



Paper to be presented at the DRUID Academy conference in Rebild, Aalborg, Denmark on January
21-23, 2015

Three triggers of search - Why young firms decrease selective revealing over time

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Abstract

Problemistic search is triggered when organizational performance is below the management's aspiration level. We propose a distinction between three types of such triggers: unsatisfactory outcomes of earlier search processes, a change in conditions that renders a hitherto successful solution suboptimal, and a shift in what the firm defines as performance. Empirically, we draw on a multiple case study within three segments of the software industry. By examining young firms that initially revealed much of their code under open source licenses and later mostly reduced their level of openness, we find evidence of all three triggers. Specifically, conditions may change due to growth of the firm and an increasing risk of imitation, and the understanding of performance may shift from surviving and being a good community player to building a scalable business.

Three triggers of search —

Why young firms decrease selective revealing over time

December 2014

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Keywords: behavioral theory of the firm, problemistic search, open innovation, firm adaptation, case studies

JEL Code: O32, M13

INTRODUCTION

Since its inception in 2009 Makerbot, a New York based 3D–printer manufacturer, pursued an open source type approach to innovation by freely revealing constructional drawings and firmware of their printers. The firm enjoyed significant growth in its first years, which analysts attributed to the “love and praise” they got from makers, open hardware people and the community (Peels 2013). In 2012, however, Makerbot abruptly reduced its level of openness. This change was followed by a trade sale in 2013 to the industry leader, Stratasys, with a deal volume of USD 403 million. The case of Makerbot parallels anecdotal evidence from numerous software firms that started out rather “open”, in the sense of selectively revealing (Henkel 2006) a considerable share of their code as open source software, but after a while took a more proprietary stance toward innovation.

Understanding this shift matters since striking the right balance between the benefits and risks of openness is challenging (Alexy et al. 2013, Chesbrough 2003, von Hippel 1988, Henkel 2006, Fauchart and Gruber 2011). In particular from a dynamic perspective this shift seems puzzling. Given that many firms only recently embraced selective revealing and started to practice it increasingly (Henkel et al. 2014), why would other firms reduce it?

The phenomenon at hand also provides a most suitable setting for studying search processes more generally, due to the dynamic situation of young firms and the relative ease of observing the focal strategy variable, i.e. the selective revealing of source code. We thus ask, can our observations be understood using the established search models of the behavioral theory of the firm or do they suggest a refinement?

To address the above research questions we conducted a qualitative empirical study. It follows a longitudinal, embedded multiple case study design with 13 technology based ventures within three segments of the software industry, enterprise resource planning (ERP), data storage, and database management software, using an extensive data set from 28 in–depth interviews and secondary sources. The segments we selected allow us to observe the full continuum between open and closed innovation, competition between small and big firms, and new software offerings like cloud computing.

Our findings confirm the established benefits of selective revealing such as external development support, marketing, boosting the sale of complements, and attracting new hires (Alexy et al. 2013, Dahlander and Magnusson 2005, Dahlander and Magnusson 2008, Franke and Shah 2003, Harhoff et al. 2003, Henkel 2006, Raymond 1999). They also confirm that it is particularly beneficial for market entrants since it mitigates liabilities of newness and smallness and lowers barriers to entry (Gruber and Henkel 2006). This argument, however, suggests in turn that selective revealing should decline in relevance when the firm matures, which is precisely what we observe in many cases. We identify three distinct reasons for such a shift. First, the earlier open approach did not allow the firm to attain its business goals, and so it was abandoned; second, the open approach worked well for a while, but then became unattractive because external development support was less needed, liabilities of newness and smallness were overcome, and the risk of imitation increased; and third, because the overall goals of the firm changed, e.g. from making a living while being a good community player to building a scalable business model and achieving an attractive return on investment.

These findings can readily be interpreted through the lens of the behavioral theory of the firm with its emphasis on search processes (Cyert and March 1963). For each of the three reasons mentioned earlier, the shift to lower levels of openness can be seen as the result of a problemistic search, that is, a search process triggered by the perception that organizational performance is below the management's aspiration level. On a more fine-grained level, however, the triggers differ. In the first case, the focal firm simply continues an ongoing search process, the trigger being the realization that its current, tentative strategic position does not allow attaining its performance goals. Expressed through the landscape metaphor introduced to organization research by Levinthal (1997), the firm continues its search for a higher peak. In the second case, the firm had a hitherto satisfactory strategic position which, however, became relatively unattractive due to changing conditions. In other words, the firm experienced a dynamic fitness landscape (Gavetti and Levinthal 2000) and had to readjust its position, in a similar fashion as innovations may trigger new search processes (Greve and Taylor 2000). In the third case, finally, the firm's understanding of performance changed altogether, implying a change of the target function the firm was optimizing. In the landscape language, the firm moved to an entirely different fitness landscape.

The paper is organized as follows. In section 2, background information is given on organizational adaptation as well as benefits and risks from openness. Section 3 gives an overview on the research design and data. In section 4, findings and results are presented. Section 5 concludes with a summary and a discussion.

ORGANIZATIONAL CHANGE AND DETERMINANTS OF OPENNESS

Organizational adaptation — the *NK* model of adaptation on rugged landscapes

The NK model of rugged performance landscapes¹ has widely been used in management literature to explain organizational search and adaptation (Levinthal 1997, Winter et al. 2007, Knudsen and Levinthal 2007, Rivkin 2000). In this article, we apply the *NK* model as metaphor of adaptation on rugged landscapes in order to explain a young firm's change over time, and more specifically an organization's changing level of openness.

Having its roots in biology (Wright 1932), the model was originally used to map an organism's genetic attributes to its fitness level. Applied to management, the *NK* model characterizes problems as a space of alternatives. Every alternative consists of N binary attributes that influence the performance of an alternative, and K interactions between the attributes. The typology of the performance landscape results from the mapping of the set of attributes, N , to its performance; where the number of interdependencies, K , determines the landscape's surface condition. Little or no interaction among attributes results in a single peak (optimum) fitness landscape showing a quite smooth surface. As the number of interactions increases, the number of peaks goes up, resulting in a so-called rugged landscape (Kauffman 1993, Rivkin 2000). Two activities need to be characterized, search and maneuvering. That is, how do organizations explore their neighborhood, i.e., are organizations able to identify local and distant alternatives? And, subsequently, how can organizations move through the

¹ Scholars have recently used the *NK* model to explore, e.g., open innovation (Almirall and Casadesus-Masanell 2010), organizational design (Levinthal and Warglien 1999, Siggelkow and Rivkin 2005), barriers to imitating a complex strategy (Rivkin 2000), and product development (Fleming and Sorenson 2004, Mihm et al. 2003).

landscape, i.e., are organizations able to move up and down the peak where they are located and to move between peaks?

Search and maneuvering Agents — organizations or individuals — explore their neighborhood, which is identifying alternatives, by engaging in search. The dominant behavioral assumption is local or neighborhood search. Reflecting bounded rationality, an organization is able to engage only in local searches and is therefore only able to consider new alternatives in the direct neighborhood. Hence, an organization is merely able to discover negative and positive gradients around its current position. This means, an organization can move up the landscape to the nearest peak (Knudsen and Levinthal 2007, Levinthal and Warglien 1999), but will not necessarily discover and move to a global maximum. Thus, the initial position of a boundedly rational acting organization determines its optimization space in a rugged landscape. Being located at the foot of or on a slope of the highest peak (i.e., in the neighborhood of that peak) is the only chance moving up the highest peak. Being located at any other peak, it is only possible to climb up this peak, as the organization cannot perform distant searches to identify the highest peak or even the gradient of distant peaks.

These assumptions result in the risk of being trapped on a local peak, as the organization remains stuck with an inferior alternative, not being capable of uncovering higher performing, but more distant alternatives in the performance landscape. Only a fully rational acting organization could perform distant searches, allowing to identify and to move to the highest peak of the landscape. However, prior knowledge allows an organization to identify a more attractive region in the problem space². Nevertheless, neighborhood search remains the dominant mode move in rugged landscapes. As the critical underlying behavioral assumptions have received hardly any empirical examination, we do not know how organizations search and navigate on rugged performance landscapes. First studies examining search behavior suggest that human subjects substantially deviated from local search as

² Sources of prior knowledge could be, e.g., science (Fleming and Sorenson 2004), analogies (Gavetti et al. 2005), or mental maps (Siggelkow 2001).

they were well equipped to move off a local peak and search more distant alternatives in the landscape (Billinger et al. 2013).

Static vs. dynamic view on openness

Looking at their early years, young firms run through phases of development and growth³. Each development phase represents a major challenge for a firm, e.g., developing from informal to formal processes, overcoming problems of coordination and communication, extending the resource base, and incorporating new functions (Greiner 1972, 1998, Dobbs and Hamilton 2007, McMahon 1998, Penrose 1995, Macpherson 2005, Phelps et al. 2007, Deakins and Freel 1998). The management decisions in that phase which are related to a firm's innovation activities have direct implications on a firm's level of openness. As a result of those decisions, the level of openness is subject to decline or increase.

Prior literature on selective revealing provides a huge pool of general benefits and risks from openness. We perceive these as static determinants of openness, or, put differently, as reasons for or against openness. Each determinant exhibits a particular relevance to a firm which changes over time and drives a firm's decision about openness. The altering relevance over time of benefits and risks for a firm is what we call the dynamic view on openness. In discussing the literature on static determinants of openness, categorized as organizational conditions, environmental conditions, and mindset and identity, this chapter sets the playing field for the development of organizational openness over time.

-----*Insert Figure 1 here*-----

Benefits and risks from openness

Organizational conditions

Financial and human resources Constraints on the application of resources negatively affects a firm's innovative performance (Garriga et al. 2013). Openness puts a young firm in position to

³ Literature provides a huge body of frameworks investigating firm growth and maturation, e.g., internal adaption, interaction of internal and external forces, dynamics of learning (Dobbs and Hamilton 2007). Although frameworks do not explicitly incorporate innovation or its dynamics, they set the boundary conditions for the development of openness.

overcome resource scarcity through extending a firm's resource and knowledge base and allows a firm to benefit from external development support, e.g., by a community, a manufacturer, an OSS community, or other firms (Henkel 2006, van de Vrande et al. 2009, Dahlander and Magnusson 2008, Franke and Shah 2003, Harhoff et al. 2003, Hertel et al. 2003, Lakhani and Wolf 2007). In addition, lack of financial resources limits a firm's ability to withstand unfavorable business conditions, and makes vulnerable even to minor inefficiencies. This opens a firm to investors, e.g., venture capitalists, or to follow new business models (Gruber and Henkel 2006, Carson 1985). Following an Open Source business model, revenues can only be generated through complementaries, as freely available knowledge can no longer be sold.

Collaboration In its early years, a firm has not (yet) established marketing, sales and reputation for its products and knowledge. In addition, a firm might be limited in financial and human resources to put marketing and sales activities in place. Openness puts a young firm in position to receive marketing benefits, build a reputation and increase sales opportunities, mainly due to price reductions and increased customizability that are the results of selective revealing, e.g., by signaling technical excellence, visibility on forums and mailing lists, and identification of new employees (Henkel 2006, Alexy et al. 2013, Henkel et al. 2014, Afuah and Tucci 2012, Baldwin and von Hippel 2011, Henkel and Baldwin 2011, Raymond 1999, Dahlander and Magnusson 2005). In addition, a firm might leverage openness to overcome partnering uncertainty, coordination cost and unwillingness to collaborate (Alexy et al. 2013).

Beyond the previously mentioned benefits, openness is seen as a means to set standards, enable content and structural compatibility with external knowledge and to shape the market environment in order to eliminate unfavorable technology trajectories (Henkel 2006, Alexy et al. 2013, Lerner and Tirole 2002, West 2003).

Technology Selective revealing allows a firm to identify and successfully engage in new opportunities to create and capture value, such as increasing demand for complimentary goods and services (Lerner and Tirole 2001). This is particularly driven by improved innovative performance and higher technological pace (van de Vrande et al. 2009, Lerner and Tirole 2002), resulting in technological benefits and mitigated transaction cost (Lerner and Tirole 2001, Alexy et al. 2013). Technological

benefits comprise added functionality and bug fixes, reduced production cost, increased reliability and reduced maintenance effort, increased compatibility and use of standard components, and access to new markets (Henkel 2006, Afuah and Tucci 2012, Baldwin and von Hippel 2011, Henkel and Baldwin 2011). However, issues of reduced compatibility, reliability, safety and security, and an increase in maintenance cost may arise (Henkel et al. 2014).

Accessing creative and motivated people is one of the main challenges of open innovation (Henkel 2006). Especially early innovation cycles are characterized by a low technological complexity where specialty skills are not (yet) necessary, giving a firm access to a broad innovation ecosystem (Braun and Herstatt 2007). As technology matures, this is subject to change. Generally, open is superior to closed innovation when technical complexity is low (Almirall and Casadesus-Masanell 2010).

IP leakage and hold up Risk of IP leakage and imitation might negatively affect openness. Competitors might use a firm's revealed knowledge and appropriate its value, which may imply a loss of competitive advantage (Henkel 2006). In other words, the firm that originated knowledge might lose control over its further development, even when it acts as the official maintainer of the respective public project. In addition, firms may experience an accidental loss of control over knowledge beyond what should have been released (Alexy et al. 2013, Henkel and Baldwin 2011, Chesbrough and Teece 1996). However, firms may also strategically benefit from others imitating and reciprocating their selectively revealed knowledge (Alexy et al. 2013, Clarkson and Toh 2010, Polidoro and Toh 2011). Relying on external IP increases hold-up, especially using short-term licenses (Henkel et al. 2013), e.g., when license fees are raised, or when a product is not enhanced or supported anymore. Open Source minimizes this risk, since revealing is usually seen as a credible commitment (Henkel et al. 2014).

Last but not least, with their openness, firms might simply follow ***customer demand*** for open innovation (van de Vrande et al. 2009, Henkel et al. 2014).

Environmental conditions

Industries differ regarding their ***open innovation market places***, e.g., communities, forums, mailing lists. As the abundance of innovation relevant external knowledge positively affects a firm's innovative performance (Garriga et al. 2013), this determines to what extent a firm can access and benefit from

external knowledge (Dahlander and Magnusson 2008). On the other hand, this affects a firm's ease of access to external knowledge and subsequently defines the effort to successfully build a community and receive benefits from openness. Hence, we expect firms to incorporate the industry's open innovation structure into their openness decision.

The desire to exclude competitors from the marketplace increases when an industry reaches maturity (Gambardella and Hall 2006, Agarwal and Audretsch 2001). Using the coexistence model for an explanation (Bessen and Nuvolari 2014), we can distinguish two stages of an *industry lifecycle*, in which we expect a firm to manage openness differently. In emerging industries, new technologies often coexist with alternatives for a certain period of time. Knowledge sharing allows inventors to make major productivity gains. Moreover, this stage is often characterized with low or medium competition and market saturation and the fact that marketable products are not yet on hand (Osterloh and Rota 2007). Put differently, knowledge sharing does not dissipate rents, it might even generate ones. A firm, acting in such industry environment, might be willing to share proprietary knowledge. In mature industries, often characterized as an environment with high competition and market saturation, declining market growth, and the fact that marketable products are on hand (Osterloh and Rota 2007), knowledge sharing might dissipate rents. Conversely, a firm, finding themselves in such an industry environment, might have tendency to limit its openness.

Mindset and identity

Founder identity, i.e. the founder's functional, educational, and employment background, influences a firm's activities and strategic decisions (Boeker 1987, 1988). Thus, founders "imprint" the firm with their background and experiences⁴. Applied to our context, an identity provides an individual with a cognitive frame of reference with which to interpret both social situations and behaviors and actions (Fauchart and Gruber 2011). Given the strategic nature of an openness decision, which may as well be socially and emotionally influenced, we conclude, that the founder identity directly influences a firm's

⁴ The notion of "imprinting" goes back to Stinchcombe (1965), who emphasized the importance of the founding period. He argued that organizations, at the time they are established, have incorporated larger elements of environmental conditions prevalent at the time of founding. In the following years, scholars added the direct influence of founders, who are likewise imprinted by their environmental background and experiences, to this theory (Boeker 1987, 1988).

openness over time. We assume that two of the three founder identity types identified by Fauchart and Gruber (2011), darwinians and communitarians, and a change in identities influence openness. However, such change is only expected in case of a weakly developed or a hybrid identity. We assume a darwinian to leverage openness if and as long as this is the most suitable development approach to grow his firm and change if necessary, while a communitarian will continuously follow an open approach.

Organizational ideology, defined as an action oriented set of beliefs and meanings (Benford and Snow 2000) and a constellation of shared beliefs that binds values to actions (Beyer 1981, Meyer 1982), affects a firm's openness and innovation activities in the broader sense in two ways. First, creating a superior product or technology might not be the only innovation goal. In addition, ambitions like sharing knowledge with a community, having the best design, or getting the widest distribution might play a role as well (Osterloh and Rota 2007, Allen 1983, Gambardella and Hall 2006). Second, people are empowered by freedom and motivated by participating in "building something new".

METHODS AND DATA

Method and sampling

Method Given the novelty of our research, we understand our study as building nascent theory⁵ (Edmondson and McManus 2007). Accordingly, we chose an inductive methodological approach to answer our research questions, which seems to be the right approach to investigate a field where little evidence is known so far and phenomena that are subtle and/or poorly understood (Yin 1984, Corbin and Strauss 2008). This methodology is in particular suitable to uncover the motivation behind a decision (Yin 1984), which is, applied to our research question, the motivation behind the strategic decision change a firm's level of openness.

This research follows a longitudinal, embedded multiple–case study design (Eisenhardt 1989) which includes, as a variant of the single–case study, two or more observations of the same phenomenon. For

⁵ Nascent theory proposes tentative answers to novel questions of how and why, often merely suggesting new connections among phenomena (Edmondson and McManus 2007).

our purpose, a multiple–case study is superior to a single case study as it enables a replication logic in which cases are treated as a series of experiments, each serving to confirm or disconfirm inferences drawn from the others. Our study used an embedded design (i.e., multiple levels of analysis) that includes firms with a decreasing or constant level of openness, founders, chief executives, board members, advisors, and venture capital firms. Although being more complex, the embedded design permits induction of richer and more reliable results (Yin 1984). Leveraging a research team of multiple investigators allows us, through stronger creativity and convergence of observations, to enhance confidence in findings (Eisenhardt 1989); overlap between data collection, coding and analysis is applied as far as possible (Glaser and Strauss 1967). Evidence from a multiple–case study is considered more compelling, more generalizable and robust, thus being a stronger base for theory building and making the emergent theory better grounded (Yin 1984).

Sampling We sampled 13 technology–based ventures within three segments of the software industry, enterprise resource planning (ERP), data storage, and database management software. Following prior research, our study focuses on young firms during the first 8 to 10 years after their foundation to control variations due to size and maturation effects (cf. McDougall et al. 1994). Firms were founded between 1995 and 2007, i.e. our observations span from 1995 to 2014.

This period covers different steps of what we call an industry wide Open Source lifecycle or Zeitgeist where Open Source was supposed to be managed differently. In particular in the late 1990s and early 2000s (“dot–com bubble”), where Open Source was extremely popular; and the following years, where Open Source was not very popular at all. Applied to our sample, firms have been at different stages of growth or maturation in this period or have been founded even after this period. This distribution of foundations allows us to control, that firms do not change their level of openness in line with the Zeitgeist, but base such a shift on strategic decisions and reasons.

We chose the above mentioned areas of software development, because our framework and determinants can best be explored in this setting and we do not exclude anything by design. In addition, with the three industry segments we observe an area where openness matters as a means of innovation strategy, an exhaustive spectrum between open and proprietary knowledge is covered, firms have similar access to value appropriation, meaning firms have comparable ease of access to

complementary products (e.g., offering ease of offering support/services, maintenance, consulting, implementation services, or proprietary products or modules), new ventures rise frequently, venture capital firms are actively financing, and competition between small and big and firms can be observed. Following Eisenhardt (1989), cases are selected because they are likely to replicate or extend the emergent theory, their process is transparently observable and/or they are regarded to be unique, typical, or unusually revelatory. In other words, we covered (among others) firms showing a gradual or abrupt shift from a high to a medium or low level of openness.

----- *Insert Table 1 around here* -----

Our sample consists to the better part of firms that successfully grow in the first decade after their foundation, what raises the question on survival bias. Thus, we included an assessment on (un-) successful firm survival in our interviews. The results however give us confidence, that a survival bias should not be an issue here.

Data and data analysis

Data This research draws on qualitative and quantitative information from two main data sources: (1) semi-structured interviews with key decision makers and (2) an extensive dataset of secondary sources such as press and product releases, internal documents, press articles, analyst reports, archives, and company websites. We conducted 28 in-depth interviews⁶ over 4 months. The interviews were typically 45–75 minutes and followed an interview guide that had variations for founders, chief executives and advisors. We distinguished two types of interviews, (1) *case related interviews* where the informant held a position within or was directly related to one single case company, e.g., as founder or chief executive, and (2) *expert interviews*, where the informant was not directly related to one single case but was able to provide information on one or multiple cases, e.g., in the role of an advisor or industry expert. In any case we concentrated on facts and events rather than on interpretations (Eisenhardt 1989). All interviews were tape-recorded and transcribed; the

⁶ Interviews were conducted with all cases in the segments of enterprise resource planning (ERP) and database management. Cases in the data storage segment have been analyzed based on secondary data in order to support findings from interview cases.

transcriptions totaled 550 double-spaced pages. We asked follow-up questions via phone or e-mail when clarification was required.

----- *Insert Table 2 around here* -----

In order to minimize informant biases, we included at least two informants for each case having different perspectives on and interests in the change process (e.g., CEO and CTO/co-founder). However, we did not observe any significant differences in their event descriptions. The observed changes took place ca. 5 to 10 years ago, but as the change decision proved to be, according to informants, one of the most important and challenging decisions during their career, we do not expect any retrospective biases in their event descriptions.

The interviews covered general background information about the informant and the company, followed by open-ended questions on the chronological history of the company with respect to openness. Interviews with founders included additional questions regarding their founder identity (cf. Fauchart and Gruber 2011). Interviews with advisors were adapted to their role during the change while interviews with experts focused more on the industry and certain specific firms. Both followed a more open-ended format.

Data analysis Our data analysis closely followed the approach of Eisenhardt (1989) and Miles et al. (2013), with the “triangulation” of interview and secondary data at its very center. The within-case was used to developed constructs, their effect and relevance over time to describe the change of one single firm. During the cross-case analysis we looked for patterns, compared cases in terms of similarities and differences across multiple cases, and established tentative propositions. The result of this iterative process was our framework, describing the mechanisms behind a firm’s shift toward a lower degree of openness, which will be presented in the following chapter.

RESULTS – THE DYNAMIC VIEW ON OPENNESS

When young firms change

Interpreting a firm's change as a search process, we use the landscape metaphor (Levinthal 1997) for an explanation and distinguish three types: ongoing optimization, adaptation to changing conditions, and adjustment to changing firm goals. All of the above search processes are problemistic searches⁷ (Cyert and March 1963) and differ with respect to their triggers. The first is triggered by the realization that the firm's current level of openness had not been optimal, such that an ongoing search process needs to be continued; the second, by a change in the fitness landscape itself, such that a formerly optimal position is no longer optimal and a new search needs to be undertaken; the third, by the replacement of the fitness landscape used so far with a different one, again making a new search necessary.

-----Insert Figure 2 here-----

Ongoing optimization A firm decides to decrease its level of openness based on the insight that the current *approach was not optimally suited to meet the firm's goals* or the firm can achieve a higher performance with a lower degree of openness. Put differently, a firm, after realizing that it is not meeting aspiration levels, changes its level of openness as a measure to improve performance and subsequently meet firm goals. In this context, we observed two reasons for this construct. First, the firm goals are not met due to bad implementation. Meaning the firm goals are fine, but the chosen course of action and execution to achieve the goals are not optimal. Second, the firm goals may be met or not, but do not represent the intended aspiration level. The firm goals base on the wrong assumptions, which is then a more fundamental problem. In the cases we observed, expected benefits of openness may not have materialized to the extent expected, and the downsides turned out greater than foreseen. This was especially true for marketing or external development support, as firms were

⁷ *Problemistic search* means "search that is stimulated by a problem (...) and is directed toward finding a solution to that problem" (Cyert and March 1963).

not able to build an active community or to incorporate external knowledge successfully into internal processes.

In order to overcome this situation, founders and the management team incorporate *another firm's expertise* into the decision on their firm's level of openness. Another firm can be accepted as frame of reference when having been in an analogue position or having faced a similar problem. Expertise can be an observation of the other firm acting, experience shared or direct advice on the decision given by the other firm:

What we did (...) was not our bright idea, this is something that SugarCRM had done very successfully; it's something that MySQL had done very successfully. [I 08]

Regardless of a positive or negative effect on openness, the relevance of this construct decreases over time as a part of the firm's growth and learning process. A firm gains experience themselves, wants to solve problems on their own and compares itself more to direct competitors as to the above mentioned frames of references. A firm sees itself as being unique and accepts only very few firms as reference which are, e.g., at least as successful as the firm itself. Investors or venture capital firms (VCs) might further decrease the range of possible references what strengthens the constructs' decreasing relevance for a firm over time and can hence be seen as a moderator of the effect.

Adaptation to changing conditions When a firm or its environment change, the optimal level of openness may change with it. Initially, for example, openness allows a young firm to overcome liabilities of smallness and newness (e.g., resource or marketing scarcity). Once the firm has attained a certain size and reputation, these liabilities decline, reducing the need for openness. Furthermore, a high level of openness may now restrict a company's further growth, which may require a scalable business model or effective protection against imitation. We identified 5 conditions driving the change and an evolving trade-off which will be presented in detail in the following sections.

Adjustment to changing firm goals The decision on a firm's changed level of openness is driven by changed firm goals. This is, in other words, a changed management perspective on openness, brought in by new people, or old people's new perspective, e.g., from community- to more business- and profit-oriented. A firm's initial decision on its level of openness goes back, inter alia, to the identity of the founders or the founding team.

Me and my partner (...) who was a second founder, we always wanted to give something back to the community. [I 10]

He [the founder] wanted to give something back to the developers, as he had profited from Open Source hugely. [I 09]

Following decisions on the level of openness are driven by a *changed founder identity*. We observed a trade-off which is represented by two dimensions of founder identity: The motivation to grow the firm and the product and the motivation to give something back to the community. Building on Fauchart and Gruber (2011), we classified the founders in our sample as darwinians, communitarians or communitarian darwinians. We did not observe any change in the identity of the founders, e.g., a communitarian developing from revealing code and being ideologically driven to profit maximizing darwinist, being distinct from other firms as major frame of reference. However, we observed a shift in emphasis between the two dimensions of motivation which then allowed other constructs to work, e.g., changes in the management team or the move toward a scalable business model.

I think the main focus of the founder's values may change over time. Starting with a very open approach, you can follow a less open approach over time. [I 16]

The decision on the firm's level of openness is driven by *new people* who joined the firm after a certain period of growth and brought in a contrary view on the firm's openness. Obviously, a growing firm needs to extend their management team and the view on openness of new people (contrary) view is known before. However, we observed a trade-off which is represented by two previously mentioned dimensions of founder identity. Our cases show three specific situations, where a firm accepted a contrary view. First, new people are brought in to facilitate future growth. However, employees with management and successful Open Source experience are a scarce resource on the job market.

Firms can only access a limited pool of managers with Open Source experience (...), which is even more limited for people with successful Open Source experience (...). These people are in high demand (...) meaning that many firms bring in people from outside [I 16].

Second, because of their expertise, e.g., industry knowledge or business sense.

Our founder knew from the beginning, that the new CEO had different thinking than he had. Growing the user base, growing the firm commercially, that was why he wanted him. [I 09]

Third, investors claim to bring in new people they name.

The [new] management team, brought in by new investors, tried to make things more closed which we [the founders] didn't want to do. What they did was, they tried to push [us] on the side (...). [I 10]

Hence, firms value the benefit from bringing in new people higher than a possible threat this could constitute to the firms level of openness. The benefits allow the firm (and their founders) to further grow firm and product. The threat and its impact to the firm are assumed to be controlled by a strong founder and organizational identity. We expect this construct to have a negative effect on openness and a constant relevance over time, as a firm will repeatedly find itself in such trade-off position(s).

The case of decreasing openness

Looking at changing conditions more specifically, we identified 5 constructs, which we will present in this section, and an evolving trade-off, which will be discussed in the following section.

-----Insert Figure 3 here -----

Contribution to marketing, reputation, and distribution A young firm has not, or only to a certain extent, established marketing, a reputation or brand name, or a wide product distribution (e.g., customer base, or number of installations). Revealing knowledge allows a firm to make itself known in the market with very low resources and cost involved. In other words, the currency in which you pay for the marketing benefits is the knowledge you reveal.

The primary reason, why we made our software Open Source was, quite simply, marketing. [I 5]

Using Open Source (...), you don't have to spend quite as much on sales and marketing (...). [I 2]

We observed several different ways how firms gained marketing benefits through openness which are closely in line with current literature, e.g., ease of product distribution, establishing a partner network, establishing credibility, and getting access to a recruiting pool. In this context, revealing knowledge triggers a positive feedback loop building the firm's foothold. Once the feedback loop sets in and the firm has gained a certain distribution, the importance declines. Furthermore, a firm takes action to build up internal resources which brings the firm into a trade-off position where to dedicate these resources to, development or marketing. Having the possibility to dedicate resources to marketing activities further decreases the need of establishing marketing using openness.

In the beginning you care much more about adoption than monetization. If no one wants to use your product, then there's no one to sell it to. It doesn't matter if its 100% proprietary, if no one cares about your product, then you have no business. [I 12]

Open Source is very much law of big numbers, get out there, get as many as possible and then get a couple of percent to actually converge into enterprise customers. [I 11]

The level of competition a firm is exposed to moderates this construct, as the need to overcome the limitations of being unknown is even higher in a highly competitive environment. Hence, it strengthens the positive effect on openness and decelerates the declining relevance over time.

Let's say that we could never have compete (...) and be the most used advance database in the world if we didn't do Open Source; not a chance. [I 10]

On the other hand, software as a Service (SaaS) moderates this construct, as it covers the above described benefits and additionally provides a higher flexibility for customers and users without the need of revealing knowledge. Hence, SaaS diminishes the positive effect of this construct on openness and accelerates the declining relevance over time.

Therefore, it is a lot easier to offer a service in the cloud, the customer tries it and I only need to make sure that he understands the functions. Openness of the code does not play a role here. [I 15]

Summarizing this, a firm utilizes the benefit of establishing a foothold indirectly through revealing knowledge as long as it has achieved a distribution which seems to be wide enough and/or it has the resources to engage in direct marketing activities. Hence, the level of openness is likely to decrease as the previously high level is simply not needed anymore.

A firm reveals internal knowledge to overcome the limitations from resource scarcity through *external development support*, especially in the area of product development. Revealing knowledge allows a firm to establish an external knowledge base and to subsequently incorporate externally generated knowledge into their product and development processes. The objective is to perfect the firm's product(s) or more precisely to achieve, at the same time, improved product quality (i.e., fewer bugs and additional features), accelerated development, and cost efficient development. As part of the growth process, a firm takes action to reduce the resource scarcity and its limitations by itself what on the other hand reduces the need for external development support.

The idea to go Open Source was in my mind from the beginning because, in order for me to make a better product than those that were on the market at the time, the only chance was to have as many people as possible trying the product out and provide me feedback. [I 7]

We observed three different ways how firms incorporated external resources in their internal development process: testing of and feedback for the code, code contributions, and prioritization of

additional features. In addition, we observed in many cases that firms reduced access barriers to their released knowledge, in our examples mostly the source code, by changing the license with the goal to grant more rights to the recipient or using an easy to use programming language.

It is great to get ideas and feedback, and testing, that is where the real value comes in. [I 2]

The level of competition a firm is exposed to moderates this construct, as the need to overcome the limitations of resource scarcity is even higher in a highly competitive environment. Summarizing this, an external knowledge base which requires a high level of openness is replaced by a knowledge base which requires no revealing or only a low level of openness. Hence, the level of openness is likely to decrease as the previously high level is simply not required anymore.

Effort to manage the community A firm bases the decision on a reduced level of openness on an increasing effort to manage their community in order to hold the benefit, e.g., an influx of external knowledge or marketing support, at a constant level. We observed two things happen over time. Either, the benefit from the contributions decreases or the company needs to increase its effort in order to hold the benefit at a constant level.

The founders were aware how much they owe their community and of the ongoing symbiosis (...). Then, I think, they found out that the community offered them progressively less (...). [I 1]

When a firm is not willing to do this investment, it might on the other hand cut the revealed knowledge, as revealing would simply not yield in sufficient benefits. The level of competition a firm is exposed to moderates this construct, as allocation of resources is even a more difficult task in a highly competitive environment, i.e. competition strengthens the negative effect and accelerates the increasing relevance over time. Summarizing this, the community as external knowledge base is, as soon as it requires the dedication of resources to increase or keep benefits a firms receives from being open at a constant level, replaced by other knowledge bases.

Imitation and value appropriation by competitors A firm decides to decrease its level of openness as their revealed knowledge has been used in competitor's products and threatens their market position. Driven by the growing amount of knowledge a firm selectively reveals with new products and by being a natural target for imitation due to company and community growth, success, and openness, the relevance for a firm of such an event increases over time. Put differently, a firm decreases the amount

of revealed knowledge in order to protect their proprietary IP from being used by competitors and to protect their market position. Thereby, the firm accepts that at the same time it restricts the benefits it previously had through revealing.

When direct clones of your products appear, and clones with minor tweaks on the trademark of your company name start showing up from people who have contributed nothing to the Open Source community, it generates an obvious discussion "well — that sucks — what should we do going forward". [I 1]

Scalable business model A firm decreases their level of openness in order to exploit new, scalable revenue segments through monetizing knowledge (i.e. products or product modules) the firm had – applying their previous model – provided for free.

We needed to continue to evolve the Open Source to be loyal to the community and show our commitment to the (...) technology. But we needed to build an enterprise version that would be compatible (...) with a certain set of features and capabilities that an enterprise would be willing to pay for. [I 8]

In general, a firm has two options in setting up their business model. A product model, where a firm generates revenues through license fees a customer pays for product usage (“product firm”), or service model, where revenues are generated through services, like consulting, service/support, maintenance, or implementation. This model is especially suitable for products which require heavy support, e.g., Linux kernel and distributions. The main resulting difference is that a service model is only scalable to a certain threshold, or can only be scaled up slowly. When a firm, currently following the service model, starts a discussion about growth and scalability, it at the same time starts a discussion to – at least partly – move to the product model. As only a lower level of openness allows this move, it negatively affects the firm’s openness decreasing the level of openness as far as necessary to support what the decision makers call a scalable business model for the firm.

Investors influence the business model insofar as they demand higher growth rates compared to a rate a founder and the management team might regard as sufficient and aim at an investment cycle of ~5 years. Hence, investors strengthen the negative effect on openness and accelerate the relevance over time.

Investors do not demand less openness per se, investors demand more revenue, or higher growth rates. Having a community edition which is widely used in the market, the question might be raised why the firm does not try to profit more from this monetarily. [I 3]

Summarizing this, a high level of openness hinders a firm to move toward a scalable business model. Deciding to scale up, this barrier needs to be removed in that way as the level of openness is reduced.

The business model–resource trade–off and openness

Putting ourselves in the position of a decision maker, we can rephrase the previously introduced constructs as dimensions of the decision on openness. First, as main part of firm strategy, a decision maker needs to allocate the resources of his organization (e.g., Mintzberg 1994). In the context of young firms, resources can either be allocated to development activities only, or additionally to sales and marketing. The more financial and human capital a firm possesses, the more flexibility it possesses for the allocation of their resources. Looking at the firm development in general, maturation, i.e., growth of resources, naturally increases an organization’s flexibility to allocate resources. Second, a firm needs to decide how it generates revenues. In our context, revenues can be generated through services, product usage, or both. As mentioned, the scalability of a business model increases from services to product.

-----*Insert Figure 4 here* -----

The decision along these two dimensions, resource allocation and business model determines the playing field for an organization’s openness, as shown in Figure 4. The 4 cases vary fundamentally in with regard to the provider of marketing (Open Source or internal resources), the provider of revenues (Open Source as the basis for revenues or proprietary modules), and if development can be supported (through Open Source). The increasing risk of imitation and effort to manage the community pushes an organization to the northwestern corner of the matrix, at least as long as these risks are not actively mitigated.

Knowing our triggers for change — ongoing optimization, adaptation to changing conditions, and adjustment to changing firm goals — you can approach this trade–off from another side. A decision maker might want to define his level of openness first, because of his identity or because the current level of openness has not been working sufficiently. This decision the other way round determines how to set up your business model and the flexibility where to dedicate your resources to.

DISCUSSION AND CONCLUSION

This research set out to examine why young firms change their level of openness over time. Perceiving this change as a search process, we identified 3 archetypes with different triggers. The first, *ongoing optimization*, is triggered by the realization that the firm's current level of openness had not been optimal, such that an ongoing search process needs to be continued. The second, *adaptation to changing conditions*, by a change in the fitness landscape itself, such that a formerly optimal position is no longer optimal and a new search needs to be undertaken. The third, *adjustment to changing firm goals*, by the replacement of the fitness landscape used so far with a different one; again making a new search necessary.

Implications

Our framework advances the understanding of the phenomenon of a young firm's move toward a lower — or, more generally, a different — degree of openness. Building on these findings, we can make three contributions to the literatures on selective revealing and organizations. First, when studying search processes, distinguishing between local and distant search (March 1991) might not be sufficient. One should additionally differentiate according to the trigger of the search: the realization of a misfit with its environment, changes in external and firm–internal conditions, or changed firm decision makers. Second, firms learn and respond by observing and interpreting other organizations (Denrell 2003). When interpreting a firm's actions, managers need to consider and understand the mechanisms driving them. By laying out the mechanisms behind a firm's shift in openness, our framework allows for a better interpretation of observations. Third, openness as a strategic tool has received only limited attention (Alexy et al. 2013). Explaining a shift toward less openness as a response to realized misfit, changed conditions, or changed firm goals, our framework emphasizes the role of openness as a strategic lever to address challenges that are subject to change.

Limitations and suggestions for future research

Our study is subject to a number of limitations. Potential issues of sample selection and survivor bias have already been discussed in previous sections, so we will not repeat them here. First, as in any case study, generalizability might be an issue, as our conclusions draw on observations from 13 technology

ventures. The industries, or the specific cases itself, from which we chose our sample may be idiosyncratic, what could further limit the generalizability of our study. Second, we focused our observations on firms changing from a high to a low level of openness. Although we think that our three identified archetypes will still be the same for this opposed development, the working constructs, especially the changing conditions, might be different or work in a different way. Third, we draw our conclusions to a wide extent on interviews and statements, e.g., given in press releases or blogs, from founders and the management teams of our cases. However, having asked for their view on the decision situation and put it in perspective from multiple informants for each case from inside and outside the organization, we can only assume that our informants gave us an earnest description of the situation. A reflection of the situation which may have been established afterwards, having more information on hand and knowing the outcomes of a decision may distort our results, e.g., the decision to change the level of openness itself, to hire a new CEO, or to accept venture capital.

Limitations aside, we assume that our study should have external validity due to the rigid methodological approach we applied (Eisenhardt 1989) which should not only be empirically valid and yield in testable constructs, but as well not be overly complex or narrow. In particular, our study should have external validity for industries with the following characteristics: (a) high entry barriers or one or two major players, as both strengthen liabilities of smallness and newness of young firms, and (b) short investment cycles, as this affects the firm's business model, and (c) industrial spying or imitation activities. We suggest that future research targets the previously mentioned opportunities, to enrich our understanding of a young organization's change in general and the development of openness over time in particular. Especially a quantitative analysis to test the presented propositions should be taken into account. In addition to our results on firm level, one could take the industry level into account as well.

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TABLES AND FIGURES

Table 1: Description of cases. Observed constructs: A = Ongoing search, B = Adaptation to changing conditions, C = Adjustment to changing firm goals.

Company	Industry and location	Profile	Observed constructs	Openness over time
Makerbot	3D-printing NY, USA	~500 employees Founded in 2009 Founder CEO	B	Abrupt shift from a high to low level of openness
SugarCRM	ERP software CA, USA	~350 employees Founded in 2004 Non-founder CEO	B, C	Gradual shift from a high to low level of openness
Compiere	ERP Software GA, USA	>150 employees Founded in 1999 Non-founder CEO	A, B	Abrupt shift from a high to medium level of openness
JasperSoft	ERP Software CA, USA	>200 employees Founded in 2001 Non-founder CEO	A, B	Abrupt shift from a high to medium level of openness
OrangeHRM	ERP Software NJ, USA	~50 employees Founded in 2005 Founder CEO	B	Gradual shift from a high to medium level of openness
MySQL	Database management software Uppsala, Sweden	400 employees Founded in 1995 Non-founder CEO	B, C	Gradual shift from a high to low level of openness
Alfresco	Database management software; Berkshire, GB	<500 employees Founded in 2005 Non-founder CEO	B	Gradual shift from a high to medium level of openness
MongoDB	Database management software CA, USA	>350 employees Founded in 2007 Non-founder CEO	B, C	Gradual shift from a high to low level of openness
Cleversafe	Data storage software IL, USA	~100 employees Founded in 2004 Non-founder CEO	B, C	Gradual shift from a high to low level of openness
Talend	Data storage software CA, USA	~400 employees Founded in 2006 Non-founder CEO	B, C	Constant level of openness
Nicira	Data storage software CA, USA	~100 employees Founded in 2007 Founder CEO	B	Abrupt shift from a high to medium level of openness
Vyatta	Data storage software CA, USA	~100 employees Founded in 2005 Non-founder CEO	B	Gradual shift from a high to low level of openness
Zenoss	Data storage software TX, USA	~100 employees Founded in 2005 Founder CEO	B	Abrupt shift from a high to medium level of openness

Table 2: Overview of interviews.

Interview	Case related/expert	Industry	Role and position
[I 1]	Case related	3D-printing	Managing director
[I 2]	Case related	ERP Software	Co-founder and CEO
[I 3]	Case related	ERP Software	Sr. Product Marketing Manager
[I 4]	Case related	ERP Software	Pre-Sales Engineer
[I 5]	Case related	ERP Software	Founder
[I 6]	Case related	ERP Software	CEO
[I 7]	Case related	ERP Software	Founder
[I 8]	Case related	ERP Software	CEO
[I 9]	Case related	Database management	VP Collaboration and Community
[I 10]	Case related	Database management	Co-founder
[I 11]	Case related	Database management	Co-founder and CTO
[I 12]	Case related	Database management	VP Marketing
[I 13]	Case related	Database management	Business Development Director
[I 14]	Expert	Statistic Software	VP Community
[I 15]	Expert	Operating Systems	Managing Director
[I 16]	Expert	Cloud Computing/Virtualization	Co-founder, VP Marketing & Sales
[I 17]	Expert	Server Operating Systems/Linux	Director Operations
[I 18]	Expert	Server Operating Systems/Linux	Managing Director and Advisor
[I 19]	Expert	Server Operating Systems/Linux	Managing Director and Advisor
[I 20]	Expert	Software Consulting	Founder and Managing Director
[I 21]	Expert	Software Consulting	Founder and Managing Director
[I 22]	Expert	Software Consulting	Founder and Managing Director
[I 23]	Expert	Media	Journalist
[I 24]	Case related	ERP Software	Co-founder
[I 25]	Case related	ERP Software	Co-founder
[I 26]	Case related	Database management	Co-founder
[I 27]	Case related	Database management	CEO
[I 28]	Case related	Server Operating Systems/Linux	CEO

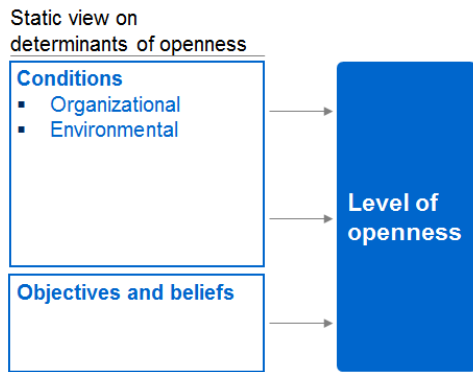


Figure 1: The static view on openness.

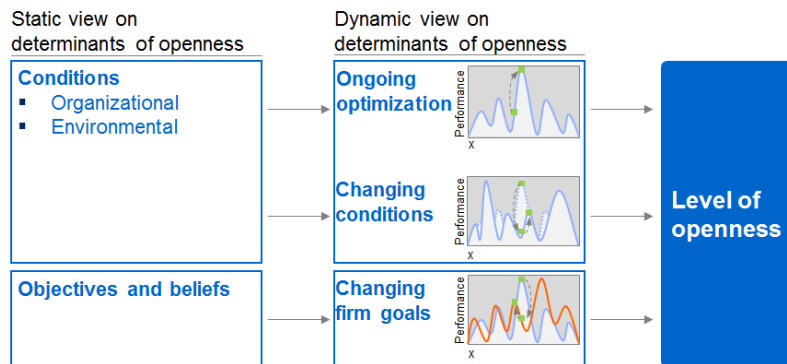


Figure 2: The dynamic view on openness.

Construct	Effect	Relevance over time
Contribution to marketing, reputation, distribution (“gain foothold”)	+	
External development support (“overcome resource scarcity”)	+	
Effort to manage community (“keep knowledge influx constant”)	-	
Risk of imitation and value appropriation by competitors (“IP leakage”)	-	
Scalable business model (“increase revenue stream”)	-	

Figure 3: Changing conditions – overview of constructs.

Business model	Product model	Hybrid	Hybrid/Closed
		<ul style="list-style-type: none"> OS needs to provide marketing PS needs to provide revenues OS could be a basis for revenues and strengthen the development 	<ul style="list-style-type: none"> PS needs to provide revenues OS could be a basis for revenues and strengthen the development
	Service model	Open	Open/Hybrid/Closed
		<ul style="list-style-type: none"> OS needs to provide marketing and to be a basis for revenues OS could strengthen the development 	<ul style="list-style-type: none"> OS needs to be a basis for revenues OS could provide marketing and strengthen the development PS could provide revenues
		Development only	Development and sales
Resources			

Figure 4: The trade-off between resources, business model and level of openness.