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ORGANIZATIONAL CAPABILITIES AND INDUSTRY DYNAMICS: A COMPUTATIONAL MODEL

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Abstract

In this paper we propose a model of bounded rational organizations that addresses the role of organizational capabilities in shaping firm size, growth rates and profitability. Our approach aims at reconciling the logic behind stochastic models of firm growth with the notion of organizational capabilities as drivers of economic performance. We extend the stochastic framework by incorporating behavioural assumptions on: (a) the interactions between the firm and the business environment; and (b) the mechanism by which firms sense and seize business opportunities. In our perspective, the degree of concurrence between the substance and organization of the firm and the context in which it operates will directly influence its profitability and indirectly (through costly mutations of the organizational structure) drive its growth. Despite its simple nature the model is able to capture well known regularities about industry dynamics. It generates firm size distributions that are skewed and heterogeneous across different scenarios. Moreover, our results suggest that the higher the selective power of the firm's organizational capabilities, the more the steady state distribution deviates from a log normal. Besides, the distribution of growth rates has a tent-shaped form which is consistent with the pattern described in empirical studies. The distribution of opportunities per firm is also skewed suggesting that a very few entities account for a large fraction of business opportunities arising throughout the simulation period. Finally, the interaction between the external environment and the internal structure of the firms also influences the heterogeneity in the value of the opportunities they capture.

Keywords: Organizational Capabilities, Firm Size Distribution, Growth Rates, Simulation Model

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1 Introduction

During the last decade, a huge amount of work has revitalized the debate on a set of well recognized regularities concerning the distribution of firm size and the strictly related distribution of growth rates. This research effort (Stanley *et al*., 1995; Axtell, 2001; Fu *et al*., 2005; Bottazzi and Secchi, 2006) has been directed primarily to designing the stochastic process that better approximates the steady state distribution of firm size that emerges from empirical observations (de Wit, 2005).

Taking as a reference the three stage law finding process described by Ijiri and Simon (1977) this study focuses on the first two: "finding simple generalizations that describe the facts to some degree of approximation"; "finding limit conditions under which deviations of the facts from generalization might be expected to decrease". Unfortunately, despite the growing sophistication of the last generation of models, it is difficult to dismiss the idea that "there is no obvious rationale for positing any general relationship between a firm's size and its expected growth rate, nor is there any reason to expect the size distribution of firms to take any particular form for the general run of industries" (Sutton, 1997: 42).

If the general rule is a skewed size distribution, then both the level of approximation and the limit conditions under which deviations are expected to decrease remain unclear. We know that some versions of stochastic growth processes reproduce the limit size distribution in some industries, better than others (see the case of pharmaceuticals described in Fu *et al*., 2005), but we cannot make predictions about whether and how they can be applied to other industries.

Moreover, a common feature of those models is that they are compatible with a minimal role of differences among firms. Such a characteristic stems from the idea underlying the Law of Proportional Effects (Gibrat, 1931) that, since its formulation, cast serious doubts about the theory of optimal size. However, even if we dismiss optimal size theory, we cannot dispose of differences among firms in driving the pattern of industry evolution (Nelson, 1991). Indeed, a parallel set of empirical regularities concerning the economic performances of business companies, outlines persistent differences in profitability even within narrow defined industrial sectors. The appearance of long-lasting profit differentials among firms has been interpreted as indicating that firm specific organizational capabilities do actually exist.

Nonetheless, persistent heterogeneity among firms can barely be reconciled with a law postulating equal chances of growth behind the observed regularities in firm size distribution.[§]

The difficulty of refining a simple generalization (the skew distribution of size), and the problem of accommodating different sets of regularities, demands new theoretical approaches. One such might be the third step advocated by Ijiri and Simon (1977: 116): "explaining why the generalization 'should' fit the facts", or "discover simple mechanisms that would produce the [empirical regularity]". A generation of models in which the random growth process was replaced by the introduction of stochastic elements in conventional maximizing models has pioneered this road (Sutton, 1997). Likewise, in what follows we try to open the way to explanatory models that do not rest on the assumption of maximization. Our starting point, instead, will be the idea of "organizational capabilities" as a basic constituent of firms' decision-making processes. In a nutshell, we propose a model of organizational behaviour in which decisions about growth are driven or constrained by organizational capabilities.

Two reasons underpin the choice of putting organizational capabilities at centre stage. On the one hand, the peculiar characteristics in the observed patterns of firm growth (e.g. the Laplace probability density function describing growth rates and the upper tail of firm size which follows a power law distribution)[**] compel further advances on theoretical grounds. This piece of evidence calls for the existence of self reinforcing mechanisms that are in accordance with the hypothesis that differences among firms play some role in drifting growth. On the other hand, the already mentioned evidence of high and persistent interfirm differences in economic performance casts doubt on the assumption of the optimizing behaviour of organizations, while being compatible with different internal structures of firms acting in imperfect markets.

The model focuses on the interplay between the internal structure of the firm (organizational capabilities) and the structure of the environment as the main determinants of the emerging patterns of growth that may eventually lead to slightly different steady state distributions of size and profitability among firms. The model we design is aimed at building artificial worlds with respect to which we can formulate precise hypotheses. Obviously, to go

[§] Moreover, both views contrast with textbook popularization according to which size depends on technology and demand, and profits are the result of market structure (i.e. number of competitors).

[**] Palestrini (2007) proposes a unifying framework that relates the double exponential distribution of growth rates and the power-like behaviour of size distribution.

a step further would require identification of the empirical counterparts of our artificial worlds.

The paper is organized as follows. In Section 2 we discuss the most widely accepted regularities concerning the size, growth and profitability of business firms. In Section 3 we review some recent contributions that provide theoretical underpinnings to the observed patterns of firm profitability and growth. Section 4 presents a simulation model that addresses the role of organizational capabilities in shaping the evolution of industrial structure. In Section 5 we provide some preliminary results of the simulation model that seem to endorse the viability of our approach for a microfoundation of emergent phenomena. Section 6 provides conclusions and highlights a strategy for future research.

2 Patterns of Firm Performance

2.1 Firm size and growth rates

The concern of antitrust policy for the implications of high degrees of market concentration, and the observation that firm size distributions are skewed across the general run of industries (Hart and Prais, 1956) led to a prominent strand of research in the Industrial Organization field, the literature on Growth of Firms. Classical economic theory relies on the shape of long-run average cost curves as the underlying mechanism influencing the degree of industry concentration. However, it cannot predict the observed shape of the size distribution whether or not the assumption of a U-shaped cost curve is maintained (Simon and Bonini, 1958). This limitation stimulated the search for an alternative theory of the firm that could predict the observed patterns of size distribution and provide reliable indicators of business concentration.

Stochastic growth models (Ijiri and Simon, 1977) emerged in the 1950s as a promising option for the accomplishment of this task. One crucial assumption allows this class of models to approximate with great accuracy the observed distribution of firm size, that is Gibrat's Law[††] (Gibrat, 1931). Gibrat's Law involves three propositions: *(i)* that average growth rates are independent of firm size;[‡‡] *(ii)* that there is no heteroskedasticity in the

[††] Gibrat's Law is a property compatible with a range of models of corporate growth (Boeri, 1989) some of which are difficult to reconcile with the bulk of empirical evidence discussed in the econometric literature on the evolution of business size (Geroski, 2000).

[‡‡] This proposition, known as the Law of Proportionate Effects, implies that "the probability of a given proportionate change in size during a specified period is the same for all firms in a given industry - regardless of their size at the beginning of the period" (Mansfield, 1962: 1030). Furthermore, note that Gibrat's Law can be formulated in three different ways. One could argue that it holds: 1) for all firms in the industry, including those

variance of growth rates; *(iii)* that there is no autocorrelation in growth rates (Kumar, 1985). According to Gibrat's conjecture, unexpected shocks drive changes in firm size, an observation that can be analytically formulated as:

$$\Delta \log S_i(t) \equiv \log S_i(t) - \log S_i(t-1) = \mu_i(t) \qquad (1)$$

where $S_i(t)$ is a measures of firm size (sales, employees, valued added, assets) and $\mu_i(t)$ is usually assumed to be a normally distributed *iid* random variable. A few remarks on the economic implications of equation *(1)* are worthwhile. Eq. *(1)* states that the unexpected shocks affecting corporate growth have a permanent effect on firm size. It also suggests that the corporate growth rates of any two firms, picked at random, are likely to be uncorrelated and therefore idiosyncratic. Moreover, Eq. *(1)* also points to a lack of any dynamics associated with past growth, evidence that is consistent with the hypothesis that companies budget for fixed adjustment costs rather than variable ones (Geroski, 2000). A final prescriptive implication of Gibrat's Law is that the size distribution of firms does not provide useful guidance to policy makers keen to endorse the expansion of business enterprises (Boeri, 1989).

Unlike stochastic growth models, a later strand of the empirical studies directly addresses Gibrat's conjecture by exploring the size-growth relationship for samples of large firms observed over successive years (Hymer and Pashigian,1962; Mansfield, 1962; Singh and Whittington, 1975). This stream of applied research transformed the Law of Proportionate Effects into a benchmark for theoretical and empirical studies dealing with the growth of business companies. More recently, a number of econometric studies (Hall, 1987; Evans, 1987a, 1987b; Dunne *et al.*, 1989) and contributions to the econophysics literature (Stanley *et al.*, 1996; Axtell, 2001) have revived the interest in the Growth-of-Firms literature by drawing attention to certain statistical regularities across industries and over time. The stylized facts discussed below summarize two major patterns revealed by both these streams of applied research.

> ***Stylized Fact 1****. Although there is no single form of size distribution that can be considered as typical for the general run of industries, observed distributions of firm size are highly skewed.*

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that fail and leave the industry during the period of observation; 2) for all firms in the industry, apart from those that exit the industry; 3) only for firms in the industry that are larger than the minimum efficient size.

Gibrat's Law would imply a distribution of firm size that approaches a log normal with mean and variance that increase indefinitely[§§] as time goes by. Extant research regards it as a first approximation of the observed patterns of firm size (Hall, 1987), particularly for companies whose accounting data are publicly available (Cabral and Mata, 2003). However, departures from the theoretical benchmark have emerged, providing indirect evidence that a simple Gibrat model does not accurately describe the growth of business firms.

Observed frequencies have been found either to exceed (Simon and Bonini, 1958; Growiec *et al.*, 2008) or to be lower than (Stanley *et al.*, 1995) the expected values in the upper tail of the log normal. Indeed, the upper tail behaviour in total manufacturing distribution seems to be the outcome of aggregation of fairly heterogeneous distributions of firm size at the sectoral level (Bottazzi *et al.*, 2007). Moreover, the measurement of skewness and kurtosis often deviates from the values of a true log normal distribution (Hart and Oulton, 1996; Cabral and Mata, 2003; Reichstein and Jensen, 2005; Angelini and Generale, 2008). The Yule and Pareto distributions are regarded as suitable alternatives to overcome these deviations and guarantee a better fit than the log normal for the observed frequencies in both tails (Axtell, 2001). These advantages notwithstanding, none of the distributions considered appears typical for all countries and all industries (Schmalensee, 1989). And most scholars take the view that firm size distribution will be skewed, but without any expectations as to the degree of skewness, or the exact form that the distribution might take (Sutton, 1997).

> ***Stylized Fact 2****. The distribution of (logarithmic) growth rates displays a tent-shaped (exponential) form.*

According to Gibrat's Law, the idiosyncratic shocks driving the evolution of firm size (*Eq. 1*) generate growth rates, $R_T \equiv \frac{S_{t+T}}{S_t}$, which, for sufficiently large time intervals T⑦☟t, are log-normally distributed. However, a strand of studies drawing on the early tradition of stochastic growth models, have portrayed a different picture. These contributions point out that the observed distribution of growth rates departs from the expected Gaussian shape implied by Gibrat's Law, and instead displays a 'tent-shaped' (exponential) form. Stanley *et al.* (1996) pioneered this stream of research investigating data for all publicly traded US manufacturing companies over the period 1975-1991. The authors find out that a symmetric exponential (Laplace) distribution, well describes the pattern of annual (logarithmic) growth

[§§] Hence, the model has no real steady-state distribution. To obtain a stability condition alternative devices that restrict the random walk of firm size are needed (de Wit, 2005).

rates, evidence confirmed by later studies that explore the growth performance of US companies over a longer period (Amaral *et al*., 2001). The "tent-shaped" form of the growth rate distribution emerges as an invariant property that holds among manufacturing firms in other countries (Reichstein and Jensen, 2005; Fagiolo and Luzzi, 2006; Coad, 2007), as well as in narrowly defined industrial sectors (Fu *et al*., 2005).

2.2 Sources and dynamics of profitability

Economists and management scholars have shown great interest in two intertwined issues concerning the economic performance of business firms: *a)* the existence of persistent differences in accounting profitability between firms; *b)* the identification of factors responsible for such differences.

Spurred by Mueller's (1977) seminal contribution, the first line of inquiry tests the competitive environment hypothesis claiming that market forces in each product areas are effective in bringing profits in line with competitive rates of return. Several studies explored the behaviour of profit, for large companies in developed countries, during the second half of the 1980s (Mueller, 1990), providing broad evidence contesting the competitive environment hypothesis.

In all countries, permanent differences across firms are observed, implying that firms enjoying above (below) normal profits at a given time can be expected to gain above (below) normal profits in the future. In addition, short run deviations from company specific equilibrium rates of return were found to erode in the space of three to five years, with dynamic forces producing their major impacts on excess profits within a single year, and rarely lasting for more than one year (Geroski and Jacquemin, 1988). Firm characteristics emerge as key drivers of long run company profits levels, while industry factors appear to be more important for explaining the speed of adjustment across firms (Waring, 1996; Goddard and Wilson, 1999; Wiggins and Ruefli, 2002).

The second stream of analysis focuses on the sources of observed variations in accounting profitability (McGahan and Porter, 2002; Hawawini *et al*., 2003; Misangyi *et al*., 2006). Strategy scholars took up this investigation following Schmalensee's (1985) questioning the relevance of corporate factors in explaining persistent heterogeneity in firm performance, which contrasted with the predictions from the resource-based theory of the firm. Disregarding identification of the factors driving superior performance and suppressing concerns over causal mechanisms, the major interest of those studies has been "the existence and relative importance of time, corporate, industry, and business-unit effects, *however generated*, on the total dispersion of total rates of returns" (Rumelt, 1991: 169).

A handful of important conclusions emerge from this far-reaching body of investigations: *a)* business-specific effects account for a large portion of profit variation; *b)* corporate and industry effects are equally important sources of variation; *c)* industry, corporate and business-specific effects are related both in cross-section and intertemporally. Overall, the relatively low fraction of profit variation associated with industry effects compared with business-specific effects, and the significant fraction attributed to corporate effects, have been interpreted as supporting the resource-based view of the firm and the central role of organizational competences that this perspective calls for. To summarize:

> ***Stylized Fact 3***. *Heterogeneity in firms' profitability persists in the long run and is significantly influenced by corporate factors.*

3 Heterogeneity, Capabilities and Firm Performance

The patterns emerging from data on firm performance puzzled scholars for some considerable time. For instance, Geroski (2005) argued that the large random component of empirically observed corporate growth rates undermines the notions of core competence and learning as drivers of corporate growth:

> The idea of core competencies has emerged largely to help explain both differences in profitability between firms within the same industry and between industries. The basic idea is that there are certain core, team-based activities that help make their possessors distinctive. These skills are thought to be durable and difficult to imitate, and they can, therefore, give rise to persistent competitive advantages which, in the end, lead to persistent profit differences between firms, even those apparently engaged in the same lines of activity. Attractive and interesting as it is, this line of argument is, however, difficult to reconcile with the random variations in corporate growth rates that we observe over time. A firm that possesses real and substantial core competencies should, one would have thought, find itself systematically able to outgrow its rivals year in and year out. And yet, this rarely happens: firms grow fast in one year, but rarely every year over a three or four year period. (Geroski, 2005: 136).

Recent contributions that draw upon the early stochastic growth models (Ijiri and Simon, 1977) reveal a series of statistical properties in the distributions of firm size and growth rates that may go some way to help reconciling the foregoing evidence on profitability and growth, with the notion of organizational capabilities. In particular, the fat tails observed in the growth rate distribution, at different levels of sectoral aggregation, hint at the existence of a self-reinforcing mechanism in the process of corporate growth that a simple Gibrat type model would rule out (Bottazzi *et al.*, 2007). Whereas the newer stochastic growth models reprise the notion that the market consists of exogenous investment opportunities, they account for the sources of such correlating mechanisms that might entail a richer structure in the growth dynamics than commonly assumed.

Sutton's (1998) model assumes the market to consist of many independent submarkets, all of the same size and all able to accommodate exactly one firm. This island model differs from the early tradition because it avoids the assumption that firms grow according to Gibrat's Law. It assumes instead that the relation between a firm's size and its growth rate satisfies a weaker restriction claiming that "the probability that the next market opportunity is filled by any currently active firm is non-decreasing in the size of that firm" (Sutton, 1998: 246). Although this modified Simon model correctly predicts the skewed distribution of firm size, it fails to account for the observed tent-shaped patterns of growth rates.

Further extensions of the island model have been proposed, which allow for self reinforcing mechanisms in the growth process and predict a growth rates distribution that accurately fits the observed data. Fu *et al*. (2005) introduce a self reinforcing mechanism that depends on two intertwined processes concerning the number and size dynamics of the constituent components of business firms. The processes at work require that the number of constituent units in a firm grow in proportion to the number of existing opportunities, and the size of each constituent unit swings in proportion to its attained size. Their joint operation, conditional on the entry rate of new firms, the number of constituting elements, the time horizon over which the process unfold, leads to a probability density function of growth rates that is Laplace in the centre with power-law tails. In Bottazzi and Secchi (2006), the self reinforcing mechanism driving the growth process originates from a relaxing of the assumption of equal probabilities in the assignment of emerging opportunities to existing firms. By modelling the probability for incumbents to capture new opportunities according to Polya's urn scheme, the authors introduce in the model a competitive mechanism that rests on the idea of "competition among objects whose *market success* [is] cumulative or self-reinforcing" (Arthur, 1994: xiv). Unlike the traditional island model in which competition operates through the entry of new firms, such an approach is consistent with empirical investigations in which the entry process is switched off and only balanced panels of firms are considered.

While the stochastic growth models presented above are able to reproduce major stylized facts concerning industry dynamics, much is left unexplained. How can these models of growth be justified? Is there any connection with the firm's decision-making process? In this paper we try to extend the stochastic framework by proposing a model of bounded rational organizations that incorporates behavioural assumptions on: *(a)* the interactions between the firm and the business environment; and *(b)* the mechanism by which firms sense and seize business opportunities. The model is meant to show that *the self reinforcing mechanisms alleged to account for the observed distributions of firm size and growth can be understood as resulting from the joint effect of organizational capabilities and the structure of the environment*.

Our perspective has strong ties to capabilities-based theories of the firm (Dosi and Marengo, 2007) as well as the theory of the "artificial" proposed by Simon (1996). Drawing on their terminology, we describe a firm as a system that purposefully trails goals and functions, and opportunely adapts to fulfil them. The firm, therefore, can be thought as an "interface" between an inner environment, that is, the organizational capabilities with which it is endowed, and an outer environment, that is, the surroundings in which it operates. Accordingly, the degree of concurrence between the substance and organization of the firm and the context in which it operates will directly influence its profitability and indirectly (through costly mutations of the organizational structure) drive its growth.[***] The achieved outcomes, in turn, will feed a process of search and mutation that make this framework intrinsically evolutionary.

Another feature that distinguishes our contribution from earlier work in the Simonian tradition concerns the way in which we model the taking-up of opportunities by incumbents. Rather than imposing any specific probability density function that might eventually well describe the partition of opportunities across entities, we try to identify and simulate a set of behaviours that might be expected to shape the allocation process. To accomplish this task we borrow from the dynamic capabilities framework which proposes an analytical separation between *(1)* the capacity to sense opportunities and *(2)* the capacity to seize opportunities[†††] (Teece, 2007). Such a reference scheme entails the identification of those elements, interactions and stages an enterprise has to manage in order to successfully address a business opportunity. We incorporate this idea in our simulation model through a two-step procedure. In the first step firms search the environment and detect opportunities. Two factors impinge

[***] Note the analogy with technology studies which explain the failure of innovating firms on the basis of the mismatch between the firm's system of coordination and control and the nature of available technological opportunities (Pavitt, 1998).

[†††] Teece (2007) also mentions the capacity to maintain competitiveness through reconfiguring the firm's tangible and intangible assets, an aspect that we do not explicitly take into account in this version of the model. Besides describing the nature of these three capacities, he extensively specifies the microfoundations that underpin such enterprise-level capabilities.

on their effectiveness in these searching and sensing activities: *(i)* their current endowment of organizational capabilities; *(ii)* their relative size. The former establishes the boundaries of the business environment that the firm can explore. The latter determines the ranking of firms according to their sensing ability. In the second step the firm that outperforms its rivals in sensing new opportunities has the chance to seize an opportunity and, eventually, earn a profit. In the next section we detail our strategy to formalize these ideas in the simulation experiment.

4 A Model of Growth Driven by Organizational Capabilities

4.1 The Building Blocks

We conceive *the inner system* of the firm as a repertoire of organizational capabilities which supposedly influence a firm's ability to take up the business opportunities populating the neighbouring environment. An explicit model of organizational capabilities is the most important feature of our model. The aim is to disentangle the relationship between firms and technologies. Were technologies freely available to firms, all observed heterogeneity would be explained by the external environment, that is, by the structure of input markets (that give access to resources) or by the nature of the competition in output markets.[‡‡‡] A long tradition of organizational studies has demonstrated that access to technologies requires particular organizational assets. Therefore, not all technologies are equally available to firms, and complementarities between technology and the organizational features of the firm are quite common. Moreover, some organizational features are not freely disposable to firms: changing organization is costly and requires more than simply acquiring a new technology.

The tradition we refer to dates back to Babbage, who demonstrated the strict correspondence between technical solution and the organization. In particular, he characterized the firm as a *structure of knowledge* that "enables [the firm] to purchase and apply to each process precisely that quantity of skill and knowledge which is required for it" (Babbage, 1835: 201). The correspondence between available knowledge and adopted technologies implies that new technical opportunities are available only if they mirror the internal structure of knowledge.[§§§]

The empirical work of Joan Woodward (1965), and the theoretical work of James D. Thompson (1967) offer a comprehensive framework to investigate the relationship between

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[‡‡‡] This was precisely the tenet in Bain's industrial economics: tell me where you live, and I will tell you who you are.

[§§§] A modern version of the same idea is Cohen and Levinthal's (1990) concept of "absorptive capacity".

technology and organization. In particular, these authors claim that organization matters in cushioning the fixed structure of technology against the variable states of the internal and external environment. In other words, organizational capabilities are a mix of tools aimed at making the technology work in a specific situation.

Finally, it is important to bear in mind that organizational capabilities are embedded in the firm, which amounts to saying that

> [t]he initial conditions … in which institutions or organizations are formed, can become enduring constraints. They can result in the selection of a particular solution for what is then perceived at the time to be the crucial generic function, for example, recruitment of participants and this can limit the design of other rules and procedures, so that even if the original rationale were to become irrelevant, altering the organisation's recruitment policy would possibly disturb many other aspects of its operations and so impose considerable readjustment costs. In this way the organisational structure can become 'locked in' to a comparatively narrow subset of routines, goals and future work trajectories. (David, 1994: 214)

The above passage recalls the same stickiness of organizational capabilities that Arrow underlines in saying that "[s]ince the code is part of the firm's or more generally the organization's capital … it will be modified only slowly over time. Hence, the codes of organisations starting at different times will in general be different even if they are competitive firms" (Arrow, 1974: 56). Assuming the inner system is the repository for organizational capabilities that can mutate only episodically at high cost, implies that firms may not be able to exploit, or even sense, all technological opportunities in their surroundings.

The outer system is described, à la Simon, by two aspects: richness and complexity. Richness is related to the number of opportunities available in the environment. A rich environment is –among others– one in which technological progress gives birth to a large number of new products and processes, or opens up new markets for the existing products. It offers many opportunities, which firms can exploit with no risk of their depletion. Satisfactory solutions are easily achieved and the "slack", that is, the numerous opportunities in the environment that are not exploited (March, 1994) is always high. Complexity represents the difficulty to predict the outcome of an alternative, given the set of already exploited opportunities. This could also be seen as the ruggedness of the environment (Kauffman, 1993). In a smooth, non complex environment, the outcomes of the nearest opportunities are highly correlated. In a complex environment, the outcome of an exploited opportunity does not carry information about the value of other near ones. Complexity translates in the difficulty of environment exploration.

The *exchange between the inner and the outer environment* is guided by two fundamental mechanisms: search[****] and feedback of information on performance. Search determines the way firms capture new opportunities. For the incumbents, we design a two-stage mechanism in which firms: *(a)* sense opportunities on the basis of their relative sizes; and *(b)* seize only those opportunities that appear in the neighbourhood of their current position in the landscape. The boundaries of such a neighbourhood, in turn, are a function of the endowment of organizational capabilities of each entity. In a nutshell, firms can only pick up opportunities that are close to their organizational capabilities.

In terms of entry, we assume that newcomers capture opportunities generated in the outer environment with a given probability. At the time of entry, their endowment of organizational capabilities perfectly matches the nature of technological opportunity with which they are associated. As a consequence, whenever an entry occurs a new combination of organizational capabilities appears in the market.

Feedback comes through performance which depends on the value of the opportunities a firm is able to seize and manage. The value of the opportunities is to some extent predictable given the structure of the environment. In a correlated environment, the value of a near opportunity should be not far from that associated with previously captured opportunities. In a rugged landscape, picking up an opportunity whose structure fits the current set of organizational capabilities does not necessarily lead to similar performance in term of profitability. Two outcomes may arise from the mechanism of feedback: when profitability reaches unsatisfactory levels, the firm can either exit or, at a cost, reconfigure its organizational capabilities.

Finally, we need to highlight the evolutionary nature of this scheme: evolution can be interpreted as the change in the set of organizational capabilities that populate the environment. This set evolves through entry and exit (the phylogenetic aspect of evolution) and the mutation of incumbents (ontogenetic evolution).

4.2 Details of the Model

Consider an industry evolving in a sequence of periods 0,1,...,t,...T, where 0 is the period in which the variables are initialized. In each period a number of firms F^t is active.[††††]

[****] Our model can easily accommodate finer processes of search, such as that described by Gavetti and Levinthal (2000) in which firms have partial representation of opportunities.

[††††] In what follows we use the right superscript to denote the period to which the variable refers; when left and right superscript are used, this means “from the period of the left superscript to the period of the right superscript”. The subscript i (i = 1, …, F^t) refers the variable to a firm.

Each firm *i* is endowed with a set of organizational capabilities: OC_i^t are represented as a vector of 1s and 0s of length *L*. As organizational capabilities can evolve, they are indexed over time. Firm *i* can be active in different submarkets: this means that, during its life, the firm captures one (which is the condition for its existence), or more opportunities.

We denote BO_i^t as the business opportunity captured by the firm *i* at time *t*. The set of all business opportunities available in the market up to time *t*>0 is given by ${}^0BO^t = \sum_{\tau=0}^{t} \sum_{i \in F^t} BO_i^\tau$. Business opportunities are described as a Boolean vector of the same length as the vector representing OC_i^t. Each opportunity has a given value, $v^t(BO)$, that can be thought of as the size of the potential market for that opportunity. The initial value of an opportunity is a random variable whose realization depends on a set of rules defining the environmental setup. In the case of a rugged environment, randomly drawn values are associated with each binary vector describing a BO. In the case of a smooth environment, a set of values is extracted randomly and ordered from the lowest to the highest score. Such values are subsequently associated with vectors of BOs which have been previously ranked by the number of 1s they contain (vectors with equal numbers of 1s are randomly ranked). In this way, BOs with a near structure have near values.[‡‡‡‡] The value of an opportunity evolves along time as we will describe below.

We define the following measures of firm performance:

- firm activities, the number of business opportunities a firm has taken up to time *t* is ${}^0BO_i^t = \sum_{\tau=0}^{t} BO_i^\tau$;
- firm turnover, the total revenue a firm earns in period *t* from all the activities in which it is involved: $V_i^t = \sum_{\tau=0}^{t} v^\tau(BO_i^\tau)$;
- market share, the ratio between firm turnover and the total revenue of the firms existing at time *t*: V_i^t / V^t , where $V^t = \sum_{i \in F^t} V_i^t$;
- firm profits, total turnover net of costs. There are three categories of costs. The first is the cost of a mismatch between organizational capabilities and business opportunities. The value of each opportunity decreases proportionally with the Hamming distance between the two, that is, with the

‡‡‡‡ While this way of generating the landscape differs from Kauffman (1993), it respects the same structure and, at the same time, enables higher variability.

number of the ordered elements in the two vectors that differ.[§§§§] Formally, we can define $m_i^t = | OC_i^t - BO_i^t |$ as the L length vector of the absolute value of the differences between organizational capabilities and business opportunities. This will contain as many 1s as the non-equal elements. Let $d_i^t = \mathrm{I}(m_i^t)$ be the scalar product of the unitary vector and the vector of distances, that is, the sum of the 1s of vector m_i^t. The mismatch between organizational capabilities and business opportunities implies a cost of $\frac{d_i^t}{L} v^t(BO_i^t)$, so that the net value of the business opportunity will be $nv^t(BO_i^t) = \left(\frac{L - d_i^t}{L} \right) v^t(BO_i^t)$. The total net value of business opportunities for firm i at time t is then: $NV_i^t = \sum_{\tau=0}^{t} nv^{\tau}(BO_i^{\tau})$. The second category of costs involves expenditures associated with organizational change born at time t, $c_i^t(OC_i)$. Finally, in each period, firms bear a fixed production cost f_i for each opportunity at hand: the height of f defines the threshold for opportunity survival in the market. Firm profits at time t are then defined as: $R_i^t = NV_i^t - c_i^t({}^{t-1}OC_i^t) - f_i$ (if fixed production costs are equal for all opportunities, $f_i = f \quad \forall\, i \in I$, the third term on the right hand side would be written as ${}^0BO_i^t f$).

Indicators of market performance can be defined accordingly as: *(a)* the number of firms operating at time t, F^t; *(b)* the total number of business opportunities available at time t, ${}^0BO^t = \sum_{\tau=0}^{t} \sum_{i \in F^t} BO_i^{\tau}$; *(c)* the average size of firms in terms of business opportunities, $ABO^t = \frac{1}{F^t} {}^0BO^t$; *(d)* turnover, $AV^t = \frac{1}{F^t} \sum_{i=1}^{F^t} V_i^t$; *(e)* profits, $AR^t = \frac{1}{F^t} \sum_{i}^{F^t} R_i^t$.

The market is initialized at period 0 as follows. An initial number of firms F^0 is created as strings of OC^0. To each firm is attached a BO_i^0 with the same structure as OC_i^0 (i.e. with the 0s and 1s in the same position) and a value is extracted for each opportunity

[§§§§] Recall Heiner's definition of uncertainty as a competence-difficulty gap, where the environmental variable determines the complexity of the environment, and competence is defined by the perceptual variables "which characterise an agent's competence in deciphering relationships between its behaviour and the environment" (Heiner, 1983: 564).

according to the procedure devised for the specific environment (smooth *vs* rugged) we are considering. In each subsequent period the following events occur.

a. *Arrival of new opportunities*. A group of business opportunities is extracted from the population of opportunities and assigned to either an entrant or an incumbent firm, according to the following rule. When an opportunity is selected it is assigned with probability p_E to a new entrant: in this case the number of existing firm is increased by 1, $F^t=F^{t-1}+1$. With the complementary probability ($1-p_E$) the opportunity is assigned to an incumbent. Among all existing firms, incumbents are selected according to their market share. The firm extracted first evaluates the newly available opportunities and retains from them, the one whose structure is closer to its set of organizational capabilities (in terms of the Hamming distance between the two Boolean vectors). The firm can also skip the choice whenever the mismatch between its organizational capabilities and all the business opportunities extracted is too high, that is, whenever $d_i^t > d^*$, with d^* defining the maximum distance that allows a firm to seize an opportunity (hereafter, seizing distance). In this case, all new opportunities are lost. Once the opportunity is selected, the firm knows its value $v^t(BO_i^t)$, and the net value $nv^t(BO_i^t)$ can be calculated. This procedure reflects the fact that a firm does not know the exact market value of the business opportunities it chooses.

b. *Updating opportunity values*. The second event occurring each period is the updating of the value of opportunities already taken. A rate of growth g_t ($-1<g_t<1$) is extracted from a normal distribution (0, σ_g). The value of each business opportunity is updated according to the rule: $v^t(BO_i^t) = (1+g_i^t)\cdot v^{t-1}(BO_i^{t-1})$.

c. *Organizational change*. Firms which, after the allocation of new opportunities and the updating of old business opportunities, present a strong decrease in profitability, $R_i^t << R_i^{t-1}$, can, with probability p_{OC}, proceed to organizational change. In this case OC_i^{t-1} are updated at a cost $c_i^t({}^{t-1}OC_i^t)$: that is, a single bit is changed such that the net value of business opportunities is maximized, all other bits remaining fixed (note that this corresponds to a backward looking process of adaptation).

e. *Exit of opportunities and firms*. If in period t, $nv^t(BO_i^t)<f_i(BO_i^t)$, the opportunity is abandoned. If in period t, $R_i^t \leq 0$, firm i exits the market.

A comments is needed on the way that competitive dynamics enter our framework. The primary channel through which competition occurs is by the entry of new firms, a standard mechanism since the early generation of stochastic growth models (Simon and Bonini, 1958). Competition, however, can implicitly underpin the updating of opportunity values described above. The shrinking and expansion of business opportunities, which we represent as random draws from a N(0, σ_g), can be conceived as the outcome of underlying processes concerning pricing behaviour and technological advances.

The absence of an explicit modelling of strategic interactions is by no means a limitation in our model. It has been convincingly argued elsewhere that this feature, albeit in an extreme way, captures the idea that "most conventionally defined industries exhibit both some strategic interdependence within submarkets, and some degree of independence among submarkets" (Sutton, 1997: 49).

5 Simulation Setting and Results

5.1 Simulation Protocol

A comprehensive simulation plan would consider three sets of parameters:

a. two factors that describe the outer environment are richness and complexity. Complexity is defined by the smoothness or ruggedness of the environment (Kauffman, 1993). The environment is smooth when the values of opportunities lying within a given neighbourhood (defined in terms of Hamming distance) are highly correlated. It is rugged in the opposite case. Richness is given by the number of opportunities available in each step.

b. one parameter describing the effect of organizational capabilities on the search process. It corresponds to the seizing distance, d^*, as defined above. For example, a parameter d^* equal to 3 implies that a firm cannot seize those business opportunities whose structure differs by more than three bits from the structure defining the organizational capabilities of that firm.

c. two parameters representing feedback and evolution: entry and costs of organizational change. If entry is easy, a high number of new opportunities translates into a growing number of firms and an enrichment of the set of capabilities in the market. If the costs of organizational change are low, firms can easily modify their structure in order to adapt their endowment of organizational capabilities to the structure of the market in which they are operating.

In what follows we focus on the impact of the first two classes of parameters, keeping the rate of entry fixed and disregarding the role of organizational change. We aim at showing how organizational capabilities shape the growth and profitability of firms in different environments, ignoring concerns about the evolutionary properties of the model which, in turn, depend on the parameters regulating feedback and mutation.

5.2 Simulation Parameters

We initialize the model with a population of 400 firms. Preliminary simulations show that above a minimal threshold, changes in the number of firms existing at the initial stage do not generate qualitatively different results. The support of the distribution of business opportunities values is in the interval [25,100]. It is important to note that the larger the support the fatter the "potential" tails in the distribution of firm size predicted by the model. Here, "potential" underlines that the existence of fatter tails also depends on other model characteristics. Or, in other words, that fat tails are "activated" by the non-linear interactions of several features of the model.

The length of the vectors representing business opportunities and organizational capabilities is set to 7. Although the results seem to be robust to changes in the value of this parameter, it should be emphasized that, in general, the longer the string the clearer are the differences between alternative scenarios. Usually, longer strings amplify the dissimilarities between the smooth and the rugged worlds. The initial number of opportunities that firms capture is set at a value of 1 in order to mimic the typical assumption made in the literature. The birth rate is exogenous and in all scenarios analysed it is set at 0.1. This choice is spurred by the need to disentangle the dynamics associated with either the evolution of business opportunities picked up by incumbents, or with the ability of entrants to bring new business opportunities into the market.

The fixed cost is set at a value of 10. It represents the cost firms have to pay to be able to produce in each time step. Note that this parameter indirectly establishes a minimal size below which firms are forced to exit the market. The magnitude of adjustment of business opportunity value over time, σ_g, is set at 0.02. This is the pseudo-Gibrat process involving business opportunities that incumbents have already captured and are exploiting to earn profits. The choice seems to be neutral, in the sense that a too high rate of evolution can cancel out other dynamics in the model, while a smaller adjustment will collapse the distribution of growth rates towards zero.

Before presenting the simulation results, we should evaluate the possibility that a steady state (SS) exists in our model. The literature dealing with industry dynamics discusses a wide range of models with different dynamic characteristics leading to different "limit" distributions of firm sizes (de Wit, 2005). The most important assumptions for a SS to exist concern the entry and exit processes and the mechanism governing the growth of firms. By playing with these assumptions one can get a wide range of size distributions, from log normal to Pareto.

Therefore, the possibility for our model to reach a SS is related to the magnitude of the processes governing the demography of the industry. The entry mechanism in our model is assumed to be exogenous; the birth rate is parametrically given. The exit mechanism is endogenous but is strongly influenced by the magnitude of fixed costs (exogenous). If, to some extent, the two processes are balanced out, we end up with a fixed number of firms in the industry. This represents a kind of necessary condition for a SS to exist.

5.3 Some Results

Our simulation exercise analyses eight scenarios generated by different combinations of parameters concerning on the one side the richness and complexity of the outer environment, and on the other side the seizing distance. As we have already seen the parameter concerning complexity can take the value SMOOTH or the value RUGGED. The parameter describing the richness of the environment can take the value 1 (POOR environment) or the value 3 (RICH environment). In the first case firms can only decide whether or not to take up the emerging opportunity. In the second case firms can choose among all newly available opportunities the one that best matches their endowment of organizational capabilities. With respect to the seizing distance, d^*, we alternate a value of 7 (organizational capabilities and business opportunities may differ in terms of their constituting bits) with a value of 3 (organizational capabilities and business opportunities may differ by no more than three bits for a firm to grab an opportunity). The eight scenarios are defined as: PRU7, PSM7, RRU7, RSM7, PRU3, PSM3, RRU3, RSM3.

Figure 1 shows the distributions of firm size and growth rates in a typical simulation run for three different scenarios. The upper box presents the histograms of the logarithmic size distribution together with a kernel estimation of the density function. A log normal distribution seems to well approximate the pattern of firm size generated in the three scenarios, a finding consistent with the empirical evidence discussed in the literature (Hall, 1987; Stanley *et al*., 1995; Cabral and Mata, 2003; Growiec *et al*., 2008). A closer look at the plots, however, reveals departures in the upper tail of the distributions that would suggest a poor fit of the log normal distribution for larger firms. These deviations (see descriptive statistics in Tables 1 and 2) lead to asymmetric (positive values of skewness) and leptokurtic (positive values of kurtosis) distributions.

The middle box in Figure 1 emphasises the deviations referred to above. It presents the Zipf plot (double logarithmic plot of size *vs*. rank) for surviving firms. The three graphs show that for small and medium sized firms the plotted data are concave in relation to the origin, as one would expect for a log normal distribution. For larger firms the curvature disappears and a straight line resembling the Zipf plot for the Pareto distribution seems to provide a better fit. Beyond that, as we move towards a rich and smooth landscape with organizational capabilities playing a selective role, the support of the distribution widens and the downward slope of the straight line alleged to fit the observations for larger firms becomes less steep. Overall, this is a first confirmation that the interaction between firms characteristics and the external environment plays a role.

The lower box in Figure 1 shows the distributions of growth rates along with kernel density estimations. The distribution takes a tent-shaped form which is consistent with the pattern described in the empirical studies. In addition, the support of the distribution is fairly constant throughout the scenarios, signalling a certain degree of homogeneity which also emerges in the empirical investigations on narrowly defined industrial sectors.

[Please insert Figure 1 about here]

When organizational capabilities are ineffective for seizing opportunities, $d^{*}=7$, changes in the degrees of richness and complexity of the external environment do not impinge on the number of surviving firms or their average size (Table 1). However, as we move from a poor and rugged environment (PR7) towards a rich and smooth one (RS7), monotonic changes appear in the higher moments of the firm size distribution. Such changes are noticeable when we compare extreme cases.

The increasing standard deviations in the fourth row of Table 1 suggest that differences among surviving firms increase as we move across scenarios. A decreasing median implies that for half of the surviving firms the size decreases as the environment becomes richer and less complex. Also, a higher kurtosis suggests that the distribution becomes more peaked. These results point to a clustering of small firms on the left hand side of the distribution. Nonetheless, as the environment gets richer and the degree of autocorrelation in the value of opportunities rises, the skewness of the distribution increases. Therefore, firms starting off in the simulation with valuable opportunities will grow larger as outside conditions improve.

Although firms can take whatever opportunity they sense in the four scenarios analysed, organizational capabilities may still be operating in a rich environment when the degree of complexity declines. One can reasonably expect that a firm's ability to order new business opportunities and to choose the one that best fits its structure will have non-trivial effects on the size distribution. Indeed, variations in the higher moments of the distribution when shifting from the RR7 to the RS7 scenario, support this idea.

[Please insert Table 1 about here]

Once the parameter for seizing distance is activated (d^*=3) the selective power of organizational capabilities can directly affect the steady state distribution of firm size. Comparisons with the previous four cases can be done, holding constant the degree of richness and complexity of the external environment. Although no significant change occurs in the support of the distribution, the standard deviations reported in the fourth row of Table 2 are close to those presented in Table 1, a composite picture emerges if we look at other statistics.

The figures in the first row of Table 2 show that whatever the external conditions, a tight seizing distance results in a lower number of surviving firms. Furthermore, a binding seizing distance determines a decline in both average and median firm size in a poor environment. On the other hand, firms operating in a rich environment show a higher average size, with even larger differences appearing when the landscape is smooth. Likewise, the median size of these firms is higher than that observed in Table 1.

The skewness and peakedness of the distribution react in different ways to changes in the seizing distance. In the context of a poor and rugged landscape no divergences emerge when we move towards a scenario with binding seizing distance (from PR7 to PR3). Major differences emerge when we consider the computed values of the kurtosis for smooth landscapes, irrespective of the degree of richness. The figures in the final row of Table 2 show a quite low kurtosis (1.07 and 1.77) for cases PS3 and RS3, implying a flatter size distribution than in all other scenarios. Beyond that, the values of skewness under d^*=3 seem to suggest that fatter upper tails in the size distribution are mainly related to the complexity rather than the richness of the environment.

[Please insert Table 2 about here]

In summary, the model generates firm size distributions that are right skewed and heterogeneous across sectors. We find that the higher the selective power of the firm's organizational capabilities, the more the SS distribution deviates from a log normal. Moreover, the interaction between the external environment and the internal structure of the firm (through the seizing distance) amplifies the selective power of organizational capabilities. In particular: *(a)* the richer the environment, the wider the set of choices firms have, the stronger the self reinforcing mechanisms in the growth process that, eventually, lead to a higher skewness in the size distribution; *(b)* the smoother the environment, the more the values of neighbouring opportunities are correlated, and the larger those firms that start off the simulation process with high value opportunities will become. This process makes the whole distribution flatter and its tails fatter. Beyond that, a high selective power of organizational capabilities in a rugged environment may prevent firms from exploiting the chances of growth that new opportunities bring. This happens in the absence of any compensation for an increased probability of choosing a good opportunity having achieved a good one in the past: in a poor a rugged environment the selective action of organizational capabilities seems to cause a sort of "competence trap".

[Please insert Figure 2 about here]

The simulation model replicates a skewed distribution of the number of opportunities per firm (Fig. 2a) that is consistent with the typical patterns in empirical investigations. Such a shape implies that most firms seize a small number of opportunities, while a very few entities account for a large fraction of the business opportunities arising throughout the simulation period. The interaction between the external environment and the internal structure of the firms also influences the heterogeneity in the value of the opportunities they capture. In order to assess the importance of this phenomenon we categorize the total variation in the value of seized opportunities into two components, 'between' and 'within' variation. The former reflects between firm differences in the portfolios of opportunities; the latter reflects the degree of variability in the portfolio of a typical firm. The analysis we conducted points out (Table 3) that the higher the selective power of organizational capabilities in a smooth environment, the lower the heterogeneity in the set of opportunities firms pick up. The result primarily depends on the fact that firms tend to capture similar opportunities and this process is self reinforcing.

[Please insert Table 3 about here]

The distribution of (logarithmic) profits displays an approximately bell-shaped form (Fig. 2b) with minor departures from a normal distribution than observed for firm size. In order to appreciate the persistence of profits and the impact of organizational capabilities on long lasting differences across firms, we estimate the autoregressive model in equation *(2)* over the simulated data of surviving firms:

$$\pi_{i,t} = \alpha_i + \beta_i \pi_{i,t-1} + \varepsilon_{i,t} \qquad t = 1900,\ldots,2000 \tag{2}$$

In the above regression β_i reflects the persistence with which profits differ period by period from their long run level. α_i captures idiosyncratic differences that may cause the long run profits, $\pi_{ip} = \dfrac{\alpha_i}{1-\beta_i}$, that firms earn to diverge from the zero excess profits conjectured in neoclassical economic theory. $\varepsilon_{i,t}$ is an error component which summarizes the influence that unsystematic shocks have on profitability.

[Please insert Table 4 about here]

Earlier research (Geroski and Mueller, 1990) found that firm characteristics are more important than industry factors in explaining the long run equilibrium value of company profits. Accordingly, we expect our capabilities-based simulation model to predict a non-negligible fraction of α_i coefficients different from a zero value. Indeed, the figures in Table 4 show that the average estimated α is significantly different from the null profit level in about 30 per cent of the series. Furthermore, the coefficient increases when organizational capabilities play a selective role (*d**==3) and the external environment is smooth. The average value of the β coefficient is quite high and constant across the four scenarios, thus signalling that, whatever the environmental conditions, competitive forces do not wipe out extra profits in the short run.

6 Conclusions

In this paper we proposed an approach to analyse firm size, growth rates and profitability, aimed at reconciling the idea of stochastic models of growth with the role of organizational capabilities in shaping performance differences among firms. This was done by building a model that conceives firms as bounded rational organizations that adapt to the structure of the environment.

A first set of simulation exercises helped us highlight the role of organizational capabilities in shaping the growth and performance of firms. The more interesting results lie in the different findings that emerge when organizational capabilities selectively act in the environment either because of the richness of the environment, or due to the constraint capabilities imposed on the ability to seize opportunities. The selective power of organizational capabilities also depends on a second environmental characteristic, that is, the degree of complexity of the landscape in which firms operate. When the landscape is smooth and correlated, firms that are better placed at the beginning of the process tend to reinforce their position as time goes by; in such a context organizational capabilities drive the capture of new, highly valued opportunities. This implies a higher dispersion of limit size, correlation of growth rates, high persistence of performance, and high heterogeneity among firms (high between components of the variance of opportunity value). In such an environment, organizational capabilities represent the core of the behavioural mechanism generating a self reinforcing process of corporate growth. By contrast, when organizational capabilities are used as a selection device in a rugged landscape, we find a case for the “curse of capabilities”: firms are trapped by their own capabilities, even when they are of no value for the exploitation of good opportunities.

Despite the preliminary nature of this work, we believe that the present paper, by opening the way to explanatory models that complement the refinement of a general law, enriches the debate on growth and performance. We sense that a few extensions could make the model more generalizable. First, competition could be modelled explicitly, making the value of investment opportunities sensitive to the number of firms that choose them. Second, it is desirable to activate the evolutionary component of our model, that is, the process of organizational change which may lead firms to modify their positions in the landscape.

Further work is required to define an empirical counterpart for the “artificial worlds” we built, a necessary step in order to test the predictive power of the model. This should allow us to classify the environmental conditions in which firms operate, and to capture the role of organizational capabilities in seizing business opportunities. Historical data on patents, new products and the volatility of sales and market shares would provide some empirical content to concepts such as environmental richness and complexity.

FIGURES

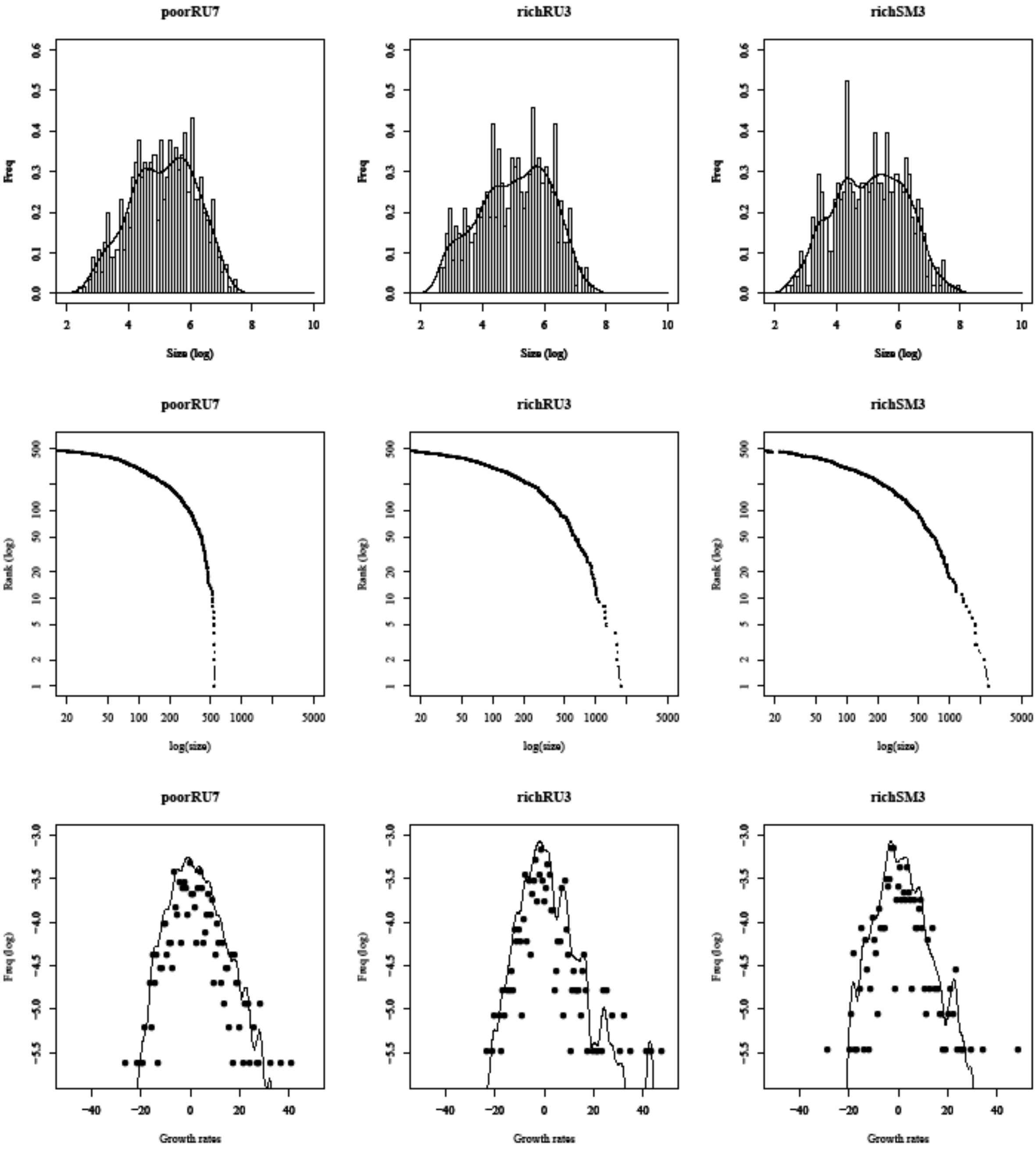

Figure 1. Simulation results of a typical run – size and growth

*Notes***.** *Upper box*, frequency distribution of logarithmic size; *Middle box*, log rank-log size plot of logarithmic size; *Lower box*, distribution of growth rates (log on the y-axis) with kernel density estimation. Results are obtained with: fixed costs=10; *d*=3*, *birth rate=0.1*; no organizational flexibility; initial number of firms equal to 400. All the pictures refer to time step 2000.

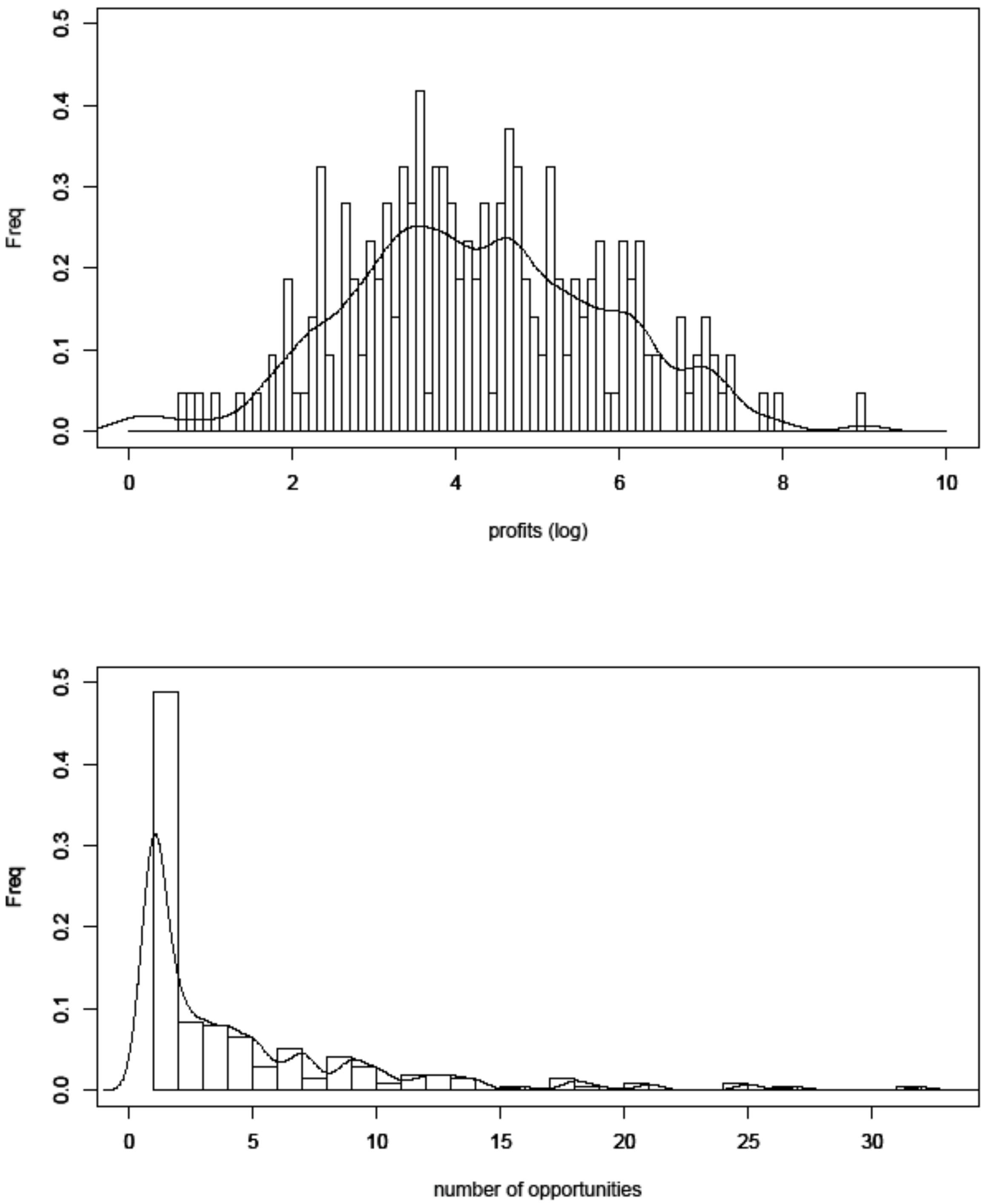

Figure 2. Simulation results of a typical run – profits and BOs

Notes. 2(a) frequency distribution of profits; *2(b)* frequency distribution of number of opportunities. Results are obtained with: fixed costs=10; *d*=3*, *birth rate=0.1*; no organizational flexibility; initial number of firms equal to 400. All the pictures refer to time step 2000.

TABLES

Table 1. Monte Carlo statistics on the firm size distributions.

Parameters	**Scenarios**			
MC mean	Poor Environment		Rich Environment	
	RU7	SM7	RU7	SM7
number of firms in the industry	602.24	602.24	602.24	602.24
	14.83	*14.83*	*14.83*	*14.83*
mean size	250.54	250.62	249.17	251.56
	9.73	*8.50*	*11.83*	*12.13*
median size	148.00	143.40	134.59	131.95
	11.44	*9.11*	*10.48*	*12.66*
standard deviation of size	277.04	281.87	292.08	322.95
	13.29	*14.44*	*17.38*	*19.46*
skewness	2.15	2.23	2.30	2.65
	0.31	*0.32*	*0.28*	*0.45*
kurtosis	6.51	7.04	7.20	10.09
	3.00	*3.32*	*2.88*	*4.72*

Notes: Monte Carlo sample size = 200. MC standard errors in italics.

TABLES

Table 2. Monte Carlo statistics on the firm size distributions.

Parameters	**Scenarios**			
MC mean	Poor Environment		Rich Environment	
	RU3	SM3	RU3	SM3
number of firms in the industry	490.7	490.28	489.54	488.28
	15.88	*10.66*	*10.81*	*8.03*
mean size	218.65	227.99	266.96	277.28
	10.03	*8.08*	*10.60*	*9.48*
median size	116.51	109.52	166.34	157.76
	11.27	*9.26*	*10.60*	*12.37*
standard deviation of size	271.75	287.08	285.22	324.60
	12.35	*16.62*	*17.16*	*17.41*
skewness	2.12	2.48	2.06	2.47
	0.26	*0.42*	*0.31*	*0.42*
kurtosis	6.10	1.07	5.68	1.77
	2.44	*4.61*	*2.38*	*4.49*

Notes: Monte Carlo sample size = 200. MC standard errors in italics.

Table 3. Monte Carlo statistics on within variability of the value of opportunities.

Parameters	**Poor Environment**			
MC Mean	RU3	SM3	7RU	SM7
Average number of firm with more than one opportunity captured	352.72	351.12	396.88	397.20
Average standard deviation of the value of opportunities	36.04 *2.67*	30.37 *2.98*	39.31 *2.86*	39.54 2.81
Median	22.34 *6.10*	21.05 *5.65*	29.77 *4.08*	*29.80* *3.76*
Standard deviation of variability of within component	98.77 *31.44*	96.29 *33.32*	110.08 *30.32*	113.33 *32.51*

Notes: Monte Carlo sample size = 200. MC standard errors in italics. Within component of variability refers to the standard deviation of value of opportunities captured by each firm.

Table 4. Monte Carlo statistics on the persistence of profits.

Parameters	**Scenarios**			
MC Mean	3RU	SM3	7RU	SM7
β	0.894 *0.02*	0.895 *0.03*	0.927 *0.02*	0.906 *0.1*
Percentage of series with a significant β coefficient	99.79	99.57	99.81	99.82
α	21.582 *0.62*	21.660 *0.71*	17.131 *0.41*	16.798 *0.62*
Percentage of series with a significant α coefficient	29.019	27.542	31.091	25.573
R^2	0.812 *0.073*	0.817 *0.100*	0.806 *0.041*	0.820 *0.018*

Notes: Monte Carlo sample size = 200. MC standard errors in italics. Coefficients α and β in the table refer to the estimation for each firm i of the linear equation: $\pi_{i,t} = \alpha + \beta\pi_{i,t-1} + \varepsilon_{i,t}$ $\quad t = 1900,\ldots,2000$

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