Paper to be presented at the DRUID 2011

on

INNOVATION, STRATEGY, and STRUCTURE -
Organizations, Institutions, Systems and Regions
at
Copenhagen Business School, Denmark, June 15-17, 2011

A Corporationâ€™s Culture as an Impetus for Spinoffs

Georg Gustav Schwesinger
Max Planck Institute
Evolutionary Economics
schwesinger@econ.mpg.de

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In many infant industries, a great share of the new market opportunities are depleted by newly founded firms that spinoff from incumbents. A model emphasizing the relation between an evolving corporate culture and the generation of spinoffs is developed to explain these regularities in industry evolution. In our framework, firm organizations reach a critical cognitive size that entails the collapse of a cooperative culture and triggers the exodus of personnel founding own firms. In this context, incumbents with a cooperative culture provide ideal training grounds for potential founders. We relate our findings to empirical evidence on developmental patterns in industries.

Jelcodes:D21,L25

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In many infant industries, a great share of the new market opportunities are depleted by newly founded firms that spinoff from incumbents. A model emphasizing the relation between an evolving corporate culture and the generation of spinoffs is developed to explain these regularities in industry evolution. In our framework, firm organizations reach a critical cognitive size that entails the collapse of a cooperative culture and triggers the exodus of personnel founding own firms. In this context, incumbents with a cooperative culture provide ideal training grounds for potential founders. We relate our findings to empirical evidence on developmental patterns in industries.

1. Introduction

This paper relates firms' evolving corporate cultures, firm size, and the generation of spinoffs out of incumbent enterprises. We offer a theory of spinoffs that explains some salient aspects of these important market entrants. Especially, we address the origins of the spinoffs' capabilities that proved to be superior to those of other types of entrants (see Klepper and Sleeper, 2005; Buenstorf and Klepper, 2009) by taking a closer look at intraorganizational learning processes. A formal model explores how changes in a corporation's evolving culture trigger spinoffs, how parent firm culture affects their performance, and how these developments at the organizational level interact with the evolution of the industry in which the firm is active. By doing so, we capture different patterns in firm development that finally will help explain the evolutionary paths that industries may follow. While many theories of industry evolution highlight the selectionist part of evolution (e.g., Hannan and Freeman, 1977; Jovanovic and MacDonald, 1994), we add an explanation that relies on intraorganizational processes.

Entrants of all kinds play an important role in models of industrial competition (e.g., Garvin, 1983; Klepper and Sleeper, 2005). We analyze the origins of some entrants – spinoffs, i.e., entrants founded by employees of firms in the same industry – and on how their specific background affects their fates. Spinoffs have begun to receive special attention in the literature in recent years due to their central role in the evolution of a number of new industries and industrial clusters particularly early in their life cycles (for an overview, see Klepper, 2009). This class of market entrants spurred the formation and growth of several well researched industries, such as semiconductors (Brittain and Freeman, 1986), automobiles (Klepper, 2002), biotechnology (Stuart and Sorenson, 2003), tires (Buenstorf and Klepper, 2009), disk drives (Agarwal et al., 2004), lasers (Klepper and Sleeper, 2005), and medical services (Chatterji, 2009). There are several existing theories of why spinoffs occur. Pakes and Nitzan (1983) offer an approach that relies on a contracting perspective to explain spinoffs, Franco and Filson (2006) argue that employees accept lower wages to work at better firms to attain knowledge they need to start their own firms, Klepper and Sleeper (2005) suggest a Hotelling-like model in which employees develop variants of their parents' products, Cabral and Wang (2009) argue that better firms spawn more and better spinoffs due to the fact that their own superior performance is based on the quality of their employees, and some more recent theories feature firms' difficulty to assess the quality of their employees' ideas (e.g., Klepper and Thompson, 2010). Our analysis of corporations' evolving cultures and spinoff generation crosses several levels of analysis: first, the firm's evolving culture as a result of collective learning processes in a growing firm, second, organizational growth in different business environments, third, the triggering of spinoffs through changes in a corporation's culture, and, fourth, the relation between firm development and the spinoff-driven evolution of an industry.

In this context, our search for recurrent patterns in firm development, spinoff generation, and industry evolution that are amenable to theoretical analysis is guided by a model of cultural learning within organizations (see Cordes et al., 2008; 2010) in combination with firm growth in different business environments and changes in firm culture as an impetus for spinoffs. It features rapidly growing firms whose success in an innovative business environment is based on a cooperative corporate culture. These organizations then systematically face a growth crisis (see Churchill and Lewis, 1983; Greiner, 1998), which leads to a dwindling of the intraorganizational level of cooperation and the spawning of spinoffs. Moreover, we argue that cooperative firm cultures and processes of "entrepreneurial imprinting" (Higgins, 2005) are important sources of spinoffs' superior capabilities concerning their later market performance. A basic premise of the model is, therefore, that a cooperative corporate culture enables employees to attain valuable

knowledge from their parents that shapes their nature at birth (also Klepper and Sleeper, 2005). The empirical fact that the performance of spinoffs is positively correlated with their parents' performance is suggestive of some kind of intraorganizational learning that endows firm founders with superior knowledge. We provide one explanation for the origins of the peculiar capabilities of spinoffs and shed some light on the determinants of pre-entry experiences. Finally, we relate these findings to the evolution of industries by showing how spinoff processes can generate genealogies of firm organizations, how certain corporate cultures contribute to a pool of well-endowed entrepreneurs in a region, and how an exploitable business opportunity affects the likelihood of spinoffs to occur in an industry.

The article is organized as follows. The next Section lays out the model of evolving corporate cultures in different business environments and relates this to cognitive dispositions of human agents and systematically appearing firm growth crises that trigger spinoff activity. Section 3 derives predictions from the model, discusses them, and relates these to empirical evidence on organizational development, spinoff generation, and industry evolution. Section 4 concludes.

2. The model

We devise our formal model in three steps. First, we capture differential firm performance in different business environments depending on a venture's corporate culture. Second, we propose a detailed description of a firm's evolving culture based on several learning mechanisms. Third, we specify how spinoff activity is systematically triggered by changes in a corporation's culture.

2.1. Firm success in varying business environments

Success or failure of firm organizations depends crucially upon their corporate culture and its coevolution with a changing business environment (Deal and Kennedy, 1982; Kotter and Heskett, 1992; Schein, 1992; Teece et al., 1997; Hermalin, 2001). We imagine an industry's evolution starting in a nascent stage characterized by a high degree of uncertainty and change. In the course of time and firm growth, the business environment develops toward a higher degree of certainty that makes possible larger investments in standardized production technologies that enable size-related economies of scale and the performance of routine tasks. We therefore differentiate between two business environments that favor different corporate cultures.

(1) In innovative, nascent, and rapidly changing environments, organizations have to rely on the discretionary contributions of their employees to be successful, flexible, and to cope with adversity appearing (Katz, 1964; Gittell, 2000). Such an unpredictable business environment necessitates employees that do not restrict their contributions exclusively to what is specified in their employment contracts and formal reward schemes, as these future contingencies cannot be fully anticipated (Deckop et al., 1999). Therefore, the organization must draw on cooperative agents that put the interest of the work unit ahead of their self-interests (Akerlof and Kranton, 2005; Witt, 2007) and that enjoy a high degree of autonomy and discretion enabling them to adapt to a dynamic business environment (Barney, 1986; Rob and Zemsky, 2002). The higher level of responsibility for firm success left to the employees, however, also entails high potential costs of opportunistic behavior. At the same time, a cooperative culture cannot be based on close monitoring to keep in check opportunistic behavior due to employees' high degree of autonomy and the fact that cooperative agents resent being closely monitored (Cooter and Eisenberg, 2001; Enzle and Anderson, 1993; Ghoshal and Moran, 1996). Small firms seem to have comparative advantages at exploiting new business opportunities in such a setting due their innovative search,

risk taking, experimentation, and flexibility (Schumpeter, 1934; Tichy, 1983; March, 1991).[1] As shown below, also the level of intraorganizational cooperation crucially hinges on firm size.

(2) In a later mature, stable business environment, more traditional mechanisms of coordination, such as rules and routines, are adequate to ensure success of larger firms (e.g., Thompson, 1967). Organizations' competitive advantage then rests more on size-related economies of scale than the extra effort spent by cooperative employees. These business environments facilitate investments in expensive capital goods for mass production (see Pratten, 1971; Jovanovic and MacDonald, 1994) and the later emergence of a dominant design so that economies of scale gain in importance while increasing minimum efficient firm size (Klepper, 1996). Moreover, in such a setting, routine production tasks become more prevalent and hierarchical modes of communication are appropriate to achieve organizational adaptation (Crémer, 1993). Due to the high share of routine tasks, employees' performance is easy to observe and control facilitating the establishment of a more formalized regime of detailed monitoring of the agents' actions to prevent opportunistic behavior (Williamson, 2002), which represents another kind of corporate culture. Hence, in mature business environments, firms requiring low-cost production strategies implement a culture that emphasizes efficiency instead of cooperation, as it is the case in dynamic, innovative environments.

Consequently, one determinant of firm success or failure is its corporate culture in combination with the business environment it is acting in. To capture the evolution of a corporation's culture and how it affects firm performance and growth, we look at the transmission of a dichotomous cultural trait within a firm, the variants labeled by c and o, where c represents the variant "cooperative behavior" and o the variant "opportunistic behavior". The state of the group is determined by the frequency of employees with the variant c, labeled p (the frequency of the opportunistic variant is therefore described by $1-p$). Besides the well established assumption of an inclination toward selfish, opportunistic behavior within the field of the theory of the firm, we consider a human behavioral disposition for cooperation (see the abundant evidence from game theory and experimental economics, e.g., Rubin, 1982; Güth and van Damme, 1998; Bolton and Ockenfels, 2000; Fehr and Gächter, 2000). Cooperation frequently emerges spontaneously in small- and medium-sized groups (Henrich et al., 2001; Boyd and Richerson, 2002; Richerson and Boyd, 2005). Before moving to the learning dynamics that determine a firm's evolving corporate culture (represented by p) in the next subsection, we analyze a firm's growth process given varying shares of opportunistic and cooperative employees in different business environments.

Ventures based on a cooperative corporate culture reap competitive advantages due to the extra effort spent by their employees. We assume that each cooperative employee contributes to a firm's profit an amount measured by r_c. Each opportunistic agent yields a profit or loss of $r_o(n)$, i.e., her contribution depends on the firm's size. $r_{c/o}$ are measured in units of a standard employee wage. Profits resulting from cooperative or opportunistic agents directly translate into new employees, i.e., firm growth. Then, the following recursion gives the firm's size in the next time step, n', given that it was n before:

$$n' = pn(1+r_c) + n(1-p)(1+r_o(n)). \tag{1}$$

[1] Therefore, although private expenditure on R&D is provided largely by big business enterprises, a critical share of innovative breakthroughs has been contributed by firms of very modest size.

The first part of Equation (1), $pn(1+r_c)$, represents the number of cooperative employees times the unit resources needed to sustain their wages plus the profit they make. Furthermore, we allow for an endogenous modification of the costs or profits of opportunistic employees in the course of firm development: $n(1-p)(1+r_o(n))$ is the aggregate contribution to a firm's growth yielded by opportunistic agents. The following expression captures the relationship between r_o and the total number of a firm's employees, n:

$$(2) \qquad r_o(n) = -r_c + \frac{n}{n_{crit\_tech} + n} 2r_c .$$

For small organizational sizes, i.e., rather young firms in nascent, dynamic business environments, opportunistic agents cause a loss until the firm reaches a *critical technical firm size*, n_{crit_tech}, beyond which opportunistic employees start to contribute a profit – instead of a loss – to firm development. This accounts for the possibility that larger firms can realize economies of scale in a later, stable business environment (e.g., Pratten, 1971; Audretsch and Mahmood, 1994). Moreover, the task structure in such a setting is characterized by a relatively higher share of easy to observe, routinized exercises enabling the establishment of a monitoring regime to prevent shirking behavior. Both effects compensate for the losses caused by opportunistic agents in smaller firms based on a cooperation regime. For large firms, r_o is asymptotically approaching r_c.

We extend Equation (1) by a logistic model to depict a single organization's growth in a population of firms. To do so, we assume a corporation's development being influenced by an increasing depletion of a given business opportunity by all firms active in an industry, i.e., we relate an individual firm's attainable growth to effects at the industry level. Organizations compete for an existing business opportunity and the intensity of this competitive process affects a firm's attainable growth rates. Then, we obtain the following recursion for a firm's growth process in an industry as measured by its number of employees:

$$(3) \qquad n' = n + n\left(p(1+r_c) + \frac{1}{n}(1-p)(1+r_o(n)) - 1 \right)\left(1 - \frac{\sum_i n_i}{K} \right) - n(S).$$

From Equation (1) we derive a firm's growth rate, which gives us the first expression in parentheses that is following n in Equation (3). Within the second parentheses, K measures the potential of the new business opportunity, while $\sum_i n_i$ sums up all employees active in this industry as a measure of overall firm activity and competition. In the industry's beginnings, K is large relative to $\sum_i n_i$ implying high potential growth rates for the pioneering firms. Later on, a growing number of employees doing business in this industry entails decreasing growth rates for single organizations, i.e., within-industry competition is getting fiercer with the emergence of new firms via the spinoff process. Business opportunities for spinoffs dry up in the course of market evolution. The term $n(S)$ will be used to specify the harm incurred by parents due to spinoff activities as measured by a decrease in the number of employees. It may be a single agent

or a team of employees that leaves the organization to found an own firm. Furthermore, this expression might capture the harm incurred on a parent firm by the exit of a very valuable employee that entails a more severe drop in employment.

2.2. A firm organization's evolving corporate culture

In this subsection, we lay out our formal approach to a firm's evolving corporate culture. This model of cultural learning accounts for the processes that change the frequencies of cooperative (as measured by p) and opportunistic behavior ($1-p$) in a growing organization. We will see the group-level consequences of individual-level psychologies, decision rules, and behaviors (Henrich and Boyd, 2002; van den Bergh and Gowdy, 2009). Models of cultural evolution are based on recursion equations in discrete time that predict the frequency of a cultural variant in a population in the next stage of the cultural evolutionary process given its frequency in the present stage (see, as points of origin, Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985).[2]

Cultural transmission from one agent to another is typically emotionally or cognitively biased, i.e., people are more likely to acquire some behavioral variants than others (Richerson and Boyd, 2005; Norenzayan and Heine, 2005). For an analysis of the evolution of corporate cultures we need to understand how cognition directs social learning toward certain individuals or behavioral variants, such as cooperative or opportunistic behavior. For that purpose, we take account of intra-firm socialization processes via cultural role models, an inherent attractiveness to adopt the opportunistic behavior, and the influence of the frequency of a certain behavior within a group on the behavior of single employees.

We incorporate socialization of employees into the model by drawing on the fact that human agents are prone to adopt behavioral variants that are shown by role models in their social environment. A human cognitive predisposition to imitate successful or prestigious individuals takes effect in cultural transmission, i.e., there is a *model-based bias* in social learning. Evidence from social psychology and anthropology shows that the adoption of cultural variants is frequently conditioned by the observable attributes of individuals exhibiting the variant (e.g., Rogers, 1983; Harrington Jr., 1999; Henrich and Gil-White, 2001; Labov, 2001).

An entrepreneur or business leader plays an outstanding role as a model in this socialization process by providing a prestigious role model for social learning processes within the firm. In this role, she can motivate and coordinate firm members, foster cooperation, and hold down opportunism (Schein, 1992; Witt, 1998; 2000). Therefore, we assume that each individual employee is influenced by the entrepreneur and n peers, i.e., the other employees. We assign different weights to these role models to account for their differing importances in socialization: A_E denotes the entrepreneur's influence and A_P measures the weight of an ordinary member of the group.[3] A large value of A_E implies that the employee is disproportionately likely to acquire the cultural variant of the entrepreneur. The entrepreneur's influence as a role model is, however, decreasing with a growing organizational size n. Then, the total, i.e., firm size adjusted, actual weight of the entrepreneur or business leader in socialization is given by

$$A_E = \frac{\alpha_E}{\alpha_E + n\alpha_P}, \tag{4}$$

[2] A cultural variant is defined as an idea, skill, belief, attitude, or value that is acquired by social learning and that influences an individual's behavior.

[3] Accordingly, nA_P reflects the weight of an employee's fellow employees, whereby $A_E + nA_P = 1$.

where α_E is the basic weight of the entrepreneur and α_P the basic weight of any given peer employee ($\alpha_P = \alpha_1 = \alpha_2 = ... = \alpha_n$). Different values for α_E reflect the fact that entrepreneurs differ in their ability to exert influence on other individuals due to personal characteristics. The latter comprises aspects such as charismatic potential, social skills, authority, personal work ethic, ability to articulate a persuasive vision, etc. (e.g., Milgram, 1974; Langlois, 1998).

Accordingly, the weight of a member of an employee's the peer group is expressed by

$$A_P = \frac{\alpha_P}{\alpha_E + n\alpha_P}. \tag{5}$$

Within the organization, the cumulative influence of the peer employees in socialization is growing with an increasing firm size and a dwindling role of the entrepreneur. Both weights, A_E and A_P, are normalized by the denominator to give the weight of a model relative to the other models encountered by an individual employee.

To capture the socialization of employees in a growing organization, the model must allow us to predict the probability of agents acquiring behavior c or o, given a particular set of models (entrepreneur, n peers) that have different total weights (A_E, A_P) and group size n (also modifying values of A_E and A_P). We assume the entrepreneur to exhibit always the cooperative behavioral variant. Given the average pairing probability of role models and their changing weights in socialization, we yield a $A_E + pnA_P$ probability of transmitting behavior c to each member of the firm (see also Cordes et al., 2008; 2011). Thus, the partial recursion for the socialization phase with the frequency of c after transmission, p', given that it was p before, is given by

$$p' = A_E + pnA_P. \tag{6}$$

The next social learning bias introduced to our model to understand an individual's behavior in groups of varying size is the *conformity bias*. Due to this bias, employees are more likely to pick the cultural variant that is modeled by the majority of the organization's members, whereas they discriminate against behaviors that are rare in the group. Anthropological and psychological evidence indicates the existence of such a heuristic in social learning (Aronson et al., 2002; Kameda and Diasuke, 2002; Cialdini and Goldstein, 2004; Henrich, 2004). As shown below, peer employees' behaviors are crucial in both maintaining a high level of cooperation and moving a corporate culture away from that regime toward the prevalence of opportunistic behavior. Finally, we incorporate a *direct bias* in cultural learning. An employee may recognize, by observing colleagues behaving opportunistically, the personal extra benefits accruing from this kind of behavior. As a consequence, she may lower her effort for the organization's goals implying an increased relative importance of her selfish interests.

Equation (7) formalizes the effects of conformist and direct bias within a group of interacting members (see Henrich, 2001). The frequency of c after these learning steps, p'', given that it was p' before, is expressed by

$$p'' = p' + p'(1-p')\{\eta(2p'-1) - (1-\eta)\mu_{co}\}. \tag{7}$$

The term $\eta(2p'-1)$ in Equation (7) measures the conformist bias. Here, the bracket term $(2p'-1)$ takes on values between -1 and 1, implying that when the frequency of cooperative behavior among employees is less than one half, the conformity bias is negative promoting opportunism as the majority behavior in the group. When $p' > 0.5$, the conformist term favors the cooperative behavioral variant. The final term in (7) models the direct bias, μ_{co} ($0 \le \mu_{co} \le 1$), continuously increasing the opportunistic behavioral variant, o, in the group (Boyd and Richerson, 1980; Richerson and Boyd, 2005). We suppose that each c employee has a μ_{co} chance of switching to this behavior. Parameter η, which varies between 0 and 1, gives the strength of conformity relative to the direct bias in human cognition, i.e., it scales the cognitive weight given to the frequency of a behavior in a group (see Henrich, 2001).[4]

The complete recursion for p, depicting the change in the level of intraorganizational cooperation as an indicator of a firm's corporate culture, over one socialization phase and one conformist learning step including a direct learning bias favoring opportunistic behavior, is obtained by substituting (6) into (7):

$$p'' = (A_E + pnA_P) + (A_E + pnA_P)(1-(A_E + pnA_P))\{\eta(2(A_E + pnA_P)-1)-(1-\eta)\mu_{co}\}. \quad (8)$$

As a consequence of our argument so far, we have a two-dimensional system of coupled recursions, one describing the development of p in time (9) and another one depicting the changing size of a firm in the course of time (10) ($p''-p=\Delta p$, $n'-n=\Delta n$):

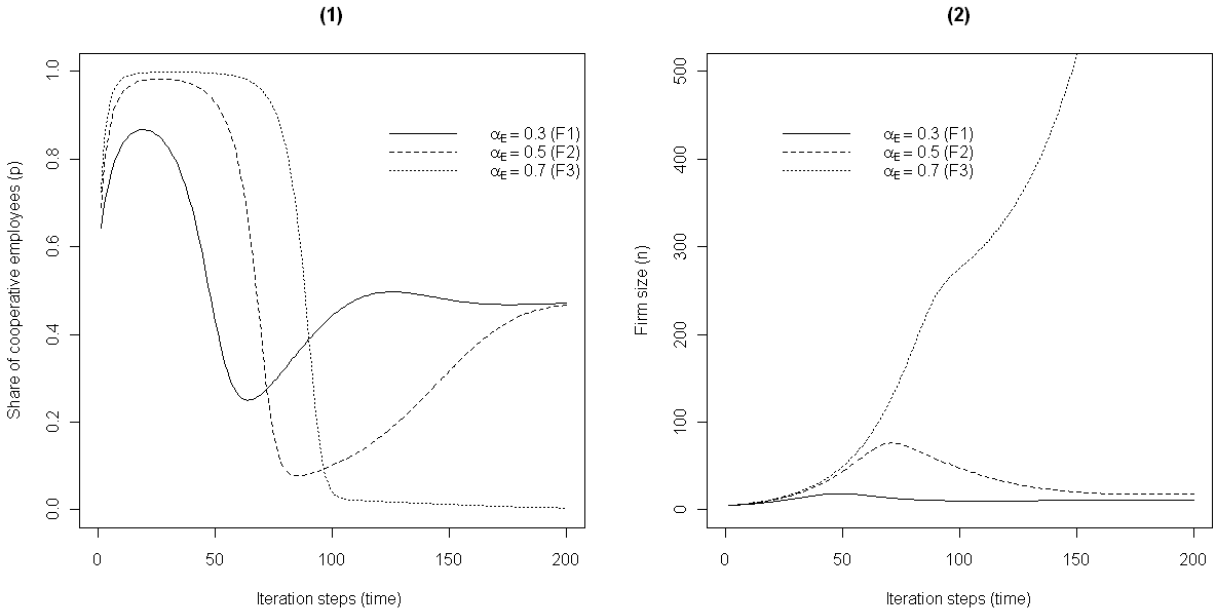
$$\Delta p = (A_E + pnA_P) + (A_E + pnA_P)(1-(A_E + pnA_P))\{\eta(2(A_E + pnA_P)-1)-(1-\eta)\mu_{co}\} - p \quad (9)$$

$$\Delta n = n\left(p(1+r_c) + \frac{1}{n}(1-p)(1+r_o(n)) - 1 \right)\left(1 - \frac{\sum_i n_i}{K} \right) - n(S). \quad (10)$$

A visualization of this two-dimensional dynamic system is done in Figure 1 that depicts the evolution of the frequencies of cooperative behavior, p, as an indicator of organizations' corporate cultures, in a set of three representative firms (F1-3) when there are no spinoffs ($n(S)=0$) and no growth constraints due to intra-industry competition ($\sum n_i / K$ is close to zero). All firms start from high levels of cooperation ($p=0.9$). For different values of α_E, the entrepreneur's charismatic potential, we observe different *critical cognitive firm sizes*. When an organization reaches this size, the continuous introduction of opportunistic behavior by the direct learning bias, μ_{co}, among peer employees in combination with a dwindling influence of the entrepreneur as a role model propagating cooperation in a growing group allows for the rapid spreading of self-interested behaviors. While having stabilized the preceding cooperative regime, the conformity bias now spurs the spreading of the more frequent behavior o. The level of p, therefore, drops rapidly after the firm has reached this critical cognitive size. Moreover, the fall in cooperation is more pronounced the higher the previous level of cooperation was. Employees

[4] Here, η is considered to be small, for when η, e.g., exceeds 0.5, no rare behavior ever spreads.

who are willing to contribute to the benefit of the organization and who are motivated by a cooperative culture, rather suddenly change behavior when the firm reaches the critical group size (Schelling, 1972; Grofman, 1974; Gladwell, 2000; Card et al., 2008). Figure 1 also shows that p increases again as firm size shrinks (F1 and F2) due to the fact that the entrepreneur's influence rises again in smaller groups. The final equilibrium values of p and n reached after some oscillations can be determined analytically.



Figures 1 and 2. The evolution of three representative corporations' cultures (1) and their corresponding firm growth paths (2)
($\eta = 0.1,\ \mu_{co} = 0.3,\ \alpha_P = 0.2,\ r_c = 0.05,\ K = 3000,\ n_{crit\_tech} = 200,\ p_{start} = 0.6,\ n_{start} = 5$)

Figure 2 depicts the growth processes for these three representative firms implied by Equations (9) and (10) without spinoffs and a constant market constraint K. In an innovative business environment where a high level of intraorganizational cooperation yields competitive advantages, firms based on a cooperative corporate culture can experience rapid growth after an initial period of slow growth. We see, however, that firms have different growth potentials at this stage of their development. The higher the entrepreneur's charismatic potential, α_E, the longer the firm's growth process lasts and the higher is its number of employees before it reaches the critical cognitive size. One representative firm in our sample, F3, the one with the most influential or charismatic entrepreneur ($\alpha_E = 0.7$), reaches the critical technological firm size. Hence, this organization attains the critical technological size before moving beyond the critical cognitive size that would result in rapid firm shrinkage. Its growth path exhibits a period of slower growth sandwiched between phases of rapid organizational development, i.e., also in this case the firm goes through a growth crisis. Overall, this organization experiences continuous growth while the other two firms face decline in the long-run.

It can be seen from Figures 1 and 2 that the successfully growing firm F3 is characterized by a corporate culture that can handle a high share of opportunistically inclined agents (low p). This is done by close monitoring of employees and by assigning routine tasks whose executions are easy to observe, measure, and specify in an employment contract. Therefore, a formalized regime

of monitoring routine performances in a stable, mature business environment prevents costly opportunistic behavior, enables further organizational growth, and the realization of economies of scale. Thus, contingent on the entrepreneur's charisma (as measured by α_E), firms have different potentials of maintaining a high level of cooperation as the organization grows. The observed range of critical cognitive firm sizes depends on the distribution of individual's charismatic potentials in the pool of entrepreneurs and should, on average, correspond with the anthropological findings concerning viable group sizes discussed above. Organizations inevitably reach this critical threshold during their growth process.[5]

2.3. The triggering of spinoffs and imprinting processes

We differentiate three stages during the development of a corporation's culture as to the firm organization's probability of generating spinoffs, measured by $P_S(p,N)$ with $N=\sum_i n_i$. (1) If the level of cooperation among employees, p, lies between one and upper threshold, p_{high}, no potential firm founder leaves the firm for they still enjoy a highly cooperative organizational environment. (2) When, however, the level of intraorganizational cooperation drops further, employees worried about this decline in corporate culture start to look for alternatives including starting an own enterprise. (3) This effect holds until p falls beneath a lower threshold, p_{low}, when the firm's culture stops providing a powerful "training ground" for potential entrepreneurs. Below, we will assume this critical level of cooperation to be at $p=0.5$. These three cases are defined by the following expression:

$$(11)\qquad P_S(p,N)=\begin{cases}0 & p<p_{low}\\ (1-p)\left(1-\dfrac{N}{K}\right) & p_{low}\le p\le p_{high}\\ 0 & p_{high}<p\le 1\end{cases}.$$

The spinoff probability given by Equation (11) for the case $p_{low}\le p\le p_{high}$ also depends on the number of firms active in the market or the intensity of competition. Given a certain market potential, K, spinoff probability decreases with an increasing number of incumbent firms, N. Schumpeter (1939) already emphasized the role of unexploited commercial opportunities, as measured by the parameter K, for firm formation in the development of capitalism. These provide additional stimuli for employees or teams of employees to create their own firm.

There are several triggering events of spinoffs discussed in the literature (e.g., Klepper and Thompson, 2010). Buenstorf (2009), for instance, distinguishes necessity spinoffs from opportunity spinoffs. While the former are triggered by deteriorating job conditions within the parent firm that may culminate in involuntary exit, the latter are caused by business opportunities perceived by an employee of an incumbent firm. Both factors are prominent in our approach: first, employees may observe the drop in the level of cooperation within the parent firm and the corresponding rise in opportunistic behavior. This may entail a new corporate culture with less

[5] The exact critical cognitive size at which cooperation collapses depends on several aspects external to our model: e.g., the maturity of the group, the personalities of its members, the details of a firm's norms, or general cultural influences. The deleterious effects on collective outcomes of increasing group size may partly be overridden when collective identity is high (Brewer and Kramer, 1986; Wagner III, 1995; Akerlof and Kranton, 2005). In any case, we argue that it should be possible to determine a certain range of group sizes wherein it becomes eminent.

discretion and autonomy on the part of the employee and more monitoring of their activities to keep in check rising opportunism. Some agents will consider this kind of organizational development as an indicator of a growth-induced crisis and leave the firm to go for a necessity spinoff. Second, we argue below that a cooperative corporate culture endows employees with capabilities that enable them to better identify profitable business opportunities, i.e., it also makes an opportunity spinoff more likely. A firm's deteriorating corporate culture can be the final impetus for going for the perceived business opportunity. The potential spinoff founder may have identified an entrepreneurial opportunity while being with the parent firm, but this discovery alone was not sufficient to induce spinoff formation before the decline in corporate culture.

There is strong empirical evidence suggesting that spinoffs founded by ex-employees of industry incumbents are particular successful entrants (e.g., Klepper, 2002; Buenstorf and Klepper, 2009). Moreover, among an industry's spinoffs, those founded by employees of better performing firms tend to outperform other spinoffs (Klepper and Sleeper, 2005; Klepper, 2009). These findings hint at the fact that spinoff founders are endowed with valuable knowledge during their prior employment, i.e., specific capabilities are passed on from the respective parent firms to their spinoffs. In addition, the capabilities of new firms are fundamentally shaped by the experiences and capabilities of their founders (Klepper, 2002). One might imagine several kinds of relationship of spinoffs to their parents. Below, we will capture this "entrepreneurial imprinting process" by assuming that the parent firm's entrepreneur passes on her α_E to the spinoff founders. This occurs directly via socialization and indirectly via intraorganizational learning: a high level of cooperation in the parent firm, which crucially depends on its entrepreneur's α_E, provides an environment in which valuable experiences can be made by spinoff founders, thereby increasing their later influence as role models within their own organizations. As a consequence of these differential endowments by the parent firms, spinoffs differ fundamentally according to their origins.

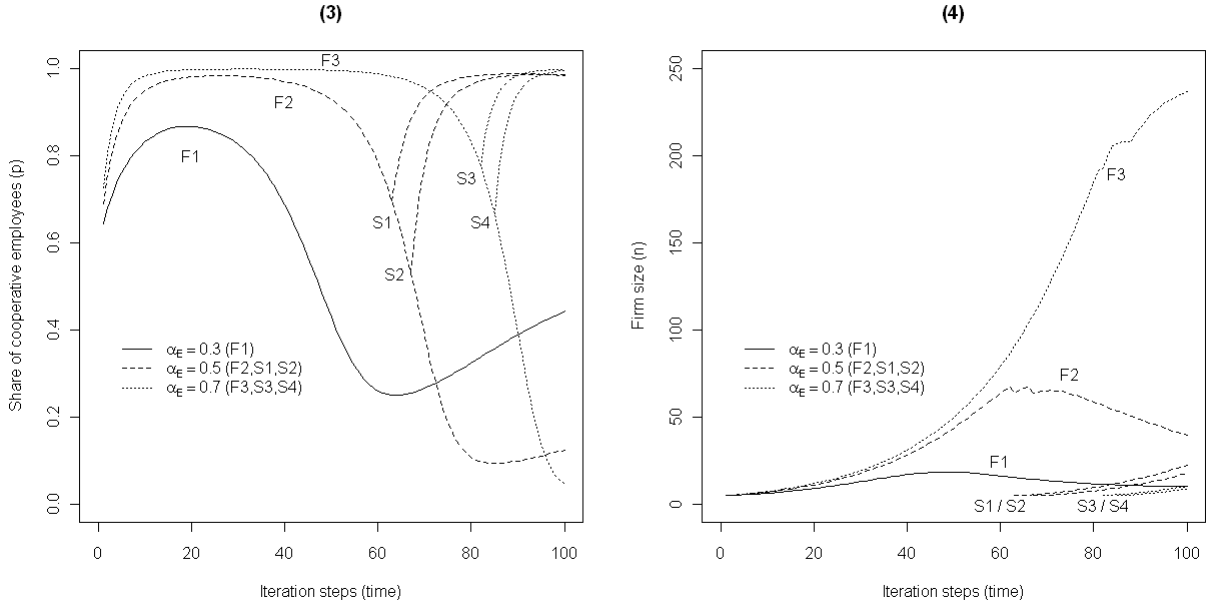
3. The provision of ideal "training grounds", the triggering of spinoffs, and an industry's genealogy

Theoretical findings derived from our model yield a number of interesting implications regarding evolving corporate cultures, the generation of spinoffs, and an industry's development. For this purpose, the properties of the two coupled recursions (Equations (9) and (10)) describing a firm's evolving corporate culture and the connected development of organizational size in different business environments are studied further in combination with our expression for the generation of spinoffs (Equation (11)).

Figure 3 shows three firms' (F1-3) changing shares of cooperative agents as measured by their respective values of p. The three organizations in the sample are lead by entrepreneurs that differ in their charismatic potentials. We again see the occurrence of distinct firm growth crises when the organizations reach different critical cognitive sizes in the course of their development. In each iteration step during these growth crises, when p lies between $p_{low} \leq p \leq p_{high}$, firms generate a spinoff with a certain probability, as has been defined by Equation (11).[6] The case depicted here is a typical one coming out of the probabilistic part included in this expression. While firm F1 does not have a spinoff in this scenario, firms F2 and F3 are more prolific in this regard and give rise to two spinoffs each (S1-2 and S3-4). All the spinoffs in our set rapidly reach

[6] We assume teams of five employees to leave the parent organizations. Furthermore, we allow a spinoff to happen if the parent firm's size exceeds this spinoff size fivefold.

high levels of intraorganizational cooperation due to small initial group size and relatively high values of α_E that are passed on to the new firms through entrepreneurial imprinting.



Figures 3 and 4. The spawning of spinoffs as a result of growth crises (3) and the organizations' growth paths (4)
($\eta = 0.1,\ \mu_{co} = 0.3,\ \alpha_P = 0.2,\ r_c = 0.05,\ K = 3000,\ n_{crit\_tech} = 200,\ p_{start} = 0.6,\ n(S) = 5$)

Figure 4 illustrates the growth paths of the parent firms and their spinoffs. Firm F3 attains the critical technological size before moving beyond the critical cognitive size. In our example, this enterprise reaches a size that enables the exploitation of economies of scale in a later, mature business environment although some employees have left the organization to found spinoffs. Their effect on the parent firm is reflected by the term $n(S)$ in Equation (10) and leads to a – in this case transient – fall in a firm's number of employees. Depending on the exact specification of $n(S)$, we can imagine scenarios in which firms do not reach the critical technological size because of strong spinoff activity, such as the leaving of whole teams of valuable employees, in combination with a changing business environment that reduces the advantages of a cooperative corporate culture. If, however, a larger team of employees leaves to start an own business, the parent firm's performance might also improve due to the fact that the intraorganizational level of cooperation increases in the now smaller group. Therefore, the exit of competing role models in employee socialization may restore the entrepreneur's influence.[7]

In this context, the parent firm's rapid decline in intraorganizational cooperativeness due to increasing group size is interpreted as a triggering event of spinoffs. We propose this effect as an addition to the catalogue of factors motivating spinoff activity as discussed in, for example, Buenstorf (2009) and Klepper and Thompson (2010):

Proposition 1. *The parent firm's evolving corporate culture is an important triggering mechanism of entrepreneurial spinoffs: with increasing firm size, a cooperative regime is*

[7] McKendrick et al. (2009) provide empirical evidence that spinoffs can have a positive impact on parent firms. The effect mentioned here may be one of those mechanisms fostering the parent's development.

becoming more and more difficult to sustain. The final drop in the level of cooperation is motivating entrepreneurially minded agents to leave the organization to found a spinoff.

Garvin (1983) argued that employees leave to start their own firms after becoming frustrated with their employers. The drop in cooperativeness resulting from firm growth and the corresponding increase in opportunistic behavior provides a potential source for frustration.

A decline in a group's members willingness to cooperate with increasing group size is a common phenomena in social psychology and experimental economics (e.g., Olson, 1994; Spoor and Kelly, 2004). As a group, such as a firm, grows larger, many problems appear: there is more misbehavior, free riding, members are absent more often, contribute less often to group activities, and are less likely to cooperate with one another (Markham et al., 1982; Albanese and van Fleet, 1985; Kerr, 1989; Levine and Moreland, 1990; 1998; Forsyth, 2006, ch. 9).[8] A meta-analysis of 31 field studies of the size-performance relationship of firm organizations by Gooding and Wagner (1985) indicates that there is a consistent negative subunit size-performance correlation (also Wagner III, 1995).

These aspects of group life have deep roots in humans' evolutionary past. Marlowe (2005) reviews the group sizes among hunter-gatherers whose way of life most closely resembles those of our Pleistocene ancestors. Base on a sample size of 294 cases, local residential groups (bands) averaged 48 (median 30) people. These local groups are nested within ethno-linguistic groups (tribes), whose sizes average 1750 (n=396). Marlowe argues that the upper limit on their size is determined by the frequency of bickering, reflecting an increase in free riding. Further evidence on that issue stemming from economics comprises studies of village scale commons management and suggests that these very small, band-based systems can be maintained by informal agreements, but that larger systems require norms, formal rules, and formal monitoring and sanctions (Ostrom, 2009). Richerson and Boyd (2005) claim that humans lived in band-scaled groups long enough to evolve the innate cooperative predispositions necessary to manage their operations.[9] Therefore, the band-sized group may represent the limits of cooperation organized by purely informal means, for example, by cognitive leadership of a charismatic entrepreneur, and would thus define the approximate range of our critical cognitive firm sizes. Larger organizations probably require explicit norms and institutions as well as subdivisions to function.

Another important stylized fact pertains to the performance of spinoffs: there is ample evidence that this kind of market entry is superior to other entrants (e.g., Eriksson and Kuhn, 2006; Dahl and Reichstein, 2007). Given the argument developed above, we suggest the following proposition:

Proposition 2. *Firms with cooperative corporate cultures active in dynamic, nascent business environments are ideal "training grounds" for potential spinoff founders.*

Due to the high degree of autonomy, responsibility, and discretion left to the employees as well as the challenging character of jobs and decentralized decision-making in a cooperative corporate culture, these agents are more likely to attain crucial skills for running an own firm and exploit new business opportunities. These organizations provide an environment in which valuable experiences can be gained by potential firm founders and an "entrepreneurial spirit" is much more common among the organization's members. Higgins (2005) provides evidence that

[8] In an experimental study, Kerr (1989) provided evidence for a decline in perceived self-efficacy with increasing group size for public goods problems (also Brewer and Kramer, 1986; Mukhopadhaya, 2003).

[9] These predispositions include a tendency to identify with larger, symbolically marked groups and norms and institutions characterizing these groups. Such groups still depend, however, upon the moral dispositions that help stabilize cooperation in local band-scaled groups as their constituents.

exposure to demanding field assignments instills an entrepreneurial attitude in employees. She shows how Baxter International, a U.S. manufacturer of medical supplies, enabled its executives to acquire an "entrepreneurial imprint" during their socialization phase within the firm. Having been trained on challenging and largely autonomous jobs, these employees played an outstanding role as entrepreneurs of new firms in the emerging biotechnology industry. Ellis et al. (2008) found that Israeli ICT firms active in more competitive business environments have higher spinoff rates hinting at their effectiveness as "training grounds" for spinoff founders. Moreover, within cooperative cultures, employees are more likely to attain specialized knowledge on emerging niches and submarkets. This provides distinctive opportunities for incumbent firms' employees to exploit (e.g., Christensen, 1993; Franco and Filson, 2006).

Therefore, a cooperative regime enhances the extent to which entrepreneurial skills can be acquired within a firm especially in dynamic, nascent business environments. In contrast, a firm based on a monitoring regime in a mature business environment does not serve as an equally effective incubator for entrepreneurially minded agents. Given our finding that small organizations are more likely to sustain a cooperative corporate culture, we expect small firms or subdivided enterprises to be better incubators for potential spinoff founders. Indeed, there is empirical evidence that employees of larger firms are less likely than those of smaller organizations to found spinoffs (Elfenbein et al., 2010). Hence, the initially high spinoff rates of small firms may reflect a rich and dynamic knowledge base for employees to draw on (Klepper and Sleeper, 2005). What is more, several empirical studies show that the performance of spinoffs is better for those founded by employees of smaller firms (e.g., Sørensen, 2007; Elfenbein et al., 2010).

Eriksson and Kuhn (2006) and Sørensen (2007) found that larger ventures spawn less spinoffs than smaller firms due to a negative effect of bureaucratic structures. Bureaucratic inertia may thus stifle spinoff initiative in great enterprises. Large companies with a sizable market share may enter a stage of ossification characterized by a lack of innovative activity, managerial inflexibility, and the avoidance of risks (e.g., Arrow, 1974, p. 49; Teece et al., 1997). Garvin (1983), finally, presents some evidence from a number of industries about spinoffs being concentrated in infant industries. Therefore, we argue that spinoffs are more prevalent in industries characterized by a dynamic business environment that favors cooperative corporate cultures. With a changing corporate culture in more mature business environments, spinoff rates fall off.[10] Taken together, there seems to be some evidence indicating that a firm's culture in combination with a certain business environment can foster spinoff formation.

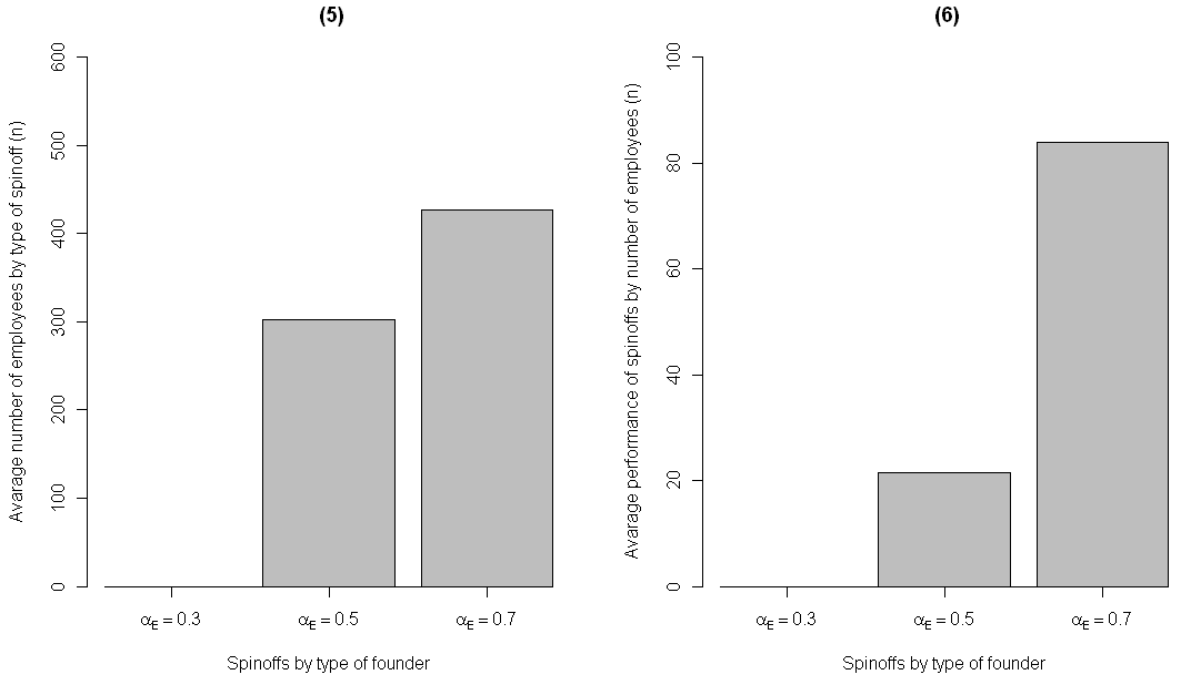
According to a further stylized observation concerning spinoffs, the performance of these entrants is the better, the better their parent firm's performance as measured by profits, market share, and quality of technology. In addition, successful parent firms endow their spinoffs with valuable capabilities. Based on evidence from our model, we can identify the kinds of firms that have relatively more successful spinoffs.

> **Proposition 3.** *The greater the entrepreneur's influence in employee socialization, the higher and enduring is the level of intraorganizational cooperation and the more successful the firm is in a dynamic, nascent business environment. As a result, employees enjoy a stronger "entrepreneurial imprinting" and a longer period of learning in such a stimulating environment. Both effects make spinoffs originating from these parent*

[10] Firms amore advanced along the product life cycle have lower spinoff rates also for other reasons: knowledge related to improvements in capital-intensive process technology adapted to mature business environments, e.g., is difficult to exploit by small spinoff firms. Valuable knowledge becomes more embodied in physical capital, making it less accessible to employees (Garvin, 1983; Klepper and Sleeper, 2005).

organizations more successful vis-à-vis other market entrants. Spinoffs attain specific capabilities from their parent firms that shape their nature at their founding time.

The greater the value of the model's parameter α_E that captures an entrepreneur's personal characteristics, such as charismatic potential, personal work ethic, and the ability to devise a convincing business conception, the higher is an organization's level of cooperation measured by p and the longer can such a cooperative regime be maintained during firm growth. Therefore, the higher α_E, the stronger is the process of "entrepreneurial imprinting" of the firm's employees (Higgins, 2005) and the longer employees enjoy the fertile learning environment of a cooperative corporate culture. As a consequence of this intraorganizational socialization, we assume the spinoff founders to be endowed with the same α_E as the parent firm's entrepreneur, which enables them to take similar influence in their newly founded organizations. This passing on of capabilities reflects the fact that spinoffs "inherit" skills from their parents that shape their nature at their founding time (Garvin, 1983; Franco and Filson, 2006; Buenstorf and Klepper, 2009).[11]



Figures 5 and 6. The distribution of employees over different types of spinoffs (5) and their differential performance (6) (average over 1000 independent simulations)

Figure 5 shows the total number of employees of all spinoffs after 300 time steps distributed over three types of spinoffs that are defined by their values of α_E. The latter have been "inherited" via socialization and learning from their respective parent organization out of our initial set of three representative firms. As can be seen, most agents are employed by spinoffs whose founders have been endowed with the highest α_E. These individual entrepreneurs or teams of founders have enjoyed the strongest "entrepreneurial imprinting" while being with their parent firm. In the case shown here, the remaining employees in this industry are employed by

[11] The timing of entry of spinoffs is determined mainly by the knowledge they gain while being with their parent, rather than by market signals (Klepper and Sleeper, 2005).

spinoffs with the second highest value for α_E, while none is employed by a spinoff characterized by the lowest α_E. This "endowment effect" is even more pronounced if measured by the average number of employees working with each type of spinoff as illustrated in Figure 6: given this indicator of firm success, spinoffs with higher values of α_E, i.e., those with more influential entrepreneurs in intraorganizational learning, on average employ more agents.

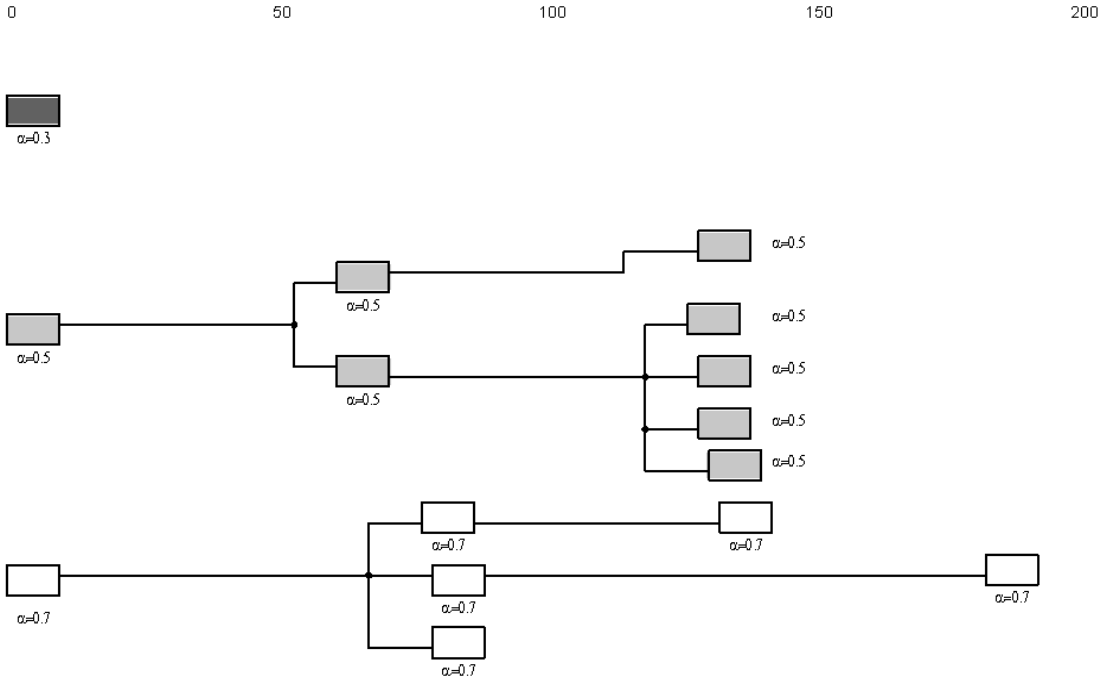


Figure 7. An exemplary genealogy of spinoffs in an industry

In Figure 7, we see an exemplary lineage of an industry's spinoffs derived from the model. The genealogy of, for instance, Silicon Valley start-up firms shows the importance of such a "fissioning" process based on spinoff activity (for a case study see Moore and Davis, 2004). In this region, many spinoffs can be traced back to a few firms – Fairchild Semiconductor alone was the origin of 124 spinoffs. Therefore, the proliferation and success of spinoffs originating from only a couple of parent firms drove the growth of Silicon Valley. A similar role of spinoffs as the driving-force of industry evolution is shown by Klepper (2002) for the automobile industry. Another "fissioning" process occurred in the LAN industry (Kenney and von Burg, 1999).

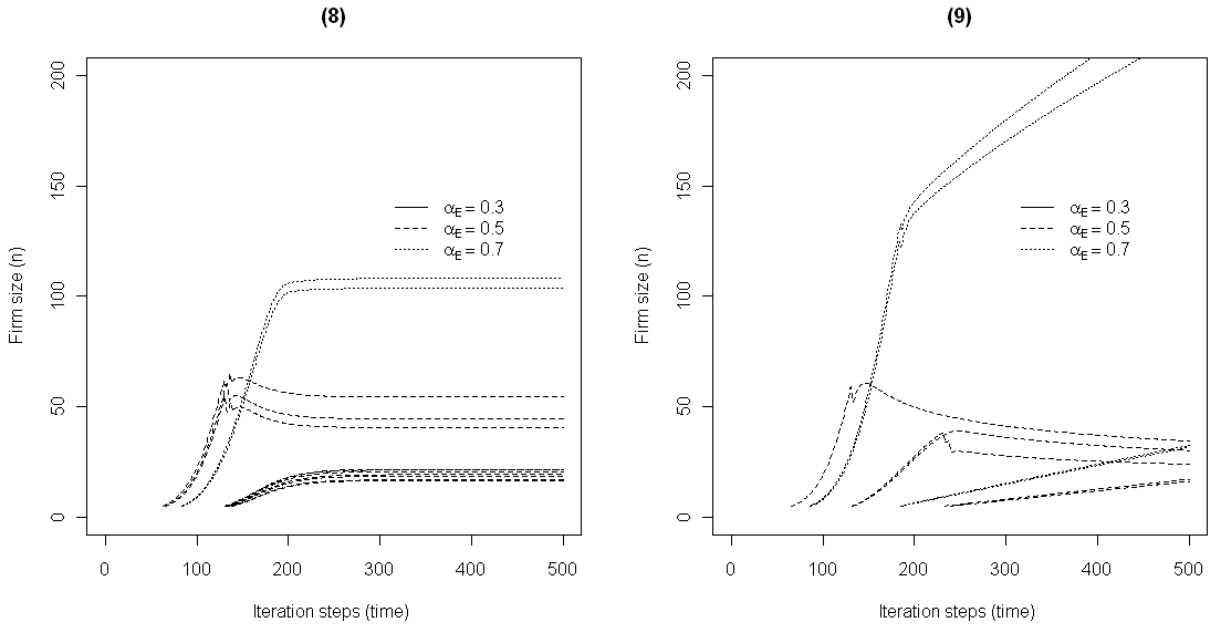
Proposition 4. *The ongoing generation of spinoffs via firm growth crises creates regional genealogies of organizations that can be traced back to few pioneering ventures.*

Successful regions are driven by entrepreneurship, i.e., a high rate of new firm formation is vitally important to the success of industries and regions (Garvin, 1983). Pre-entry experiences of founders play a crucial role and existing firms with cooperative corporate cultures are an ideal training ground for new entrants (see Klepper, 2002). An industry or region with many innovative firms whose business cultures are based on a cooperative regime can profit from the availability of a great number of entrepreneurially minded agents as potential spinoff founders.

The exodus of entrepreneurially skilled personnel from established firms can initiate mutually reinforcing processes of firm creation, exploitation of business opportunities, and regional or industrial development (e.g., Kenney and von Burg, 1999). Although many regions have universities that provide well-educated, creative agents that may become entrepreneurs, the additional existence of a number of smaller, dynamic firms that offer the opportunity to gain on-the-job entrepreneurial experiences to individuals is essential to trigger a self-reinforcing regional and industrial development. Therefore, the structure and characteristics of organizational populations affect the supply of nascent entrepreneurs (see, e.g., Sørensen, 2007).

Proposition 5. *Ingredients for successful regions are an unexploited technological opportunity (K), a (low) number of young, rather small firms whose corporate cultures are based on cooperation (high p) that provide ideal "training grounds" for potential entrepreneurs, and a (initially small) pool of skilled entrepreneurs endowed with a high charismatic potential (α_E) that facilitate entrepreneurial imprinting of their employees and potential spinoff founders.*

Figure 8 illustrates the effects of the market potential, as measured by parameter K, on spinoff formation. While we observe the emergence of spinoffs in the beginning of industry evolution, these market entrants disappear as the market potential is exploited by incumbent firms. As long as K is large relative to the aggregate number of employees in the industry, N, the probability that changes in a corporations culture, i.e., the drop in the intraorganizational level of cooperation beyond the critical cognitive firm size, can trigger spinoffs is large, as has been specified by Equation 11 in Section 2. The existence of unexploited business opportunities is therefore a prerequisite for dynamic spinoff processes to happen. For instance, an important difference between Silicon Valley and Route 128 that has determined their differential economic performance was to be found in the different market potentials of their industries, i.e., the semiconductor versus the minicomputer industry (Kenney and von Burg, 1999). Figure 9 illustrates the case of a growing market potential that allows for the appearance of spinoffs also later in an industry's life cycle. Several studies show that spinoffs can enhance an industry's overall market potential benefiting all incumbent firms (e.g., Higgins, 2005).



Figures 8 and 9. Spinoff generation with constant capacity K (8) and growing capacity (9), where we add 5 units of capacity for each spinoff added to the industry

4. Conclusions

We suggested a model of organizational development to explain some facets of the regular occurrence of spinoffs in industry evolution. We brought forward the core idea that changes in a venture's corporate culture can be an impetus for spinoff formation. Moreover, a parent firm's culture also influences the further development and performance of these new organizations. We have shown that our model can explain various stylized facts that have been accumulating in empirical works regarding the generation and performance of spinoffs (see Klepper, 2009). As spinoffs gain increasing attention in research, new theories are necessary to guide the discussion and further empirical work.

During their growth process, organizations systematically reach a critical cognitive size beyond which the initially high level of cooperation deteriorates. These firm growth crises can motivate entrepreneurially minded employees to leave the organization to found a spinoff. We also argued that cooperative corporate cultures, in contrast to cultures based on monitoring, provide ideal "training grounds" for potential spinoff founders. In line with the existing empirical evidence, our model presented mechanisms that explain why spinoffs are a relatively more successful form of market entrants: socialization and learning processes on the part of the employees while being with the parent firm endow these with crucial capabilities and pre-entry experiences. Finally, we related our findings on the level of the firm to an industry's evolution. We demonstrated how ongoing spinoff processes can generate genealogies of firm organizations. Moreover, we discussed the ingredients necessary for successful regional or industrial development, especially the availability of a pool of well-endowed potential firm founders in combination with entrepreneurial opportunity.

Our focus on evolving corporate cultures as an impetus for spinoffs resonates well with a number of other approaches that emphasize the role of firm cultures in organizational and industrial development (Deal and Kennedy, 1982; Kotter and Heskett, 1992; Schein, 1992; Hermalin, 2001). Of course, we do not deny the importance of factors such as incentive and ownership structure, legal settings, employment contracts, or financial circumstances in the context of a business's development. There are, however, additional – behavioral – aspects that are worthwhile a closer scrutiny to understand organizational development: intra-firm learning and socialization processes based on cognitive dispositions of human agents, systematically appearing growth crises due to increasing group size that entails behavioral changes, and employees that may profit form the former while taking the latter as an impetus to leave the organization to start their own firms, thereby influencing an industry's evolutionary path.

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