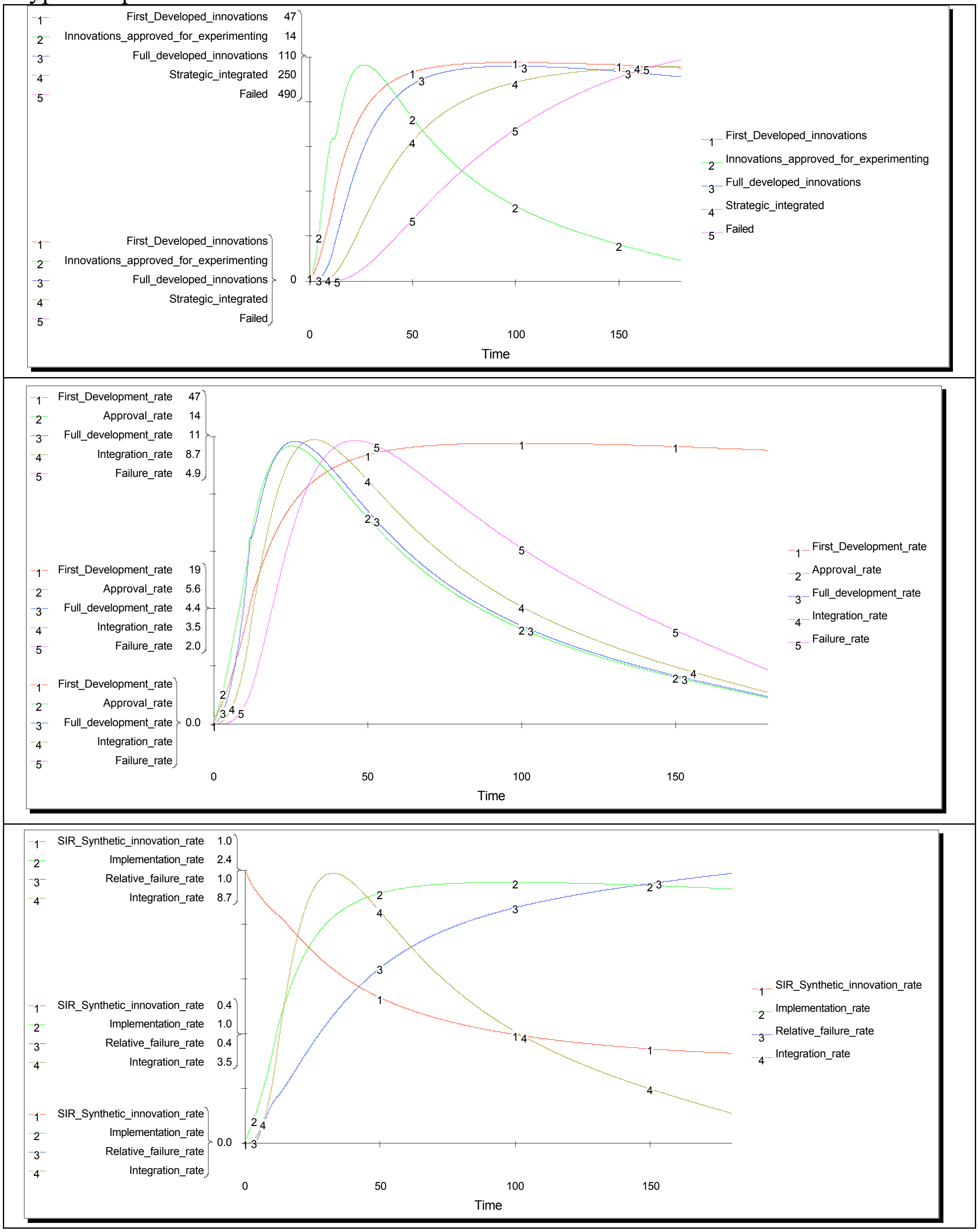
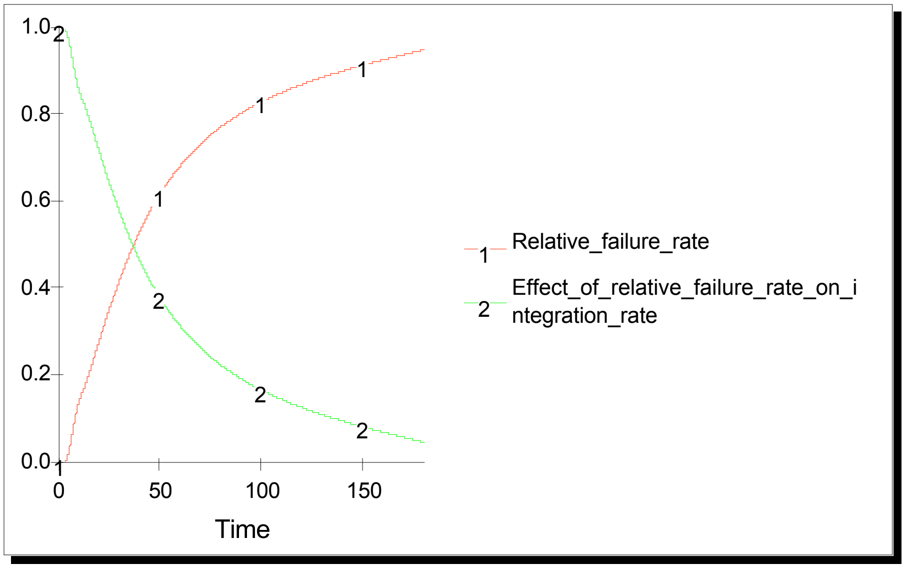

1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
Time
1 Relative_failure_rate
2 Effect_of_relative_failure_rate_on_integration_rate

Figure 20. Selection of simulation results for the Conservative firm in an hypercompetitive environment



….Figure 20



Conclusions

The model simulations validate the basic propositions of our theoretical construct for which the introduction of organisational innovations that define entrepreneurial orientation can influence strategic renewal. In particular the model highlights two very different dynamics. The first is related to organisational innovations that control the entrepreneurial energy of middle level managers. The second dynamic depicts the integration efforts of top management.

The model contributes to the existing theoretical findings, introducing a feedback view of the strategic innovation process. The entrepreneurial orientation is the result of certain organisational innovations. It affects innovation processes (in particular: approval, development and integration rates) and it is influenced by the effectiveness of innovation processes (failure rate).

The feedback approach to entrepreneurial orientation allows us not only to understand *why* firms act entrepreneurially, but also *how* they act in relation to strategic innovations generation.

In this context the integration efforts of top managers play a fundamental role. The integration time has a strong influence on the success rate of strategic innovations. If it is not well governed an increase in the failure rate progressively depresses the entrepreneurial orientation of middle-level managers, thus jeopardising the entire innovation pipeline function.

An "active posture" toward innovation is not necessarily a positive component of entrepreneurial orientation. Firms with more traditional orientation obtain better strategic innovation performance in traditional as well as in hypercompetitive environments (Figure 21).

Figure 21. Comparison table of simulation performance

		Base run	*Proactive firm*	*Conservative firm*
Traditional environment	Strategic Innovations	138	92	362
	SIR	0.35	0.27	0.42
Hypercompetitive environment	Strategic Innovations	180	283	725
	SIR	0.30	0.25	0.33

The effectiveness of innovation processes is influenced by top managers' ability to balance the entrepreneurial orientation of middle-level managers with a high degree of discipline. The degree of "strategic discipline" in our model is represented by the choice of reference selection and retention rates that become more restrictive with the advance of the innovative projects through the innovation pipeline. This seems to be in contrast with studies on strategic innovations that, referring to a general business model of the "proactive" firm, sustain that it is the most successful model in turbulent competitive environments [D'Aveni, 1999].

The managerial implications of the research findings must be found in the area of organisational innovations introduction. It is essential for top managers to control the quality of innovations rather than to stimulate a relevant flow of innovations.
Only by controlling the quality at different stages and during the integration phase can top managers assure a successful strategic renewal process.
The model simulation clearly shows how the introduction of organisational measures alone, aimed at releasing entrepreneurial energy, does not produce a great deal because the low quality of the innovations jeopardises the sustainability of strategic innovations. The failure of integrated strategic innovations has deep negative effects on top managers' behaviour. In fact they perceive as unsuccessful the process of strategic innovation and, consequently, reduce the organisational innovations suffocating the entrepreneurial behaviour and the development of further innovation by middle level managers.

The research has two main types of limitations.
Firstly, there are limitations related to the utilization of modelling methodology. The representation of the process of strategic integration was extremely simplified with the concept of "developing integration capabilities" because further assumptions would nor have been supported by previous research findings and other theoretical contributions.
In addition the representation of organisational innovations was anchored to modifications of the software part of the organisational structure, like for example, new procedures for the approval of innovative projects and new criteria for the allocation of

resource. The model could be improved including, in an explicit way, the introduction of innovations that concern the hardware part of the organisation, as for example modifications in the organisational structure.

Secondly, there are some limitations that affect coherence with the general theoretical framework that inspired the model.
According to the scholars who introduced the dynamic view of strategy, [D'Aveni, 1994], the rate at which new strategies are implemented influences competitors' behaviour, and therefore the level of rivalry and, at the end, competitive pressure.
In our model, this variable was modelled as exogenous. The model could have been improved with the construction of a specific structure that represents how the implementation of strategic innovations can modify the competitiveness of one or more rivals and consequently, competitive pressure.

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