PAPERS on Economics & Evolution

0921

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The *Papers on Economics and Evolution* are edited by the Evolutionary Economics Group, MPI Jena. For editorial correspondence, please contact: evopapers@econ.mpg.de

ISSN 1430-4716

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How Corporate Cultures Coevolve with the Business Environment: The Case of Firm Growth Crises and Industry Evolution

Christian Cordes, Peter J. Richerson, and Georg Schwesinger*

Abstract

This paper shows how cognitive human dispositions that take effect at the level of an individual firm's corporate culture have repercussions on an industry's evolution. In our theory, the latter is attributable to evolving corporate cultures coupled with changes in a firm's business environment. With the help of a formal model of evolving corporate cultures, we demonstrate how firms can establish a cooperative cultural regime that yields competitive advantages in an innovative, fast changing environment. Depending on within-firm social learning processes and cognitive constraints of human agents, organizations then reach a critical cognitive firm size in their development beyond which the level of cooperation deteriorates rapidly – they systematically face a growth crisis. Organizations successful in such an environment and reaching a critical technological size may, however, reap economies of scale in a later, mature and stable business environment with altered corporate culture. Furthermore, we relate these findings to empirical evidence on firm survival and performance in different industries, the evolution of organizational structures, technological advancements in production technologies, and identify some determinants of market structures.

Keywords: Industry Evolution – Critical Firm Sizes – Firm Growth – Corporate Culture – Human Cognition

JEL Codes: D21, L10, M13, M14, C61

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1. Introduction

There is a long-standing interest of researchers in the field of the theory of the firm in the determinants and consequences of firm growth (e.g., Penrose, 1959; Ijiri and Simon, 1967; Albach et al., 1984; Audretsch and Mahmood, 1994; Witt, 2007). In this paper, we offer a behavioral explanation of firm growth crises and corporations' culture-based performance in different business environments by relating firm development and cognitive constraints of human agents. Humans' cognitive apparatus and its constraints involved in structuring our social world evolved in a natural environment and still have implications for firm development. Moreover, we include two ideas concerning the primary sources of performance differences among firms: (1) the impact of the changing business environment or industry on organizational performance (e.g., Porter, 1980) and (2) the particular differences between organizations' capabilities and corresponding corporate cultures as drivers of competitive advantage (e.g., Wernerfelt, 1984).

Our analysis of firm development crosses three levels of analysis: the entrepreneur's or business leader's influence in the socialization of employees, the evolving corporate culture as a result of collective learning processes in a growing firm, and the changing role of the corporation's external business environment on its success. In this context, the evolution of business organizations moves through phases as they make the transition from small to large. This transition is characterized by a typical form of crisis. Therefore, although businesses vary in many respects, they experience common problems arising at similar stages of their development (e.g., Churchill and Lewis, 1983; Greiner, 1998). These recurrent patterns, we argue, are amenable to theoretical analysis. Moreover, the determinants and consequences of firm growth take center stage in an analysis of the evolution of an industry. While a firm's corporate culture influences an organization's success and is itself influenced by the consequences of firm success, especially increasing organizational size, the coevolution of firms' corporate cultures with a changing business environment accounts for regularities in industry evolution and reveals some forces governing these distinctive developments.

Our search for recurrent patterns in firm growth and industry evolution is guided by a model of cultural learning within organizations in combination with firm development in different business environments. It features a critical cognitive limit on firm size determined by human social predispositions, an innovative business environment favoring a cooperative corporate culture, and another, more mature business environment that allows for the realization of economies of scale based on a monitoring regime after the firm has reached a critical technical size. A number of distinctive predictions are derived regarding the relation between firm development and the evolution of an industry. Questions are raised on how evolving corporate cultures affect market structure and firm performance as well as on how an entrepreneur or business leader influences these developments.

The article is organized as follows. The relation between a firm's corporate culture and its business environment is the subject matter of Section 2. Section 3 presents findings on changes in humans' social behavior when group size increases and relates this to evolved cognitive dispositions and firm growth crises. Section 4 lays out the model of evolving corporate cultures in different business environments, while Section 5 derives predictions from it, discusses them, and relates these to empirical evidence. Section 6 concludes.

2. The role of corporate cultures in different business environments

While most economic theories of the firm posit clearly defined "production frontiers" to facilitate analysis, real-world organizations face conflicting constraints. Some of these constraints can be better understood when firm evolution is interpreted as a story of coevolution between an organization's corporate culture and its changing business environment (e.g., Freeman and Boeker, 1984; Schein, 1992; Kauffman and Macready, 1995; Hodgson, 1996; Teece et al., 1997; Hermalin, 2001). By doing so, we capture different patterns in firm development that finally will help explain the evolutionary paths that industries may follow. Within the scope of our analysis, we differentiate between two business environments – an innovative, nascent, and rapidly changing environment and a mature, stable environment – which favor different corporate cultures, a cooperative regime and a monitoring regime.[1] The question is what kinds of culture are likely to be adaptive and persist in the face of a certain business environment?

In innovative environments, where the range of environment variations is large and unpredictable, traditional mechanisms of coordination devised for stable business environments, such as rules and routines, are inadequate as contingencies cannot be accounted for in a proper way (Katz, 1964; Thompson, 1967). Therefore, in these complex, uncertain environments, organizations depend on the discretionary contributions of their members to maintain efficiency, flexibility of response, and coordination (for empirical evidence see Gittell, 2000). If a firm's employees restrict their contributions exclusively to what is specified in their employment contracts, this would severely impair its functioning. The organization must achieve the necessary adaptation by a high degree of autonomy, entrepreneurial spirit, and discretion given to its members, which again implies that monitoring fails as a means of keeping in check opportunistic behavior (Cooter and Eisenberg, 2001). The firm must, therefore, rely on cooperative employees. Cooperative behavior within organizations involves actions that go beyond the call of duty and are not explicitly recognized by the employing organization's formal reward system (e.g., Deckop et al., 1999), thereby contributing to organizational effectiveness and innovativeness (for a review of some empirical evidence see Podsakoff and MacKenzie, 1997). Such behavior reduces the need for more formal mechanisms of control.[2]

Hence, the competitive advantage of ventures based on a cooperative corporate culture is not the result of scale but of the extra effort spent by employees identifying with their organization, even though this effort is not specifically stipulated in an explicit contract. Members put the interest of the work unit ahead of their self-interests (e.g., Akerlof and Kranton, 2005; Witt, 2007). Moreover, cooperation fosters team spirit, morale, and cohesiveness of a group. Employees who are willing to take on responsibilities, actively disseminate information, or learn new skills enhance an organization's ability to adapt to changes in its dynamic environment.[3] These small firms have comparative advantages at exploiting new business opportunities, an activity that involves search, risk taking, experimentation, and flexibility (Schumpeter, 1934; Tichy, 1983; March, 1991). A corporate culture based on cooperative – rather than opportunistic – behavior among employees is a source of sustainable competitive advantage in dynamic business environments (Barney, 1986; Rob and Zemsky, 2002).

[1] This bears some resemblance to Winter's (1984) discrimination between stylized entrepreneurial and routinized regimes.

[2] For instance, Agell (2004) finds that small corporations rely less on pecuniary incentives and have a more hostile attitude toward incentive schemes based on competition. These firms rely more on social work norms, group identity, and peer pressure.

[3] As a classical example, Chandler Jr. (1962, p. 52-113) presented the case of DuPont's formal departmental organizational structure after World War I that inhibited intense communication between employees, which is essential in the development and introduction of new products.

On the other hand, larger corporations do relatively better at exploiting existing possibilities that require skills such as refinement, production, efficiency, and execution. More stable settings allow for investments in, for example, expensive capital goods for mass production. Moreover, while firms that act in very innovative business environments have to rely on non-hierarchical lines of communication to ensure flexible responses, hierarchical modes of communication seem more appropriate as routine production tasks become more prevalent in a mature business environment (e.g., Crémer, 1993). Organizations facing a stable task environment can rely on rules to achieve their adaptation to such an environment (Thompson, 1967, p. 71). The employees' effort and results of performance would most probably be easy to observe and control. Firms can then establish a formalized regime of a detailed, hierarchical monitoring of the employees' actions to prevent opportunistic behavior (see Williamson, 2002). Furthermore, larger organizations are able to realize size-related economies of scale (Pratten, 1971; Jovanovic and MacDonald, 1994).

A firm facing such a mature business environment at a later stage of industry evolution requiring low-cost production strategies implements a culture that emphasizes efficiency instead of cooperation, as it was the case in the early, innovative environment. Such a development of an industry is, for example, observed in markets when the early appearance of dramatically different versions of a product or service is followed by the later emergence of a few dominant designs, where economies of scale gain in importance. In the longer run, however, 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). These corporations are then viable only until there is a major change in the business environment calling for a more flexible corporate culture.

3. Critical group size and firm growth crises

Group size affects many aspects of group life (e.g., Olson, 1994; Spoor and Kelly, 2004). As a group, such as a firm, grows larger, many problems appear: members of larger groups tend to be less satisfied with their membership, are absent more often, contribute less often to group activities, and are less likely to cooperate with one another (e.g., Markham et al., 1982; Albanese and van Fleet, 1985; Kerr, 1989; Levine and Moreland, 1990, 1998; Forsyth, 2006, ch. 9). Moreover, there is more misbehavior in larger, more anonymous groups; coordination problems, free riding, and motivation losses often prevent reaping the productive potential that larger groups offer. For instance, 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, 1995). In an experimental study, Kerr (1989) presented evidence for a decline in perceived self-efficacy with increasing group size for public goods problems (also Brewer and Kramer, 1986; Mukhopadhaya, 2003). Subjects generally perceive smaller groups to be more efficacious and cooperative than larger groups.

Anthropologist Carleton Coon (1946) argued that small, natural groups in which people know one another personally and meet and communicate habitually form the fundamental units of human organization. Inclusion within a small, intensely interacting group reduces social distance among its members weakening the sharp distinction between their own and others' welfare. Further, Coon claimed that the only successful way to organize human agents in complex societies and institutions is through combination of such small groups as face-to-face organizations. Essential organizational processes are grounded in person-to-person relationships that are not part of, for example, the control system maintained by a firm's management.

In line with Coon's classical argument, Dunbar (1993; 2008) shows that human social groupings exhibit unique and distinct size and structure. Thereby, he draws on insights from different disciplines that indicate the existence of cognitive constraints on our ability to maintain social, personalized relationships at a given level of emotional intensity. To a great extent, the evolution of primate brains was driven by the need to coordinate and manage increasingly large social groups. The finding that average species social group size correlates with relative neocortex size gives an expected size of human groups of about 150, which corresponds with the average size of clans in hunter-gatherer and horticulturalist societies (Sawaguchi and Kudo, 1990; Zhou et al., 2005).[4] Groups below this maximum size can develop a deeper degree of social coherence and a higher level of intra-group cooperation. What is more, groups of similar size are also found in large-scale organizations of contemporary society.[5]

In the context of firm development, Witt (1998; 2007) argues that intense intra-organizational communication processes are a prerequisite for a high degree of "cognitive coherence" via shared "cognitive frames" among its members (also Hodgson, 1996). The latter affect the interpretation of information, the coordination of dispersed knowledge, and the motivation to contribute to a common goal instead of private interests. Within these processes of social interaction, observational learning from social models of behavior plays a crucial role. An entrepreneur or business leader is a prominent role model that exerts influence in the socialization of employees and the implementation of a cooperative corporate culture as a shared cognitive frame. In our model of evolving corporate cultures, we will account for this prominent role model in intra-firm learning. "Cognitive coherence" or the related concept of "group identity" (Akerlof and Kranton, 2005) are, however, impaired as the organization's size increases and the frequency of face-to-face interactions declines and with it the entrepreneur's influence in the socialization of employees.

Consequently, while at a natural group size, cooperative behavior can be maintained on the basis of personal loyalties, social role models, and face-to-face contacts, with larger groups, this not only becomes much more difficult, but gives rise to rather dramatic changes in the group members' behavior: the more frequent appearance of opportunistic behavior among peer employees in a growing group in combination with a dwindling influence of a role model such as the entrepreneur allows for the rapid spreading of self-interested behaviors. Employees who are willing to contribute to the benefit of the organization and who are easily motivated by a cooperative corporate culture, rather suddenly change their behavior when the firm reaches a critical group size (e.g., Schelling, 1972; Grofman, 1974; Gladwell, 2000; Card et al., 2008). By incorporating human social learning biases that influence cultural transmission, the model of evolving corporate cultures analyzed in the next section will account for such a critical cognitive firm size and the rather sudden changes that occur when an organization reaches this size.

Thus, given the fundamentals of humans' psychology operating through the evolution of organizations' cultures, firms should – in the course of their development – systematically face growth constraints and corresponding growth crises. As firms reach this critical cognitive size, effective coordination of tasks, information-flow through direct person-to-person contacts, and overall willingness to contribute to group aims are impaired. The exact critical cognitive size at which cooperation collapses depends on several aspects external to our model: for example, the number of members in an agent's private networks, the maturity of the group, the personalities of group members, the details of a firm's norms, or general cultural influences. For instance, the

[4] The neocortical areas involved include those for the recognition of faces, maternal behaviors, and vocalization that are known to be critical for the maintenance of social bonds.

[5] Most professional armies throughout history, e.g., have a basic unit (the company) of about 150 men.

deleterious effects on collective outcomes of increasing group size may partly be overridden when collective identity is high (see Brewer and Kramer, 1986; Wagner, 1995). In any case, we expect this cognitive constraint to systematically take effect in firm development and that it should be possible to determine a certain range of group sizes wherein it becomes eminent.

4. A model of evolving corporate cultures

To portray firms' evolving corporate cultures as a key force shaping an industry's evolution, we focus on the cultural transmission by social learning of two kinds of behavior, cooperative and opportunistic, in firms of varying size. Besides the common assumption of an inclination toward selfish, opportunistic behavior, 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). Nevertheless, cooperative tendencies are highly labile, as is shown dramatically by the cross-cultural variation in behavior in the ultimatum and public goods games (Henrich et al., 2006; Herrmann et al., 2008). According to Deal and Kennedy (1982), also the cross-firm variation in levels of cooperative behavior can be expected to be high. Hence, to understand how corporate cultures evolve, we account for the processes that change the frequencies of cooperative and opportunistic behaviors in a growing organization.

Models of cultural evolution allow one to deduce the group-level consequences of individual-level psychologies, decision rules, and behaviors (Henrich and Boyd, 2002; van den Bergh and Gowdy, 2009). These models involve deriving recursion equations in discrete time that allow us to predict the frequency of a certain 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).[6] In the following model, 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 $1-p$).

Cultural transmission from one individual to another is typically emotionally or cognitively biased; people tend to acquire some behavioral variants more easily than others (Richerson and Boyd, 2005; Norenzayan and Heine, 2005). Hence, for an analysis of the evolution of corporate cultures, we need to understand how cognition directs social learning toward certain individuals or cultural contents. To do so, 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 firm on the behavior of single employees.

A direct and a conformist bias in social learning

The influence of peers' behaviors is crucial in both maintaining a high level of cooperation and moving a group away from that regime toward the prevalence of opportunistic behavior. This fact is captured in the model by a *conformity bias* and a *direct bias* operating on cultural transmission. Due to the conformity bias, agents are more likely to pick the cultural variant, i.e.,

[6] 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.

in our context, cooperative or opportunistic behavior, that is modeled and approved by the majority of group 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). Equation (1) formalizes conformist transmission within a group of interacting members (see Henrich, 2001). As is shown in the Appendix A, the frequency of c after direct and conformist biased transmission, p'', given that it was p' before transmission, is expressed by

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

The final term in (1) models the direct bias, μ_{co} $(0 \le \mu_{co} \le 1)$, favoring the cultural variant o, i.e., the opportunistic behavior (Boyd and Richerson, 1980).[7] An employee may recognize, by observing colleagues behaving opportunistically, the extra benefits accruing from it. As a consequence, she may lower her effort for the group's goals implying an increased relative importance of her selfish interests. We suppose that each c employee has a μ_{co} chance of switching to the opportunistic behavioral variant.

The term $\eta(2p'-1)$ in Equation (1) measures the conformist transmission bias. Parameter η, which varies between 0 and 1, gives the strength of conformity relative to the direct bias μ_{co} in human cognition, i.e., it scales the cognitive weight given to the frequency of a behavior in a group (see Henrich, 2001).[8] The 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. When $p' > 0.5$ the conformist term favors the cooperative behavioral variant.

Socialization processes within the firm via cultural role models

Next, we incorporate a socialization phase into the model (here we draw on previous work done in Cordes et al., 2008). An entrepreneur or business leader plays an outstanding role in the socialization process of a firm's employees. By offering herself as a role model and implementing a business conception as a shared cognitive frame within the firm, an entrepreneur provides crucial cognitive inputs in organizing production and trade (Schein, 1992; Witt, 1998; 2000). Thereby, she can motivate and coordinate firm members, foster cooperation, and hold down opportunism. In model-based social learning there exists a human predisposition to imitate successful or prestigious individuals, i.e., there is a *model-based bias* taking effect in cultural transmission. Evidence form 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 can draw on this human characteristic by providing a prestigious role model for social learning processes within the firm and by demonstrating cooperative attitudes as a worth-while. We assume that a firm's employee is influenced by the entrepreneur and n peers, i.e., the other employees. To depict the differing importances of these role models in social

[7] In cultural evolution, individuals are more likely to adopt some cultural variants based on their content (Richerson and Boyd, 2005). Such a direct bias can result from the calculation of costs and benefits associated with alternative variants or from cognitive structures that cause people to preferentially adopt some variants rather than others.
[8] Here, η is considered to be small, for when η, e.g., exceeds 0.5, no rare behavior ever spreads.

learning, we assign different weights to them: A_E denotes the entrepreneur's influence and A_P measures the weight of an ordinary member of the group.[9] Here, a large value of A_E implies that the employee is disproportionately likely to acquire the cultural variant of the entrepreneur. We do, however, argue that the entrepreneur's influence as a role model is decreasing with a growing group size n. Given these assumptions, the total, i.e., firm size adjusted, actual weight of the entrepreneur or business leader in cultural transmission is given by

$$A_E = \frac{\alpha_E}{\alpha_E + n\alpha_P}, \tag{2}$$

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, i.e., their charismatic potential (social skills, personal work ethic, ability to articulate a persuasive vision, etc.) and the wider cultural context.

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

$$A_P = \frac{\alpha_P}{\alpha_E + n\alpha_P}. \tag{3}$$

Within the group, the cumulative influence of the employees on the social learning process 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 so that they give the weight of a model relative to the other models encountered by the individual in question.

To characterize socialization of group members in a growing firm, the model must allow us to predict the probability of agents acquiring trait c or o, given a particular set of models (entrepreneur/leader, 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 – in her function as a prominent role model – to be always cooperative. As is shown briefly in the Appendix B and more detailed in previous work (Cordes et al., 2008), given the average pairing probability of role models and their changing weights in the cultural transmission process, we yield a $A_E + pnA_P$ probability of transmitting behavior c to each member of the firm. Thus, the partial recursion for the socialization phase is expressed by

$$p' = A_E + pnA_P. \tag{4}$$

The complete recursion for p, depicting the change of the level of intra-firm cooperation as an indicator of a firm's corporate culture, over one conformist learning step and one socialization phase, is obtained by substituting (4) into (1):

$$p'' = (A_E + pnA_P) + (A_E + pnA_P)(1 - (A_E + pnA_P))\{\eta(2(A_E + pnA_P) - 1) - (1 - \eta)\mu_{co}\}. \tag{5}$$

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

We can now calculate the equilibrium frequencies of the cooperative behavioral variant among the firm's employees: at equilibrium, the group's composition does not change, so $p'' - p = 0$. By subtracting p from both sides of (5), we determine the equilibria of the coupled recursions implied by (5). Solving for $\hat{p}$, denoting the equilibrium frequency of the cooperative behavior c, we find two equilibria

(6) $\hat{p}_1 = 1$ and

(7) $$\hat{p}_2 = \frac{-\mu_{co}\sqrt{an}(1+an)(\eta-1)+\sqrt{an}(an-3)\eta-(1+an)\sqrt{an(\mu_{co}(1-\eta)+\eta)^2-8\eta}}{4(an)^{3/2}\eta},$$

$$a = \frac{\alpha_P}{\alpha_E}.$$[10]

Figure 1 plots p'' as a function of p as given by the recursion described by Equation (5) for all values of p from zero to one. The intersections of this function and the dashed 45-degree line (where $p'' = p$) indicate the recursion's equilibria. Given a certain firm size ($n = 50$) and the parameter values chosen here ($\eta = 0.1$, $\mu_{co} = 0.3$), a high influence of the entrepreneur in within-firm social learning, as measured by α_E (here $\alpha_E = 0.95$), can lead to a perfect cooperative regime ($\hat{p} = 1$). However, the upper equilibrium, $\hat{p}_1$, becomes unstable with a decreasing influence of the entrepreneur in socialization (e.g., $\alpha_E = 0.8$). It is then that the direct bias favoring opportunistic behavior, μ_{co}, can push the group away from the upper equilibrium at $\hat{p}_1$ and toward the equilibrium given by $\hat{p}_2$, which is characterized by a lower level of within-firm cooperation. The position of the second equilibrium, $\hat{p}_2$, depends, *ceteris paribus*, on α_E: the lower the entrepreneur's charismatic potential, the lower is the final equilibrium of the cooperative trait in the firm (e.g., when $\alpha_E = 0.5$).

Figure 1: The equilibria for Equation [illegible] 0.1, [illegible] 0.3, n [illegible]

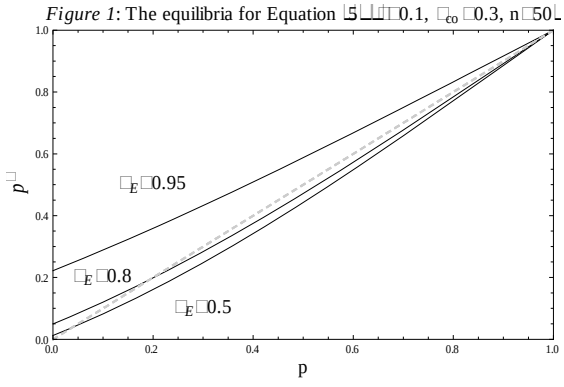
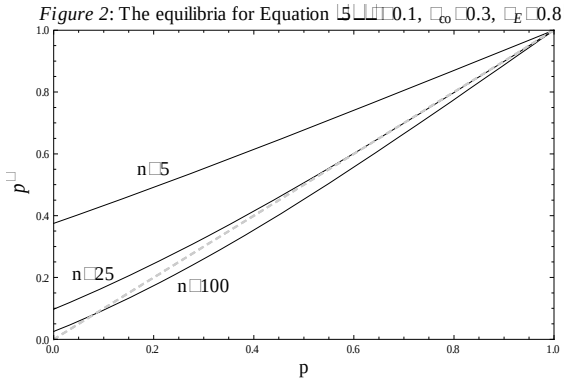


Figure 2: The equilibria for Equation [illegible] 0.1, [illegible] 0.3, [illegible] 0.8



[10] A third solution for $\hat{p}$ yields a value greater than one and is therefore irrelevant in this context.

Figure 2 shows the equilibria for Equation (5) in the case of varying firm sizes holding the entrepreneur's charismatic potential, α_E, constant ($\alpha_E = 0.8$, $\eta = 0.1$, $\mu_{co} = 0.3$). As can be seen, a perfect cooperative regime ($\hat{p} = 1$) can be reached in a very small group ($n = 5$). With increasing group size, a diluted influence of the entrepreneur or business leader in socialization, and a rather high direct bias, this equilibrium level of cooperation in the firm becomes unstable ($n = 25$, $n = 100$). The larger the firm, the lower is, *ceteris paribus*, the final equilibrium level of cooperation within the group.

Moreover, by setting the parameters of our system of recursions, we can model its long run behavior by conceptually iterating Equation (5) recursively for many conformist learning and socialization steps. This is done in Figure 3 that visualizes the values of p, i.e., the share of cooperative agents within the firm, depending on group size as measured by the number of employees. It illustrates the occurrence of distinct firm growth crises. The group starts from a high level of cooperation ($p = 0.9$). For different values of α_E, i.e., the entrepreneur's charismatic potential, we yield different *critical cognitive firm sizes*: when the organization reaches this size, the level of cooperation deteriorates rapidly due to a dwindling influence of the entrepreneur in socialization, new opportunistic agents introduced by the direct bias, μ_{co}, and the conformity bias that, while having stabilized the preceding cooperative regime, now spurs the spreading of the more frequent behavior o. Therefore, *ceteris paribus*, contingent on the entrepreneur's charisma, firms have different potentials of maintaining a high level of cooperation as the firm grows. Hence, the observed range of critical cognitive firm sizes depends, among other things, on the distribution of charismatic potentials (as measured by α_E) in the pool of entrepreneurs. Firms do, however, inevitably reach this threshold in the course of their growth process. The cognitive constraints on group size take effect in the development of the firm by systematically causing growth crises.[11]

Modeling firm growth in different business environments

Next, we model the firm's growth process by connecting its evolving corporate culture with firm performance in different business environments. In Section 2 we have argued that ventures based on a cooperative corporate culture reap a competitive advantage due to the extra effort spent by employees sharing a cognitive frame or identity. This effect is especially significant in rapidly changing, innovative business environments where flexible responses of employees are inevitable to firm success. To account for these gains from cooperation, we assume that each cooperative employee contributes to the firm's profit an amount measured by r_c. Each opportunistic agent, on the other hand, causes a loss of r_o in such a nascent, innovative business environment. $r_{c/o}$ are measured in units of a standard employee wage. Furthermore, we capture the fact that firms can realize economies of scale in a later, more mature business environment by allowing for an endogenous modification of the costs of opportunistic behavior. We will argue that the latter change in the course of firm development and dependent on the total number of employees, n. Then, the following recursion describes the firm's growth process:

$$n' = pn(1 + r_c) + n(1 - p)(1 + r_o(n)). \tag{8}$$

[11] Organizations of such an intermediate size are especially vulnerable to failure, an observation for which there is ample empirical and theoretical evidence (e.g., Hannan and Freeman, 1977; Boone et al., 2004). Our theory offers one explanation for why this is the case.

Here, $pn(1+r_c)$ represents the number of cooperative employees times the unit resources needed to pay their wages plus the profit they make. Hence, to support one employee requires the generation of one unit of revenue, while r_c is the profit resulting from their cooperative behavior that allows new employees to be hired. Accordingly, $n(1-p)(1+r_o(n))$ is the aggregate contribution to a firm's income yielded by opportunistic employees. The following expression describes the relationship between r_o and n:

$$r_o(n) = -r_c + \frac{n}{n_{crit\_tech} + n} 2r_c . \quad (9)$$

[12]

In this context, the function $r_o(n)$ captures the effect of the opportunity to realize economies of scale in a stable business environment (e.g., Pratten, 1971; Audretsch and Mahmood, 1994): the *critical technical firm size*, n_{crit_tech}, determines the organizational size at which opportunistic agents start to contribute a profit – instead of a loss – to firm development. For large firm sizes, r_o is asymptotically approaching r_c. Thus, if the firm reaches this critical technological size, economies of scale and the task structure in a stable business environment compensate for the losses caused by opportunistic agents in smaller firms that are based on a cooperative corporate culture. For instance, the task structure of larger firms that engage in mass production of standardized goods in more mature markets is characterized by a relatively higher share of routinized exercises. The effort and results of performance of these tasks are relatively easy to monitor preventing great losses from shirking behavior. A monitoring regime is then sufficient to keep opportunism in check. At the same time, these firms are capable of reaping further cost advantages emanating from economies of scale and size.

Consequently, a firm's business environment enters Equation (8) in several ways. We imagine an industry's evolution starting in a nascent stage characterized by a high degree of uncertainty and change that prevents economies of scale from being realized. At the same time, it enables relatively high gains emanating from cooperatively-minded employees in rather small firms below their critical cognitive size that are characterized by a high share of cooperative agents (as measured by r_c and p respectively). Then, according to Equation (8), firms with a high share of opportunistic agents fail, which may be due to an entrepreneur that is not well-suited as a role model, while those capable of maintaining a cooperative regime prosper and grow. In this dynamic business environment, the higher level of discretion left to the employees entails high potential costs of opportunistic behavior, i.e., it implies a high negative value of r_o. The same would hold true for older industries that nevertheless exhibit a fast changing market because of a continuously high level of innovative activity. In such a setting we would still expect small firms – or larger organizations based on small subunits – with cooperative corporate cultures to dominate. If, however, a firm's business environment develops toward a high degree of certainty over time and firm growth, this makes possible larger investments in standardized production technologies that enable size-related economies of scale and the performance of routine tasks. This enters Equation (8) via a modification of the costs and benefits accruing from

[12] For simplicity, we assume a close to symmetrical profit/loss case in the beginning for very small firm sizes where $r_c \approx r_o$.

opportunistically behaving agents in larger and older firms, as measured by $r_o(n)$ in combination with $(1-p)$, the share of opportunistic employees in a corporation.[13]

At equilibrium the firm size does not change, so $n'-n=0$. Solving Equation (8) for $\hat{n}$ denoting a firm's equilibrium size yields:

(10) $\hat{n}_1 = 0$ and

(11) $\hat{n}_2 = n_{crit\_tech} - 2n_{crit\_tech}p$.

The equilibrium at $\hat{n}_2$ is unstable implying that above it firm size is increasing, while it is shrinking below it. We ignore solutions that yield negative values for n, which is the case when $p > 0.5$, which again entails a continuously growing firm. We then find that this unstable equilibrium increases in n_{crit_tech}, i.e., a growing critical firm size has to be reached beyond which sustainable firm growth is facilitated. Moreover, it decreases in p as long as $p < 0.5$, i.e., $\hat{n}_2$ decreases with a growing level of cooperation within the firm.

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 (12) and another one depicting the changing size of a firm in the course of time (13) ($p''-p=\Delta p$, $n'-n=\Delta n$):

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

(13) $\Delta n = pn(1+r_c) + n(1-p)(1+r_o(n)) - n$.

While it is possible to solve this dynamic system analytically, the resulting terms are too complex to be interpreted in a straight forward manner. We can, however, visualize its dynamic properties to further discuss its implications.[14]

5. Implications for firm growth in different business environments and industry evolution

The model devised in the preceding section enables us to derive some interesting insights concerning firm growth processes in different business environments and their implications for industrial evolution. For this purpose, the properties of the two coupled recursions (Equations (12) and (13)) describing a firm's evolving corporate culture and the connected development of organizational size in different markets are studied further by iterating this two-dimensional dynamic system for many cultural transmission and firm growth steps.

Figure 4 shows the growth processes for three representative firms implied by Equations (12) and (13) over many iteration steps capturing progressing time given different values of the entrepreneurs' basic weights in the socialization of employees, as measured by the parameter α_E ($\eta = 0.1$, $\mu_{co} = 0.3$, $r_c = 0.1$, $p = 0.5$ and $n = 4$ in the beginning). In an innovative business environment where a high level of intra-firm cooperation yields competitive advantages,

[13] For simplicity and tractability, we assume gains from cooperative agents also in a mature environment, i.e., they are not frustrated by the new corporate culture.

[14] The corresponding author will provide exact analytical solutions upon request.

organizations based on a cooperative corporate culture can progress from slow initial growth to rapid growth. We see, however, that firms have different growth potentials at this stage of their development. The higher the entrepreneur's charismatic potential, the longer the firm's growth process lasts and the larger is the size finally reached before it decreases again due to the dwindling influence of the entrepreneur in within-organizational learning and the spreading of opportunistic behavior.

Proposition 1. *In the course of their growth process, firms reach a critical cognitive size beyond which the level of cooperation among its employees deteriorates rapidly and, ceteris paribus, firm size shrinks. This critical size depends on within-firm learning dynamics and constraints on the influence of the entrepreneur or business leader therein.*

The existence of a firm culture introduces time lags; culture really does evolve. Both the growth and the shrinking phase of a firm are spurred by the conformity bias. First, it stabilizes the cooperative regime enabling the organization to reap gains from cooperation, which is the majority behavior at this stage, in a variable business environment. Second, the conformity bias promotes the dissemination of opportunistic behavior around the critical cognitive firm size where it becomes more frequent among employees, finally causing a rapid decline in firm size and performance. This is illustrated by Figure 5 that depicts the evolution of the frequencies of cooperative behavior, p, in these growing firms as an indicator of an organization's corporate culture. The level of p drops rapidly after the firm has reached a certain critical cognitive size, again depending, *ceteris paribus*, on α_E. This fall in cooperation is more pronounced the higher the previous level of cooperation was. p increases again as firm size shrinks due to the fact that the entrepreneur's influence rises in smaller organizations. The final equilibrium values of p and n reached after some oscillations can be determined analytically from Equations (12) and (13).

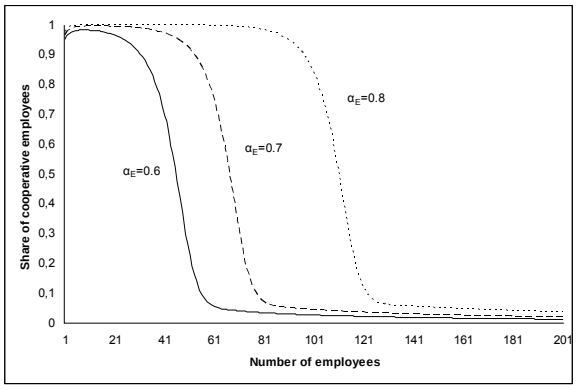


Figure 3: Levels of cooperation in growing firms for different α_E given that $p = 0.9$ in the beginning ($\eta = 0.1$, $\mu_{co} = 0.3$).

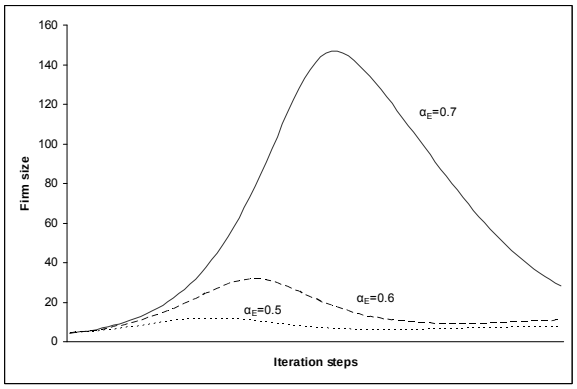


Figure 4: Firm growth paths for different α_E ($\eta = 0.1$, $r_c = 0.1$, $n_{crit\_tech} = 250$).

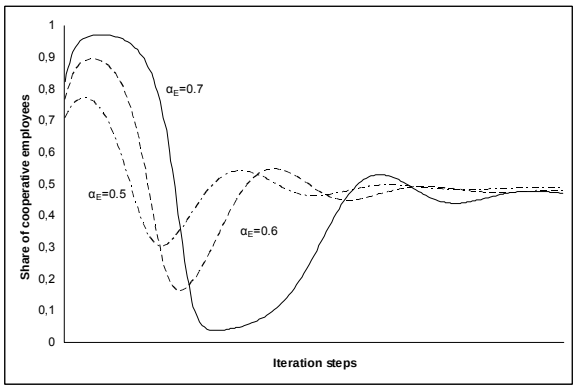


Figure 5: Levels of cooperation in growing firms for the cases depicted in Figure 4.

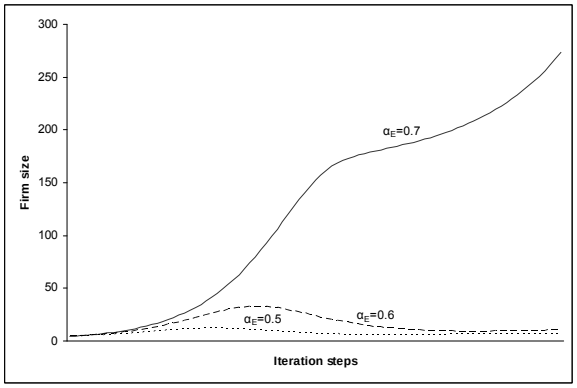


Figure 6: One Firm reaching the critical technological size, $n_{crit\_tech} = 170$.

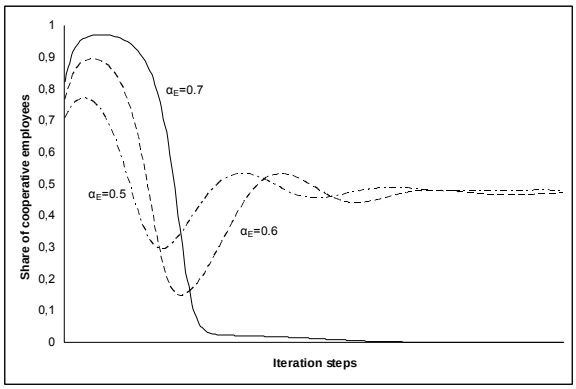


Figure 7: Shares of cooperative employees for the cases depicted in Figure 6.

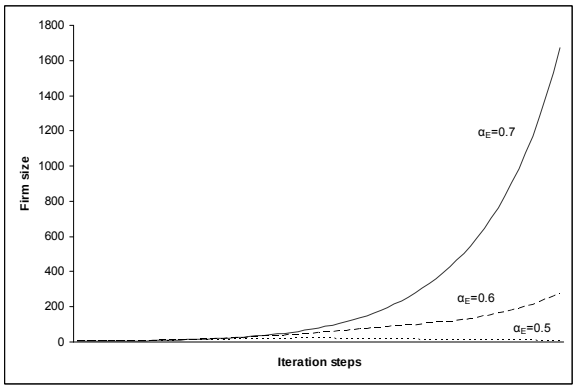


Figure 8: Two firms reaching the critical technological size, $n_{crit\_tech} = 50$.

In a nascent, innovative business environment, none of the firms shown in Figure 4 would reach the size beyond which economies of scale in an assumed later, stable task environment would compensate for the losses caused by opportunistically behaving employees. In this case,

the critical technological firm size lies at $n_{crit\_tech} = 250$. However, if we lower this critical technological firm size, which may be caused by technological progress, a firm's growth process can change significantly (see Figure 6): we now assume that this parameter amounts to $n_{crit\_tech} = 170$. This organizational size is reached by the one representative firm with the most influential or charismatic entrepreneur in the sample ($\alpha_E = 0.7$). The firm now attains the modified critical technological size before moving beyond the critical cognitive size that would result in rapid firm shrinkage. The successful firm's growth path shown in Figure 6 also exhibits a period of slower growth sandwiched between phases of rapid organizational development, i.e., even in this case the firm goes through a growth crisis. Overall, this organization experiences continuous growth while the other two firms still face decline in the long-run (also Witt, 2000).

Proposition 2. *If firms reach – and possibly maintain for some time – a certain size in an innovative environment based on a cooperative corporate culture, they may be able to reap economies of scale based on a monitoring regime in a later stable task environment that necessitates such a technological minimum size. Otherwise, due to competitive pressures resulting from such a setting, they are likely to fail and exit the market.*

Figure 7 shows the changing shares of cooperative employees in the set of firms in the course of organizational development given the altered critical technological size. As can be seen, the successfully growing firm is characterized by a corporate culture that can handle a high share of opportunistically inclined agents, potentially by close monitoring and by assigning routine tasks whose executions are easy to observe, measure, and specify in an employment contract. Hence, a formalized regime of monitoring of the employees' routine performances in this stable, mature business environment prevents costly opportunistic behavior, enables further organizational growth, and the realization of economies of scale. Firms reaching the critical technological size can subsequently experience a take-off. Ventures that do not reach the critical technological size will be unlikely to survive in this market and probably will be forced to exit, although they might have been very competitive in the earlier innovative environment (e.g., Audretsch and Mahmood, 1994). The merging of organizations may provide a way for smaller firms to reach the critical technological firm size – potentially at the cost of their cooperative corporate cultures.

However, not all business environments evolve into such a situation: in environments characterized by permanent uncertainty and complexity, making necessary continuous mutual adjustment, sustained effective coordination of a firm's employees' actions is always facilitated most easily in cooperative corporate cultures:

Proposition 3. *A market that is lastingly characterized by a complex, innovative, and uncertain business environment can be expected to host many small firms or organizational units that are based on cooperative corporate cultures and that stay below their critical cognitive size in order to yield competitive advantages related to small size.*

In addition, in such dynamic business environments, opportunistic behavior of highly independent, specialized employees would be especially harmful, i.e., $r_o(n)$ would take on high negative values. Consultant firms, whose structure is explicitly based on small groups, are a case in point. Here, a cooperative culture is an appropriate means to keep in check opportunism. Moreover, many specialist firms are small because they occupy niches in markets that, on the one hand, do not allow for reaping economies of scale and that, on the other hand, necessitate non-routine tailoring of products to the needs of costumers that relies on employees enjoying a great degree of discretion (e.g., Greve, 2008). Furthermore, smaller ventures relative to larger established firms tend to excel at exploiting new business opportunities (e.g., Winter, 1984).

Consequently, as is shown by the empirical evidence, many industries are dominated by small enterprises (see Audretsch, 1997).

In business environments that require a relatively smaller critical technological firm size, we expect more firms to attain this threshold size before having crossed the critical cognitive firm size. This is illustrated in Figure 8, where the critical technological firm size is, *ceteris paribus*, lowered to $n_{crit\_tech} = 50$. We now find that two out of our set of three representative firms are capable of exploiting economies of scale or taking advantage of easily specifiable routine tasks in a later business environment. These two exhibit continuous growth, albeit at different rates.

Proposition 4. *Technological progress may lower the firm size beyond which economies of scale can be realized. In this case, more firms can be expected to have the potential to reach this critical technological size in the course of their growth process in an earlier innovative business environment and before reaching the critical cognitive size. Finally, one would expect there to be more firms active in such a market than in the case of a higher critical technological firm size.*

Consequently, industries with a high critical technological firm size are characterized by a relatively low likelihood of survival and *vice versa* (Audretsch and Mahmood, 1994). Moreover, after a shakeout phase, industries of the former kind may then evolve into, for example, an oligopolistic structure (Klepper, 2002). Such an oligopoly would be a natural consequence of critical cognitive and technological firm sizes. These findings have, therefore, direct implications for theorizing about the determinants of market structures.

Our analysis allows for different patterns of firm development in changing business environments and thus industry evolution. The first stage of firm development is characterized by growth through flexibility and creativity in a cooperative corporate culture. This stage often ends with a critical phase due to the firm's reaching of a critical cognitive size and related changes in corporate culture. A venture's likelihood of failure is extraordinarily high at this point of firm development. Further subsequent developmental paths of a business organization are possible:

(1) Some firms may pass through the first growth phase and then plateauing, remaining the same size with some profit over a long period of time. Consequently, a corporation aware of its constraints may limit its own further organizational growth and stay below the critical cognitive firm size. It may then be restricted to a niche market that does not permit sustained firm growth or to highly innovative business environments. This may also be the right moment for the entrepreneur to sell the business – provided the owner recognizes her limitations soon enough.

(2) A company can implement an intra-organizational subdivision of entrepreneurship to keep its parts below the critical cognitive firm size, while allowing for growth of the organization as a whole. Sub-leaders assigned to these subdivisions would then be capable of maintaining cooperative cultures in their groups via proximal cognitive leadership (Witt, 2007).[16] Moreover, organizations may cope with lasting uncertainty in some innovative environments by creating certain subunits dedicated to deal with them, while specializing other parts in operating under environmental conditions of near certainty. As a result, different optimal subunit sizes with different corporate cultures emerge depending on the different business environments. Ideally, organizations can tune their structures to achieve either the capacity to adapt to a rapidly evolving business environment or to reap the advantages of scale production in a stable environment. In that case, organizational differentiation is linked to subunit performance rather than to organizational size per se.

[16] Much larger groups than the natural social units require, therefore, different cognitive strategies for maintaining their coherence through time (e.g., Olson, 1994; Dunbar, 2008).

(3) Finally, a company as a whole may surpass its critical cognitive size by reaching a critical technological size beyond which it can realize economies of scale in an emerging stable business environment. Its corporate culture would then rely on a formalized regime of a detailed, hierarchical instructing and monitoring of the employees' actions to prevent opportunistic behavior (Williamson, 2002). Precondition for this to happen is a business environment in which technological and market conditions allow for mass production and routinized tasks in providing the service or product.

We argue here that evolving business cultures as an endogenous source of firm performance are one common force governing the evolution of an industry: Klepper (1996; 1997), for example, shows that in many markets the number of firms in an infant industry initially grows and then experiences a sharp decline or shakeout in the course of these firms' further development (also Jovanovic and MacDonald, 1994). According to our behavioral model of firm development, part of the shakeout phenomenon can be traced back to many organizations' reaching of a critical cognitive firm size beyond which firm performance deteriorates. This corresponds to Wernerfelt's (1984) perspective on organizations' internal capabilities.

Furthermore, also the exogenous business environment affects organizational performance and industry evolution: small, cooperative firms experience a shakeout if a mature business environment calls for larger firms realizing scale economies even if they stayed below the critical cognitive size in an earlier innovative business environment. In such an industry, growth is a prerequisite for survival (e.g., Jovanovic and MacDonald, 1994). Therefore, technological improvements that reduce production costs while increasing the firm's optimal scale can cause a shakeout of firms in a market because of cognitive constraints in firm development. On the other hand, larger corporations' monitoring regimes fail in innovative business environments that require a high degree of cooperation on the part of the employees. This may be the case if, for example, an established large company's business environment turns – due to technological progress – into an innovative environment again asking for a high degree of organizational flexibility. These processes reflect Porter's (1980) emphasis on the impact of a changing business environment on organizational performance.

6. Conclusions

This paper has shown how cognitive human dispositions that operate as forces on the development of an individual firm's corporate culture have repercussions on an industry's evolution. In our theory, the industry level effect is attributable to evolving corporate cultures coupled with changes in a firm's business environment. With the help of a formal model of evolving corporate cultures, we demonstrated how firms can establish a cooperative cultural regime that yields competitive advantages in an innovative, fast changing environment. Depending on within-firm social learning processes, organizations then reach a critical cognitive firm size in their development beyond which the level of cooperation deteriorates rapidly – they systematically face a growth crisis. There is strong evidence that human social group sizes have a cognitive limit. Organizations successful in an early dynamic business environment and reaching a critical technological size may, however, reap economies of scale in a later, mature and stable business environment based on a monitoring regime that keeps in check employees' opportunistic behavior in an altered corporate culture. Furthermore, we related these findings to firm survival in different industries, the evolution of organizational structures, technological advancements in production technologies, and identified some determinants of market structures. These findings, therefore, have potential implications for public policy making (e.g., Klepper, 2002).

This paper's behavioral approach to firm development in varying business environments offered new insights on organizational performance and the evolution of industries. The emphasis on evolving corporate cultures shaping firm development resonates with a number of other theoretical avenues (e.g., Deal and Kennedy, 1982; Denison, 1984; Kreps, 1990; Kotter and Heskett, 1992; Schein, 1992; Lazear, 1995; Hermalin, 2001). While factors such as ownership structure, incentives, or financial circumstances of a business certainly are important, other aspects are also at work in firm development: changing group sizes, systematically appearing growth crises, the influence of the entrepreneur or business leader in intra-firm socialization of employees, evolving corporate cultures, and firm performance in different business environments depending on these cultures. Moreover, the fact that organizations pass different stages in the course of their evolution represents an important insight for management practice (e.g., Churchill and Lewis, 1983): managers who can assess the stage their organization is in can better understand emerging problems and challenges. Finally, future empirical research should probe the predictions of our theory.

Appendix A

- We assume employees to choose an individual at random from the total number of a firm's employees. Due to the direct bias μ_{co} alone, which captures the attractiveness of opportunistic behavior, agents are probabilistically more likely to adopt behavior o ($0 \le \mu_{co} \le 1$) when they encounter it or to stick to it if they already behave opportunistically and meet a cooperative colleague. In addition, the conformist component, $(2p'-1)$, which depends on the frequency of behavior c in the firm, modifies the adoption probabilities as described in the text. Then, the probabilities of switching are given by Table A1.

Table A1 The probability of employees acquiring behavior c or o given a particular behavior encountered.

Cultural Variant of		Probability That an Agent Acquires Cultural Variant	
Self	Other	c	o
c	c	1	0
c	o	$\frac{1}{2}\{1+[\eta(2p'-1)-(1-\eta)\mu_{co}]\}$	$\frac{1}{2}\{1-[\eta(2p'-1)-(1-\eta)\mu_{co}]\}$
o	c	$\frac{1}{2}\{1+[\eta(2p'-1)-(1-\eta)\mu_{co}]\}$	$\frac{1}{2}\{1-[\eta(2p'-1)-(1-\eta)\mu_{co}]\}$
o	o	0	1

Using the probabilities of each possible pairing of "Self" and "Other", we can calculate the frequency of behavior c after this kind of transmission process by multiplying the former by the different probabilities of switching to behavior c. We get the following recursion:

$$p'' = p'^2[1] + 2p'(1-p')\left[\frac{1}{2}\{1+(\eta(2p'-1)-(1-\eta)\mu_{co})\}\right] + (1-p')^2[0]. \quad \text{(A1)}$$

Simplifying gives Equation (1) in the text.

Appendix B

• In order to account for the effects of new personnel joining the firm and the necessary "renewal" of the socialization of existing employees, who are then considered as if they were personnel just joining the firm, we suppose that in each time step a cohort of n employees "retires" and is replaced by n new employees who are socialized by all n old employees, plus the entrepreneur. In addition, we assume that all new employees show neutral behavior when they join the firm. Moreover, these new firm members encounter other employees at random. With the help of the cultural transmission table below (Table B1), we specify the probability that a particular set of role models with different weights makes an individual acquire the cultural variant c or o, given a changing group size.

Table B1 The probability of agents acquiring trait c or o given a particular set of models (Entrepreneur/Leader, Peers) that have different total weights (A_E, A_P).

Cultural Variant of		Probability That an Agent of the New Cohort Acquires Cultural Variant	
Entrepreneur/Leader	n Peers	c	o
c	$c...c$	$A_E + nA_P$	0
c	$c...c,o$	$A_E + (n-1)A_P$	A_P
c	$c...c,o,o$	$A_E + (n-2)A_P$	$2A_P$
⋮	⋮	⋮	⋮
c	$o...o$	A_E	nA_P

The variable p measures the frequency of the c type in an infinite meta population of firms of size n. That is, for illustrative simplicity we are here modeling only the deterministic effect of evolutionary processes. In any given firm, stochastic effects will be important. However, in an infinite population of firms with particular characteristics, p will perfectly describe the average frequency of the cooperative variant and $(1-p)$ the opportunistic variant. Therefore, the average pairing probability of role models in the transmission table will have $A_E + pnA_P$ probability of transmitting c to each new member of a cohort and probability $(1-p)nA_p$ of transmitting the cultural variant o. Thus, in an infinite population of firms of size n, the partial recursion for the socialization phase with the frequency of c after transmission, p', given that is was p before transmission, is expressed by Equation (4) in the text.

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