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The chosen ones:The Selection of Capabilities in Professional Service Firms

Ammon Salter
Imperial College London
Business School
a.salter@imperial.ac.uk

Paola Criscuolo
Imperial College
Business School
p.criscuolo@imperial.ac.uk

Thorsten Grohsjean
LMU Munich

t.grohsjean@lmu.de

Abstract

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Abstract

How do organizations select between different capabilities and what factors lead organizations to break away from their past investments? Using a micro-foundations approach to understand capability emergence, this paper suggests that organizations' display a strong 'preference-for-cumulativeness' in the selection of capabilities and that this preference is present at both the knowledge domain and individual level. It then argues that both endorsements by senior leaders and external collaboration may enable organizations to deviate from the 'preference-for-cumulativeness'. These ideas are tested on a unique, multi-source dataset of R&D projects selection in a leading professional service firm. Implications for theories of capabilities are advanced.

Keywords: capabilities, capability emergence, micro-foundations, R&D projects, selection processes, cumulativeness

INTRODUCTION

Alongside routines (Nelson and Winter, 1982) and resources (Barney, 1991), organizational capabilities are a key driver in explaining differences in firm performance (Ethiraj, Kale, Krishnan and Singh. 2005; Arikan and McGahan, 2007). Hence, strategic management scholars have devoted considerable effort to explain where organizational capabilities come from (Rothaermel and Hess, 2007; Helfat and Lieberman, 2002; Daneels, 2008) and how they evolve over time (Zollo and Winter, 2003; Kale, Dyer and Singh, 2002).

Central to the emergence and development of capabilities are both learning (Zollo and Winter, 2002) and decision rules (Teece, 2007). While prior research mainly focused on different types of learning to explain the development of organizational capabilities, how organizations choose between different potential capabilities remains shrouded in darkness. Although it is clear that by choosing to invest in some capabilities rather than others managers make deliberate choices about the nature and direction of their organizations, it has remained difficult for researchers to unlock the mechanisms that underpin managerial selection. This is because the main factors that drive these decisions are usually hidden from public view. As a result, in the study of capabilities, we are often left only with information about the chosen, visible activities of the organization, such as patents (Katila and Ahuja, 2002), alliances (Kale and Singh, 2007) or acquisitions (Arikan and McGahan, 2010; Zollo and Singh, 2004), and thus we are unable to see how capabilities emerged in the first place as a product of deliberate managerial choice among a range of competing and possibly equally compelling options. The lack of understanding of these selection processes means we are unable to explore how managerial choices can reinforce positive features of capability development to support learning and competitiveness, but also their potential to act as a brake on organizational adaptation (Knudsen and Levinthal, 2007).

Further, as research on capabilities made progress in the characterization of the phenomena, in the field called for a better understanding of the nature and micro-foundations of these capabilities (Zollo and Winter, 2002). This view is echoed by contributors (Teece, 2007) and critics (Felin and Foss, 2005). The latter argue that although individuals and projects are considered in the theory building, the general assumption is that individual and organizational behaviors are largely driven by the collective context. Accordingly, they infer that the underpinning processes at the individual and team-level, which produce the macro-level results, are under-theorized and call for more research at the micro-level.

Taking up these two issues – the selection and micro-foundations of capabilities – we explore factors that determine which new capabilities an organization will support, focusing on R&D projects in professional services as our setting. We first examine how an organization's past investments shape its future investments, suggesting that managers involved in the selection process will display a 'preference-for-cumulativeness'. This preference will manifest itself in terms of knowledge domains and people, as managers will focus on what the firm already knows and in people who have been successful in the past. Yet, since the 'preference-for-cumulativeness' in knowledge domains and individuals can lead to core rigidities, we then explore two mechanisms – endorsements of senior leaders and external collaboration - that might lead managers to break away from this tendency. We suggest that projects in new knowledge domains and projects proposed by inexperienced people that expand what is considered legitimate can only be approved through the support of senior leaders. We also argue that external collaboration on projects may provide not only a mechanism to enable distant, path-creating search; but it may also enable the organization to leverage additional resources, therefore lowering the costs of deviating from its 'preference-for-cumulativeness'.

To examine these hypotheses, we draw upon a unique database from a large, international professional service firm, which includes records of both selected and rejected R&D projects over several years. In addition, we have matched information from these records to the firm's human resources records and the organization's expertise location system. By combing this information, we are able to look at the characteristics of the selected and rejected projects, documenting how the project initiator's experience and the knowledge domain investigated in the project, inform how the organization responds to these proposed R&D projects.

Overall, we find strong empirical evidence for the 'preference-for-cumulativeness' by managers in terms of both knowledge domains and individuals. While endorsements of senior leaders can help the firm to break away from cumulativeness in terms of the people carrying out these research projects, collaboration with external partners appears to reinforce this type of cumulativeness. We further find some evidence that external collaboration can help a firm to break away from cumulativeness in terms of knowledge domains.

The paper makes three contributions to our understanding of capability formation. First, by adopting a micro-foundations approach, we describe how the features of new initiatives shape the way organizations decide which capabilities to invest in. In doing so, we are able to explore how the 'preference-for-cumulativeness' – at the level of the individual and project – may be hardwired into the formation of capabilities. Second, we bring attention to the role of individuals in capability development. Although Levinthal and March (1993) emphasized that internal firm selection processes are subject to strong dynamic and cumulative tendencies to invest in some individuals, this subject has been rarely touched upon in subsequent research on organizational learning. Third, by showing how the 'preference-for-cumulativeness' can be broken through endorsements by senior leaders and external collaboration, we provide insights into the mechanisms that enable firms to proactively reshape their capabilities. In doing so, we elicit the organizational antecedents for deliberate learning through the selection of capabilities.

THEORETICAL BACKGROUND

Although the idea that inter-firm performance differences can be explained by differences in organizational capabilities was already present in the early work of Penrose (1959), the notion has achieved greater prominence over the last thirty years with the emergence of the evolutionary theory of the firm (Nelson and Winter, 1982), the resource based view (Barney, 1986; Wernerfelt, 1984) and the dynamic capability approach (Eisenhardt and Martin, 2000; Helfat and Lieberman, 2002; Teece, 2007; Teece, Pisano, and Shuen, 1997). The central tenet of all capability-based research is that firms can be seen as a bundle of capabilities and that these capabilities are heterogeneously distributed among organizations.

An important stream of research within this literature focuses on the conceptualization and definition of capabilities with an emphasis on the difference between zero-level and second or higher-order capabilities (Eisenhardt and Martin, 2000; Schreyögg and Kliesch Eberl, 2007; Teece et al., 1997; Winter, 2003). Another stream of research addresses the question where and how capabilities emerge and how they influence firm performance (Arikan and McGahan, 2010; Ethiraj, Kale, Krishnan, and Singh, 2005; Nerkar and Paruchuri, 2005; Zollo and Singh, 2004; Zollo and Winter, 2002). Research in the latter area suggests that the antecedents of capabilities can be found at different levels (Eisenhardt and Martin, 2000). First, research at the organizational-level shows how different learning processes, especially experiential and deliberate learning, influence organizational capabilities. Ethiraj et al (2005) for example study the emergence of capabilities in the Indian software industry and show that higher levels of client-specific capabilities develop through repeated interaction, and that these client-specific capabilities are associated with a higher project performance. Along these lines, Zollo and Singh (2004) analyze the post-acquisition performance implications of experience accumulation and knowledge codification, finding that codification positively influences integration performance, while experience does not. Further, research on alliances shows that an alliance learning process including knowledge articulation, codification, sharing, and internalization has a positive impact on a firm's overall alliance success (Kale and Singh, 2007). Besides different types of learning, research has found that the willingness to cannibalize, constructive conflict, tolerance of failure, environmental scanning and slack resources have a positive impact on the development of second-order marketing and R&D capabilities at the firm level (Danneels, 2008). Second, at the network-level, scholars have studied how the structural characteristics of network ties influence capability acquisition (Gulati, Nohira, and Zaheer, 2000; Mahmood, Zhu, and Zajac, 2011).

While these studies shed light on the question of how capabilities develop over time and how they influence firm performance, they do not explain why firms choose to develop some capabilities rather than others. As Knudsen and Levinthal (2007) suggest, there has been only limited attention to the mechanisms of selection within organizations. One reason for this lack of attention is that studies of capabilities have tended to focus on the path dependent character of these capabilities, describing how they evolve out of the firm's past decisions, actions and routines (Nelson and Winter, 1982). Although this approach helps to stress the semi-automatic or bottom-up character of routines within organizations, it has only recently directed attention to the managerial choices about which capabilities the firm will develop (Winter, 2003; Zollo and Winter, 2002). To be sure, to enable organization adaption and survival, managers must proactively engage in path creation, making investments in new areas that are distant from the firm's current practices and domains of knowledge (Garud, Kumaraswamy, and Karnøe, 2010;

March, 1991). Indeed, experiential and deliberate learning can only happen if the organization gives their members the time and resources to engage in these activities.

Picking up on this concern, recent research has proposed that there is a need for more micro-foundations in capability-based research (Felin and Foss, 2005; Gavetti, 2005). Research in this spirit tries to complement the antecedents at the organizational level, especially organizational traits and organizational learning, with antecedents at the individual-level. Research in this emerging area has to date focused on managerial cognitive and emotional capacities (Helfat and Peteraf, 2011; Hodgkinson and Healey, 2011), individual traits like cognitive frames and personal values (Zollo and Verona, 2011), or ordinary activities (Salvato, 2009). Yet, we are still only at the first stages of understanding the micro-foundations of organizational capabilities, especially how these influence the emergence of new capabilities.

In terms of the selection of capabilities, there are two main aspects on which a firm must decide: in what areas should the firm seek to learn (the 'know what'), and who should do the learning (the 'know who'). As Levinthal and March (1993) argue firms' decisions about what capabilities to explore involves choices about different areas of knowledge development to invest in, and much of the capabilities literature has focused on this question. In addition, however, Levinthal and March (1993) suggest that firms also must make decisions about 'know who', choosing to invest resources in some individuals rather than others to guide the firm into new areas. To date, there has been little attention to this question in the wider literature. Yet, such a focus would help strengthen the micro-foundations for our understanding of capability development. One paper that takes an important step in this direction is Nerkar and Paruchuri (2005). Drawing upon network theory, they find that the position of an inventor in a firm's knowledge network shapes the organization's technological paths. Nevertheless, this paper provides little information about the nature of selection within the firm at the individual and project-level, and therefore the literature remains incomplete on this topic.

In this study, we examine the emergence of R&D capabilities (Danneels, 2008; Dierickx and Cool, 1989; Helfat, 1997; Mahmood et al., 2011), a higher-order capability that underpins the development of new products, process and services, and facilitates the acquisition of external knowledge (Cohen and Levinthal, 1990). By investing in R&D, organizations are able to engage in off-line learning, stepping away from normal operating routines to consider new routines or practices (Nelson, 2003). Moreover, since R&D projects are funded largely from retained or set-aside resources, they represent an area of high managerial discretion (Kim, Kim, and Lee, 2008). In this respect, they differ from some other capability investment decisions, such as fixed plant and equipment, where there are very high sunk costs and immobile assets. In addition, R&D activities themselves are future oriented, yielding uncertain outcomes. In choosing between different R&D projects, therefore, organizations are making choices about what the organization will look like in the future. Thus, focusing on R&D project selection provides a window to observe the early stages of capability selection within organizations.

HYPOTHESES

The literature on capabilities points to the notion that cumulativeness is the central mechanism in capability development (Nelson and Winter, 1982). Levinthal and Myatt (1994) argue that capabilities evolve along a particular trajectory that may become augmented and deepened by new rounds of investment. This means that managers involved in selection processes in organizations are likely to favor new initiatives that build on what organizations already know and can do. In effect, they will display a strong ‘preference-for-cumulativeness’ in the selection of new capabilities. There are several reasons for this tendency. First, the cumulativeness of capabilities means that past investments in an area can be harnessed to generate future rents. Managers are liable to see cumulative investments as sustaining and extending existing organizational routines (Zollo and Winter, 2002). This is especially likely to be the case if this area can be characterized by asset mass efficiency, as described by Dierickx and Cool (1989). Indeed, research on R&D shows that organizations can gain from past investments by leveraging these investments into related domains through economies of scope (Helfat, 1997; Henderson and Cockburn, 1996). Moreover, investments in capability development in one area will allow a firm to successfully absorb knowledge from adjacent areas, allowing it to engage in local search (Katila and Ahuja, 2002).

Secondly, investments in existing capabilities offer opportunities for incremental, experiential learning (Argote, 1999; Helfat and Peteraf, 2003). There are often high sunk costs of previous investments in capabilities. A legacy of investment in a particular knowledge domain presents important organizational resource commitment, one that an organization may walk away from with great trepidation. This fear of cannibalizing past investments may lead managers to stick to areas where they have made prior investments (Chandy and Tellis, 1998; Danneels, 2008).

Finally, the logic of cumulativeness may be ‘locked-in’ to organizational filters and structures, as its operations and routines are centered on current activities (Henderson and Clark, 1990). An investment in a new capability may require a firm to re-organize the relationships between different business units, upsetting well-established linkages and ways of working. Therefore, managers may be loath to break away from the past because doing so would upset organizational ‘truces’- the set of mutually agreed boundaries for actions and behaviours between different interests within the organization (Cyert and March, 1963; Nelson and Winter, 1982). In the face of these potential disruptions, managers are likely to favour investment in activities that have low disruption costs to the firm's internal governance arrangements. Moreover, managers may become more skilful in evaluating one set of common alternatives as they fit the organizations filters and structures, but are unable to accurately evaluate novel sets of alternatives (Knudsen and Levinthal, 2007). Thus, our hypothesis is:

Hypothesis 1a: The greater the knowledge domain cumulativeness of the R&D project, the higher the likelihood that it will be selected.

Alongside the tendency for managers to favor past knowledge investments, organizational scholars have highlighted the tendency for organizations to reward and promote people who have been successful in the past (Levinthal and March, 1993). There are some compelling reasons why this 'preference-for-cumulativeness' among selectors within organizations is also present at the individual-level. First, success often breeds success, as previous investments in some individuals may lead organizations to further invest in the same individuals. This process mirrors the 'Matthew effect' in science, where a researcher's success leads to further status and credit, creating a virtuous (or vicious) cycle of positive (negative) reinforcement between performance, status and then resources (Merton, 1973). Secondly, as suggested by Levinthal and March (1993: 103), within organizations, successful people are likely to display greater confidence in their own abilities and how these abilities can be used by the organization. This confidence may enhance the visibility of their efforts inside the organization, leading it to choose them over their less visible colleagues in contests for scarce resources. Third, although investing resources in talented staff is an important way of ensuring that these individuals have access to the resources they need to perform their work; it can also ensure that their unique or valuable skills are retained. In many organizations, 'stars' emerge and are given favorable treatment in terms of autonomy, status and compensation (Groysberg and Lee, 2009). Therefore, managers are likely to favor successful employees to help make them more ‘sticky’ to the firm, to help lower the potential adverse effects of their exit on the organization’s performance (Campbell, Ganco, Franco, and Agarwal, 2012). Finally, since engaging in new areas is risky, managers often prefer to invest in those individuals that have established track records in the development and delivery of new ideas. By investing in these people, managers may believe that they can lower the risks associated with non-cumulative investments. Thus,

Hypothesis 1b: The greater the individual cumulativeness of the R&D project, the higher the likelihood that it will be selected.

Breaking away from cumulativeness: the role of senior endorsements

Although the ‘preference-for-cumulativeness’ can have many positive benefits for organizations, it can also overtime undermine organizational effectiveness. Indeed, organizational adaptation challenges tend to arise from the tendency of organizations to focus too much on what they already know. This danger has been described in a variety of forms, including core rigidities (Leonard-Barton, 1992), routine and resource rigidity (Gilbert, 2005), cognitive inertia (Tripsas and Gavetti, 2000) and competency traps (Ahuja and Lambert, 2001; Levinthal and March, 1993; March, 1991). In each of these cases, a self-reinforcing cycle takes hold where organizations engage excessively in exploitation of known areas, limiting the organization’s ability to adapt to changes in its external environment (March, 1991).

Hence, we ask, how can firms break away from the ‘preference-for-cumulativeness’? We suggest a critical aspect in giving the confidence for the organization to do so, will be the opinions of senior leaders towards frame-breaking ideas, emerging from within the organization. Since senior leaders inside organizations are critical to determining the future direction of the organization and their views often cascade down the organization (Hambrick and Mason, 1984), it can be expected that these senior leaders will have a strong voice in decisions about the selection of different capabilities. Along these lines, Nerkar and Paruchuri (2005) suggest that central individuals inside the organizations can lay claim to organizational resources, and are in a position to render judgments that are credible for others in the organization.

The effect of endorsements by senior leaders of new initiatives can help to break the link between cumulativeness and selection for at least three reasons. First, as suggested above, since managers face considerably uncertainty about the merits of new areas or inexperienced individuals, they may display a strong tendency to stick to past areas of investments and people. Yet, the endorsement of prominent people within the organization for a novel idea will provide greater legitimacy for their decision to award support to a project that breaks away from convention (Kanter, 1983, 1988; Van de Ven, 1986). Without a strong voice of support from senior leaders, novel ideas and people may be turned aside in favor of more conventional ones.

Secondly, since senior figures inside an organization have limited attentional resources (Ocasio, 1997, 2011), their willingness to proactively endorse a project and/or an individual is a signal to managers involved in the selection process that the project has benefits beyond the interests of the individual or group proposing the idea. In effect, senior endorsement is an indication that the project, although differing from what the organization has done in the past, has commercial or technical merits that align to the overall strategy of the organization.

Third, in order for a new effort that breaks away from convention to be successful, it is important to ensure that senior managers inside the organization are committed to the project. Such commitment may involve providing material support for the project as well as enabling individuals the time and space necessary to deliver the project. Senior individuals may also act as advisors to the project, providing referrals to other colleagues in the organization and eliciting the interest of others inside the organization for the project (Ancona and Caldwell, 1992; Galbraith, 1982). Hence, for managers, senior endorsements are a strong sign that the project will be successfully completed, and, more importantly perhaps, that its outputs will be used and transferred across the organization, allowing managers the luxury to disregard the lack of cumulativeness in the project and the person. Thus,

Hypothesis 2a: The positive effect of knowledge domain cumulativeness on R&D project selection will be negatively moderated by the level of endorsement by prominent people within the organization.

Hypothesis 2b: The positive effect of individual cumulativeness on R&D project selection will be negatively moderated by the level of endorsement by prominent people within the organization.

Breaking away from cumulativeness: the role of external collaboration

A second mechanism to allow managers involved in capability selection in organizations to break away from the 'preference-for –cumulativeness' is external collaboration. Researchers have long recognized that working with external partners is a vehicle to enable firms to learn about new domains and access new skills (Cassiman, Di Guardo, and Valentini, 2010; Nelson and Winter, 1982; Rosenkopf and Nerkar, 2001; Stuart and Podolny, 1996). External partners have different ways of working and may operate under different inventive systems, such as universities (Dasgupta and David, 1994), allowing the organization to experiment with knowledge domains that are new to the firm. In this sense, external collaboration can be a source of path creation, allowing for category-breaking efforts by organizations (Garud et al., 2010).

As a result, projects that involve external partners are usually viewed differently from internal projects. In the case of the ‘preference-for-cumulativeness’, those managers responsible for selection in organizations may be willing to put aside concerns about building upon what they know and invest in novel activities, but only with the help of an external collaborator. In effect, external collaboration can provide an effective and possibly low-cost mechanism for non-cumulative investments, as these collaborations rely on resources from external organizations as well as from the focal organization. With these external collaborations, managers can take an option on a new area, sharing the risk with external partners. For example, the firm may engage universities to help them develop new methods to explore an emerging knowledge domain (Rosenberg, 1990). Moreover, as these external collaboration projects access resources that differ from the host organization, they do not have the same pressure to conform to past investments as internal projects. In a similar vein, through the engagement of external collaborators, managers may overlook the inexperience of the firm in a particular area or an individual’s lack of track record as they may assume that the external partner may provide the necessary knowledge and experience to deliver the project. Thus,

Hypothesis 3a: The positive effect of knowledge domain cumulativeness on R&D project selection will be negatively moderated by external collaboration.

Hypothesis 3b: The positive effect of individual cumulativeness on R&D project selection will be negatively moderated by external collaboration.

METHOD

Research setting

This study is based on a unique dataset of R&D project applications made by employees of a large multinational engineering consulting company. These firms, like other professional services firms, profit by using the skills and knowledge of their employees to deliver a range of specialized and unique projects for their clients (Hitt, Bierman, Shimizu, and Kochhar, 2001; Teece, 2003). Professional services firms are characterized by high proportions of professionally qualified staff, low capital intensity and high knowledge intensity (Von Nordenflycht, 2010). Their highly skilled workforce has strong bargaining power and often displays a preference for autonomy. As such, management in these organization tend to operates in a 'guiding, nudging and persuading' role rather than a command and control function (Malhotra, Morris, and Hinings, 2006). Moreover, the workforce operates under regulated and certified professional associations that uphold norms of responsibility (Suddaby and Greenwood, 2001).

This environment setting provides a rich domain to explore our research questions for three reasons. First, since professional service firms have high knowledge intensity, their investments in knowledge domains represents a critical element in their future organizational performance. Hence, decisions about where and in who to invest have significant consequences for the direction of the organization's capabilities. Second, the low capital intensity of these firms in contrast to manufacturing firms means there is a higher degree of managerial discretion about such investments. In manufacturing settings, it is likely that the selection of capabilities might be driven by non-knowledge related factors, such as market size, or by past investments in high cost fixed assets, such as production facilities. Third, as professional service firms allow their staff considerable autonomy, they give scope to individuals to develop new ideas for consideration for selection by the wider organization. This means that ideas for new initiatives tend to emerge from the 'bottom-up' within the organization before senior managers select them (Burgelman, 1983). As a result, capability development is widely distributed and the firm's selection processes are often informal in character (Von Nordenflycht, 2010).

The case company itself employs several thousand engineers, and operates in over 40 different countries. Since its inception, it has invested in capability development in a structured way, setting aside funds for R&D efforts. Its current R&D system is organized around individual projects, which are developed by individuals and teams across the organization. The R&D funding is designed to enable individuals and teams to address specific problems professionals have encountered in their day-to-day work. The projects often seek to investigate specific technological areas of interest to the individual and the firm, and are intended to induce changes in the organization's way of working within a relative short period. In Table 1, we report summaries of two projects in our dataset. R&D projects are sometimes carried out in collaboration with external parties such as universities, clients and competitors that may, in certain instances, co-fund the project. Engaging with external collaborators is an individual initiative, and the organization does not centrally manage these collaborations.

/***INSERT TABLE 1 HERE***/

To gain a better understanding of R&D projects in professional service firms; we carried out 21 interviews, covering 11 randomly selected R&D projects. From the interviews, we learned about the nature of R&D activities. It was clear that the R&D projects undertaken by the firm were quite diverse, including the creation of engineering protocols, the development of new processes, computer simulations and numerical models. Very rarely was the aim of an R&D project to develop a prototype, as one might have expected in a manufacturing firm. The average size of R&D projects funded in 2008 was less than $25,000 and only involved 10 days of professional time.

In addition, to understand the nature of selection for R&D projects, one of the authors attended a R&D project selection meeting. The R&D selection process is itself carried out several times in different locations, with five evaluation panels working to a common set of guidelines. These evaluation panels are made up of senior managers as well as a small central R&D team both in charge of representing the firm's interests.

Data

To address our research hypotheses, we combined data from four sources. The first source consists of all R&D project applications made since the launch of the R&D investment program in 2004 until 2008, which includes 1,078 projects. As part of the application process, each applicant was required to fill in an electronic form, which was then uploaded to the R&D department website. The application contained information on the title, aims and outcomes of the R&D project as well as its expected duration and cost. The name of the project director and the project manager were also mentioned in the application. Each application also reported details of any external organization that was involved in the project. Most importantly, the dataset enables us to identify those applications that were funded and those that were rejected.

The second source was the list of comments made by individuals within the organization on the intranet page of each project that we exploited to derive our measure of endorsement. In total, there were 3,336 comments on projects prior to selection. These comments were provided by a variety of people inside the organization as the website is open to all members of the firm, for example by the line manager of the project director and/or the project manager, but also, and more importantly, by the company's business and technical leaders. The company had 18 different business units, and, for each there is a global leader and several regional leaders. It also operates 25 communities of practice, which also have a global leader and several regional technical leaders. Since a global leader may also act as a regional leader, there were in total 262 business and technical leaders in the organization. From our interviews and observations of the selection process, it was clear that the endorsement by technical and business leaders was not a necessary condition for a project to get funded, but if the applicant of an R&D project was able to secure supportive comments from these prominent people this could increase its likelihood of receiving funding. In Table 2, we report some examples of comments endorsing an application.

/***INSERT TABLE 2 HERE***/

The third data source was the expertise location system of the company that we accessed in 2004. We used this information to build our measure of domain cumulativeness. Each employee in the organization was encouraged to provide a description of his/her expertise on the company expert yellow pages. Although this is a voluntary activity, about two-thirds of the firm's employees had completed their profiles when we accessed this data, providing us with information on the skills of 3,131 people inside the organization. This information is reviewed every year during the appraisal process so there is a strong incentive to provide both an accurate description of ones' expertise as well as to update it regularly. This information is structured and searchable by internal staff, and it is used intensively in peer-to-peer exchanges on common problems on projects within the organization. On average, the skills descriptions were 30 words long but they could reached up to 250 words and be quite detailed.

The fourth data source was the organization's human resource records which we obtained in 2006 and from which we extracted information on individuals' tenure and location.

Measures

Dependent variable

Our dependent variable is a dichotomous variable, selected, indicating whether or not the R&D project application received funding. Although we have information on all R&D applications made between 2004 and 2008, in our analysis we examine the selection of R&D

applications submitted in 2006, 2007 and 2008. This is because we needed to have a sufficient number of applications prior to our sample period to derive the measure of individual cumulativeness. Thus, the sample we used in our regressions consists of 606 applications made between 2006 and 2008.[1] The success rate was high, with 475 applications out of 606 funded.

Independent variables

We measure the degree to which an R&D project application builds upon existing capabilities using two variables. The first variable measures the level of experience of the firm in the R&D project investment area (Domain cumulativeness). In order to build the domain cumulativeness variable, we exploited the information stored in the company's extensive expertise location system, as described above. From the text of all the expertise descriptions in the organization's yellow pages, we derived the most frequently occurring words (e.g. 'acoustics'), pair of words (e.g. 'traffic calming') or triplets of words (e.g. 'computational fluid dynamics') using as a cut-off value of 10 occurrences. To ensure that important areas of knowledge were not missing from the list, senior managers were asked to review and validate the final list of 574 keywords.

We then considered the frequency with which each keyword appeared in the skills descriptions as an indicator of the level of expertise the company had in a particular domain. Among the most frequently occurring keywords we found traditional engineering activity areas such as 'railways' and 'bridge', while among the least frequent keywords we found 'logistics' and 'environmental engineering', which reflects the emerging nature of these businesses in the

[1] Due to individuals joining the company after 2006, when we gained access to the human resource records, we are unable to include 23 R&D applications in our final sample. However when we compared the R&D applications that were included in our sample with those who were excluded, we found no difference with respect to domain and individual cumulativeness, endorsement, external collaboration, size, and length of the proposal.

company. We then counted how often each of these keywords appeared in the text of the 606 project applications. The level of domain cumulativeness of a project was derived as follows:

$$\text{Domain Cumulativeness} = \sum m_i KW_i \qquad i=1...574$$

where KW_i is equal to 1 if keyword i appears at least once in the body of text of the application and m_i is the frequency of keyword i in the expert yellow pages.

R&D applications that build on areas where the organization already had a strong knowledge base have a high value of domain cumulativeness. For example, the R&D applications with the highest values relate to traditional areas of engineering consulting services, such as concrete and the performance of steel structures. In contrast, R&D projects in areas such as crowd behaviour and renewable energy scored very low on this variable, which indicates that they represent a nascent knowledge domain in the organization.

The second cumulativeness variable measures the level of experience of the individual, the project manager, in carrying out research activities (Individual cumulativeness). To construct the individual cumulativeness variable, we exploited the entire sample of R&D applications (1,074) since 2004, the year in which the company started to fund R&D projects using this funding scheme. From this sample, we identified all successful prior applications made by the project manager of the focal R&D application. We focus on the project manager, as it was clear from our interviews they were often the initiator of the idea for the project and that project directors had relatively limited involvement in the bidding process. The individual cumulativeness variable is then equal to the log transformation of the sum of all funding received through these successful applications prior to the focal application discounted at a rate of 15%. Our 15%

discount rate was consistent with research on the depreciation of other knowledge assets, such as patent stocks (Henderson and Cockburn, 1994).[2]

Our first moderator variable is endorsements by senior leaders. To construct this variable, we manually coded the comments posted on the website of the R&D project applications prior to the selection decision. Because most comments are short updates on the submission process, we had to identify those comments demonstrating support to the research described in the application. To this end, two of the authors independently coded the comments, reaching a level of agreement of 86%. Inter-coder reliability using Cohen's kappa was .71, indicating adequate agreement. Discrepancies between the two coders were reviewed by a third person. A total of 214 comments of support by senior leaders were identified among 3,336 comments for all projects in our sample. The degree of endorsement was then calculated as the length - measured by the number of words - of supportive comments received by an application from either business or technical leaders. Given that these senior leaders have extremely limited attention, the length of the supporting statement provides a measure of the level of interest and support they have in a given project.

Our second moderator is a dummy variable, which captures whether the project had an external partner (External collaboration). This information was derived directly from each R&D application, where applicants had to list the name of their external partner. The types of external collaborators on the projects varied, but many included university partners.

[2] As a robustness test, we derived the individual cumulativeness variable using the number of successful applications prior to the focal application discounted at a rate of 15%. Results are consistent with the ones reported here. We also constructed the individual cumulativeness variables without applying the discount rate and obtained similar results to the ones shown in the paper.

Control variables

We included several control variables to address potential heterogeneity in the underlying characteristics of the R&D application. Since expensive and long projects are usually less favored as they consume a greater share of the R&D resources of the organization, we control for the size of the project (Size), i.e. the amount of money requested in the application expressed in the corporate headquarters local log in the local currency of the country of the x. We also control for the length of the proposal (Length proposal) measured by the number of words in the body of the application. The degree of codification of the project may affect its perceived value, as projects that provide only low levels of information to the selection committee are both difficult to evaluate and suggest a lack of effort by applicants (Haas and Hansen, 2005). The number of non-supportive comments posted on the intranet page of each R&D application might also have a negative impact on the likelihood of a project been selected. We therefore included a variable that counts how many Unfavorable comments each project application received. To identify these comments, we adopted the same approach we followed to derive the endorsement variable.

In addition, we control for the project manager tenure in the organization (PM tenure). Tenure is likely to be a factor in predicting the likelihood of a project being selected, as people with long tenure in organizations are often able to learn about a wide range of activities that are undertaken inside the firm. Also, individuals with shorter experience in the organization might lack or be considered as lacking relevant skills (Rollag, 2004). Accordingly, our measure of tenure is the number of years the project manager spent working in the organization. We also include a dummy variable for whether the project manager works at the company's headquarters (HQ) since this might increase their awareness of the firm strategies and investment plans. To account for another form of endorsement by business and technical leaders, we derive a dummy variable that is equal to one if the project director of the focal R&D application is among the prominent people inside the organization (PD prominent). Finally, we include regional and year dummies to control for where and when the selection decision was taken.

RESULTS

We tested our hypotheses using a logit model given the dichotomous nature of our dependent variable. To control for the lack of independence among the observations due to the fact that the same project manager may apply for R&D funding more than once, we estimated robust standard errors clustered by the project manager.[3] To avoid high correlations between the main effects of domain and individual cumulativeness and the interaction terms with level of endorsement, we standardized these variables by subtracting the mean and dividing by the standard deviation (Neter, Wasserman, and Kutner, 1990). To assess whether multicollinearity could be affecting our estimates, we derived the variance-inflated factors, which were less than two. This suggests that multicollinearity is not a concern in our regressions.

We also follow 'best practice' in interpreting the significance of interaction terms in logit models and conduct post-hoc analyses of the significance of the moderation effects since in a non-linear model the effect of the interaction between two variables cannot be assessed by simply looking at the sign and statistical significance of the coefficient of the interaction term (Ai and Norton, 2003; Hoetker, 2007; Wiersema and Bowen, 2009; Zelner, 2009). To this end, we used the simulation-based procedure proposed by King, Tomz and Wittenberg (2000) in the field of political science, which Zelner (2009) has advocated for strategy research. The approach consists in repeatedly drawing estimates from the multivariate normal distribution of the estimated coefficients and the variance matrix through repeated statistical simulation. By using

[3] As a robustness check, we estimated our model using a random intercept logit model, which is another estimation technique that deals with the non-independence in the error terms. Results obtained using this alternative estimation approach produce consistent results to the ones reported here.

these simulated coefficients, one can derive the difference in predicted probabilities and its confidence interval of an R&D application been selected at two levels of the moderator variable over the entire observed range of the moderated variable, when holding all other continuous explanatory variables at their mean and binary variable at their mode values. This procedure is particular useful when one wants to assess whether the effect of a moderated variable differs across groups because predicted probabilities are not affected by residual variation, i.e. the variation in outcomes beyond that explained by the independent variables (Hoetker, 2007).

Table 3 provides descriptive statistics for the variables. The average applicant had spent nine years working in the company. Almost a third of R&D applications had a business or a technical leader as project director and 40% involved an external collaborator.

/*** INSERT TABLE 3 AND 4 HERE ***/

In Table 4, we report the coefficient estimates of the logit model. Model 1 includes only the control variables. These estimates indicate that the tenure of the project manager, the degree of endorsement by senior leaders and the length of the proposal have a positive impact on the likelihood of a project being selected, while the size of the proposed R&D project and the number of unfavorable comments have a negative effect on the chances of a proposal being funded.

Estimates of Model 2 indicate that knowledge domain cumulativeness has a positive influence on the likelihood than an R&D project application will be selected ($\beta = 0.24$, $p < 0.1$). In particular, a standard deviation increase in the knowledge domain cumulativeness variable will increase the likelihood of funding an R&D project by 3.6%, holding all the other variables at their sample mean and dummy variables at their mode values. This result is consistent with

Hypothesis 1a, which predicted that managers in charge of the selection process would favor those projects that built on prior knowledge.

Model 3 shows that individual cumulativeness has a positive and significant impact on the probability of a project receiving funding (β=0.75, p<0.01). A standard deviation increase above the mean in individual cumulativeness increases the likelihood of being selected by 10 percent, keeping all the other variables at their mean values and binary variables at their sample mode. Thus, we find support for Hypothesis 1b.

In Models 4-7, we test our moderation effects. The moderation effects of endorsements are introduced separately in Models 4 and 5, while the effects of external collaboration are added individually in Models 6 and 7. Model 8 reports the full model with all the interaction terms. To begin, we explore the effect of senior leader endorsements. In Model 4, we find no support for Hypothesis 2a, as the coefficient of the interaction term between domain cumulativeness and endorsements is positive and not significant. However, Model 5 finds support for Hypothesis 2b, which stated that the level of endorsement by senior leaders negatively moderates the relationship between individual cumulativeness and selection. The coefficient for the interaction term between individual cumulativeness and endorsements is negative and highly significant (β =-0.952, p<0.01). Using the estimates from Model 8, we derived Figure 1 which illustrates the difference in predicted probability and its 95% confidence interval associated with an increase of the level of endorsement from its mean to two standard deviations above the mean at different levels of the standardized domain cumulativeness variable. Figure 1 shows an increasingly negative relationship between the change in predicted probabilities and domain cumulativeness as endorsements by senior leader increases. However, this effect is significant only when domain cumulativeness is between one standard deviation above and below the mean.

/*** INSERT FIGURE 1 HERE ***/

We further explore our findings on the moderation effect by separating the endorsements of business and technical leaders as these two groups may provide different types of legitimacy and support. In particular, business leaders might focus on the potential market size and economic value of the outcome of the project, while technical leaders might pay attention to its technical feasibility. Results of these models are shown in Table 5. Model 1 presents the results of our control variables and shows that both endorsements by business and technical leaders are positive and significant. Models 2 and 3 add the main effects for the cumulativeness variables confirming what we found in Table 4. Model 4 includes the interaction between business leaders' endorsements and domain cumulativeness, while Model 5 adds the interaction between this cumulativeness variable and endorsements by technical leaders. Contrary to what we obtained in Table 4, we now found support for our Hypothesis 2a but only when we consider the level of support by business leaders: the coefficient for the interaction term between domain cumulativeness and endorsements by business leaders is negative and significant (β=-0.230, $p<0.05$). Models 6 and 7 include the interaction between the individual cumulativeness variable and endorsements by business and technical leaders, respectively. The estimates from the two models suggest that the results found in Table 4 for Hypothesis 2b are driven by the support provided by technical leaders: the coefficient for the interaction term between individual cumulativeness and endorsements by technical leaders is negative and significant (β=-0.782, $p<0.001$). Estimates from Models 8 and 9 are consistent with those of Models 6 and 7 in Table 4.

/*** INSERT TABLE 5 HERE ***/

Using the estimates from Model 10, we then conducted post-hoc analyses of the significance of the moderation effects. Figure 2a depicts the difference in predicted probability and its 95%

confidence interval when the level of endorsement by business leaders increases from its mean to two standard deviations above the mean across the entire range of the standardized domain cumulativeness variable. Figure 2a shows an increasingly negative relationship, which is significant only for values of the domain cumulativeness variable below the mean. Thus, this post-hoc analysis qualifies our support for Hypotheses 2a as it indicates that the effect of domain cumulativeness on the probability of an R&D application to be funded is dampened by the endorsement by business leaders, but this is only significant at low values of domain cumulativeness. Figure 2b displays the difference in predicted probability and its 95% confidence interval associated with an increased level of endorsement by technical leaders from its mean to two standard deviations above the mean at different level of the standardized individual cumulativeness variable. The figure shows an increasingly negative relationship between individual cumulativeness and the difference in predicted probability of an R&D application to be funded as endorsements by technical leaders increase, however this difference is statistically significant for below the mean values of the individual cumulativeness variable.

/*** INSERT FIGURE 2 AND 3 HERE ***/

Turning to the role of external collaboration in shaping the 'preference-for-cumulativeness' in selection, we found that the interaction between domain cumulativeness and external collaboration in Model 6 of Table 4 is negative and significant (β=-0.478, $p<0.05$), which is consistent with Hypothesis 3a. Yet, contrary to what we predicted in Hypothesis 3b, Model 7 of Table 4 shows that the interaction term between individual cumulativeness and external collaboration is positive and significant (β=0.891, $p<0.05$). As pointed out by Hoetker (2007), the approach of including an interaction term with a dummy variable for group membership in a logit model often fails to detect true cross-group differences unless differences in unobserved variation can be ruled out.[4] Thus, using the full model estimation coefficients reported in Model 8 of Table 4, we graph in Figure 3a the change in predicted probabilities and its 95% confidence interval of an R&D application been funded when it involves an external partner at different levels of the standardized domain cumulativeness variable. Figure 3a shows an increasingly negative relationship that is significant only for values below the mean of the domain cumulativeness variable. Thus, this figure qualifies our support for Hypotheses 3a, as it suggests that the presence of an external partner decreases the effect of domain cumulativeness on the likelihood of an R&D application being selected only when the degree of domain cumulativeness is low. Figure 3b displays the change in predicted probabilities of an R&D application being funded when it involves an external partner at different levels of the standardized individual cumulativeness variable. This graph indicates that the moderation effect of external collaboration on individual cumulativeness is positive, but only significant for values of individual cumulativeness above the mean. This suggests that, contrary to our expectations, the effect of individual cumulativeness is reinforced when an R&D application involves an external collaborator, but only when the project initiator has a relative strong track record of prior successful R&D investment.

DISCUSSION AND CONCLUSIONS

This paper aims to advance our understanding of the selection of capabilities by focusing on the micro-foundations of this process. By exploiting a unique database of over six years of R&D project applications in a professional services firm, we found that – consistent with previous macro-level theorizing – organizations display a strong 'preference-for-cumulativeness' in the selection of capabilities. This preference is expressed in terms of decisions for both projects that

[4] We tested for equality of unobserved variance between the sample of R&D applications with and without an external collaborator using the Allison test and found that we could reject the hypothesis of equal residual variation (Log-likelihood ratio test= 0.82, p-value=0.36).

build on existing areas of the firm's knowledge base but also individuals with a track record in delivering R&D projects. The results suggest that a strong logic of cumulativeness appears to drive organization decision-making, even in future-oriented R&D contexts. Moreover, this logic prevails at the individual-level as well, because individuals who have been successful in the past are awarded greater scope to undertake novel activities. Indeed, we found that the decision to select a given R&D project application is more strongly affected by the history of the project initiator than the domain cumulativeness of the project.

However, our study also sought to understand the mechanisms that would allow managers to break away from this preference and actively support novel or non-cumulative projects. We argued that the level of endorsement of senior leaders inside the organization would be critical to give the legitimacy, support and commitment to enable the firm to select projects that did not build on its past knowledge and successful individuals. The results for this part of the study were mixed. In particular, we found that the level of endorsement by senior leaders for individuals with little experience in conducting R&D activities was important, suggesting that senior figures may give their blessing to inexperienced staff so they receive opportunities to engage in off-line learning. However, in our initial analysis, we found little evidence that knowledge domain cumulativeness could be overcome by senior leader endorsement. Yet, probing our data more intensively, we found that it depends on who was making the endorsement, particularly whether it was senior technical or business leaders. In our post-hoc analysis, we found clear evidence that business leader endorsements will encourage the managers involved in selection to move away from domain cumulativeness, moving it to investment in areas that were to a certain extent distant from what the firm already knows. This analysis also suggested that technical leaders were central to the breaking away from past individual investments with an average level of prior successful experience, overcoming the 'Matthew effect' of success re-enforcement. These results suggest it is the nature of senior endorsement rather than the senior endorsement itself that drives the organization to select ideas that break away from conventional categories.

The effect of external collaboration on the link between cumulativeness and project selection presents confounding findings. In the case of knowledge domains, we find evidence that external partners allow organizations to break away from past investments. Although the effect of external collaboration on knowledge cumulativeness is significant and negative, the moderation effect is only significant for below average levels of domain cumulativeness. One explanation for this finding is that external collaboration may also carry with it the previous choices of knowledge domains and therefore when individuals within the firm look for external partners they may do so for areas where the firm is already active. In this respect, external collaboration may not at times be a vehicle for distant search, but rather a mechanism for further local search.

The results for external collaboration on individual cumulativeness impact on selection were contrary to our expectations, with external collaboration reinforcing the tendency of the firm to stick to previously highly successful individuals. One reason for this result may be that the reputational costs of external collaboration may be high and therefore the firm is unwilling to support less experienced staff in these roles. Moreover, given the coordination costs of external collaboration are often greater than for internal projects, managers may weigh against inexperienced bidders, whose research management experience is too limited and who are working on areas too far removed from the firm's prior investments.

Managerial implications

Our study has implications for how firms can proactively manage the selection process to shape future opportunities. Although the 'preference-for-cumulativeness' in knowledge domains can have negative implications for organizational learning if pushed too far and for too long, it is clear that managers can take several proactive measures to shift the organization from this tendency towards the proximate. First, given the important role of prominent people in signaling support for novelty, firms should allow individuals to expose their ideas to senior staff prior to formal submission. Organizing presentations of early stages ideas to panels of senior staff, with opportunities for further development afterwards, could facilitate this. A second mechanism to break the link between cumulativeness in people and selection is to hide the name of the applicant (Simcoe and Waguespack, 2012). This would help to ensure that the organization discounts status effects in its selection efforts. Third, organizations could use innovation tournaments to engage different internal and external communities in the selection process, helping to encourage frame-breaking ideas to come forward (Girotra, Terwiesch, and Ulrich, 2010; Terwiesch and Ulrich, 2009). This approach may also help to mitigate the lack of experience and knowledge of selectors about novel domains that leads organizations to select local solutions (Knudsen and Levinthal, 2007).

Our study also points to the important role that external collaboration plays in the selection process, shaping the views of selectors towards different forms of cumulativeness. Although our case study organization had no explicit, ex-ante requirement for external collaborators to be part of R&D project applications, selectors did favor external collaboration when selecting projects that would shift the organization into new domains. This suggests that encouraging staff to open up to external partners in early stages of the formulation of new ideas may provide a useful mechanism to allow the organization to overcome its trepidation towards newness in terms of knowledge domains. However, our results also suggest that encouraging external collaboration by inexperienced staff may have negative consequences for selection and therefore novelty creation. Therefore, managers need to ensure external engagement is closely tied to staff with prior skills in idea development to help overcome selectors concerns about the reputational or coordination risks to the wider organization of external engagement.

Limitations and future research

Although this study exploited a rich dataset and offered insights into the micro-foundations of capability formation, it suffers from some notable limitations. The first drawback comes from the use of data from a single organization, which limits the generalizability of our findings to other organizations. In the future, it will be useful to replicate similar studies in other firms to assess to what extent our findings are specific to the organization we studied or whether they reflect general patterns in capability formation. It is worth noting that gaining access to rich firm-level information on selection remains a major challenge, as often the selection process of organizations remain hidden from public view. Moreover, our case study organization is a large and diverse organization, with a wide range of operating units and locations. In addition, the selection process is not completely centralized, as five different panels review projects independently. We also observe the selection process over several years, indicating that the observed patterns are not the direct outcome of a single set of decision-makers at one point in time.

A second limitation refers to our focus on R&D capabilities. Although R&D investments are an important source of new capabilities, the concept of capabilities comprises a broader array of expertise, routines and practices. Research on new practice formation in professional service firms looks at further downstream capability development, documenting how new practice areas have to overcome major organizational hurdles to win support (Anand, Gardner, and Morris, 2007). Our focus on R&D projects, which involves little of the ‘horse-trading’ associated with new practice development in professional service firms, means we were unable to observe the downstream efforts to help bed down these new capabilities within the organization.

A third limitation is that although we deal with the selection of projects, which we use as a proxy for capabilities, we are not able to observe the impact of the selected projects on the organization. Therefore, we are unable to comment on whether the patterns we observe in the selection process have negative (or positive) implications for the allocation of the firm's R&D efforts, leading to the Type I and II errors that commonly beset selection processes. It must be said there are relatively few established metrics for R&D projects in the professional service environment. Moreover, within our case study organization, there was a strong tendency to rely on informal metrics and anecdotes about the value of particular R&D projects. In this setting, it is also difficult to assess the impact of non-selected projects, as little or no information is kept on the non-selected. Other settings with richer information on ex-post selection effects, including information on 'near miss' cases, could allow for a fuller appreciation of how selection drives the emergence of capabilities, and how different deliberate efforts by the firm would allow it to overcome the chance of becoming stuck in competency traps.

Despite these limitations, the paper has helped to open up the often hidden world of capability selection within organizations. By examining how firms' 'preference-for-cumulativeness' are present at the level of knowledge and individuals, and how endorsements by senior leaders and external collaboration may offer an opportunity for organizations to turn away from their history, our study allows us to gain greater insights into the micro-foundations of capabilities.

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Table 1. Examples of R&D projects

Physical modelling of skirted foundation installation: The basic idea of this work is to further progress the state of the art in regards to predicting the interaction between soil and offshore skirted foundations during installation and extraction from the seabed. The work will be the first known research into the interaction mechanisms between complex multi-directional skirt stiffening elements and clay soil.
Development of look-up tables for proven designs of columns/walls subjected to blast loading: the aim of this research is to build a library of design solutions with known resilience to specified blast threats. This may be used by design teams at the early stages of a project, without requiring the need for time consuming and costly analysis.

Table 2. Examples of comments of endorsement

This software initiative fills a critical gap in our current array of digital tools for building projects. The ability to seamlessly integrate separate packages into an efficient workflow gives us the freedom to choose the best possible tools for each task. There is no reason why this tool cannot eventually become ubiquitous throughout the company, greatly enhancing our capabilities
This project will help to develop another security related aspect of our growing capability in Injury Biomechanics. In addition to its forensic ballistics applications, the work will complement the sharp force penetration modeling project and enhance our capability to predict and quantify potential human injury from blast generated debris.

Table 3. Descriptive statistics and correlation matrix

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10
1 Selected	0.78	0.41	0	1										
2 Domain Cumulativeness	1525.98	894.03	22	5986	0.07									
3 Individual Cumulativeness	13.17	9.77	0	43.38	0.25	-0.07								
4 Endorsements	15.19	52.11	0	974	0.10	0.11	0.01							
5 External Collaboration	0.40	0.49	0	1	0.04	0.18	0.01	0.01						
6 Size	9.29	0.81	6.91	11.32	-0.20	0.21	-0.02	-0.01	0.21					
7 Length of proposal	182.11	87.52	26	727	0.03	0.68	-0.07	0.15	0.19	0.29				
8 Unfavourable comments	0.07	0.29	0	2	-0.28	-0.03	-0.07	0.03	-0.07	0.05	-0.04			
9 PM tenure	9.16	8.21	0	33	0.09	-0.13	0.24	-0.08	0.11	0.02	-0.23	-0.01		
10 HQ	0.36	0.48	0	1	0.05	-0.09	0.25	-0.07	0.01	0.04	-0.12	-0.04	0.26	
11 PD prominent	0.32	0.47	0	1	-0.01	-0.03	0.02	0.08	0.03	-0.04	-0.04	0.02	-0.02	-0.08

Correlations greater than |0.08| are significant at 5%. Number of observations: 606

Table 4. Selection of R&D capabilities: logit model (N=606)

	1	2	3	4	5	6	7	8
Size	-0.723	-0.73	-0.728	-0.726	-0.7	-0.753	-0.762	-0.767
	(0.167)***	(0.168)***	(0.176)***	(0.177)***	(0.182)***	(0.176)***	(0.176)***	(0.183)***
Length Proposal	0.003	0.001	0.001	0.001	0.001	0.002	0.001	0.002
	(0.002)*	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Unfavourable comments	-2.023	-2.016	-2.146	-2.143	-2.187	-2.173	-2.068	-2.135
	(0.429)***	(0.407)***	(0.500)***	(0.501)***	(0.520)***	(0.477)***	(0.460)***	(0.474)***
Tenure PM	0.039	0.038	0.022	0.023	0.021	0.023	0.021	0.02
	(0.015)**	(0.015)**	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
HQ	0.138	0.138	-0.13	-0.127	-0.103	-0.112	-0.135	-0.092
	(0.265)	(0.268)	(0.258)	(0.259)	(0.266)	(0.259)	(0.260)	(0.270)
PD prominent	-0.188	-0.177	-0.245	-0.245	-0.28	-0.239	-0.248	-0.29
	(0.231)	(0.232)	(0.231)	(0.231)	(0.237)	(0.227)	(0.232)	(0.236)
Endorsements [a]	0.991	0.973	0.94	0.926	1.129	0.928	0.892	1.103
	(0.327)***	(0.321)***	(0.328)***	(0.325)***	(0.334)***	(0.329)***	(0.324)***	(0.338)***
External Collaboration	0.211	0.192	0.205	0.206	0.247	0.195	0.507	0.508
	(0.239)	(0.242)	(0.244)	(0.244)	(0.247)	(0.253)	(0.327)	(0.313)
Domain Cumulativeness (DomCum) [a]		0.244	0.293	0.312	0.303	0.482	0.296	0.452
		(0.145)*	(0.138)**	(0.153)**	(0.142)**	(0.166)***	(0.139)**	(0.187)**
Individual Cumulativeness (IndCum) [a]			0.75	0.748	0.624	0.757	0.539	0.402
			(0.173)***	(0.173)***	(0.182)***	(0.172)***	(0.189)***	(0.197)**
IndCum X Endorsements				0.11				-0.013
				(0.372)				(0.330)
DomCum X Endorsements					-0.952			-1.043
					(0.306)***			(0.304)***
IndCum X External Collaboration						-0.478		-0.422
						(0.197)**		(0.209)**
DomCum X External Collaboration							0.891	0.829
							(0.439)**	(0.376)**
Constant	8.021	8.438	8.916	8.899	8.793	9.185	9.116	9.333
	(1.561)***	(1.588)***	(1.700)***	(1.707)***	(1.760)***	(1.696)***	(1.697)***	(1.754)***
Log-likelihood	-266.29	-264.99	-247.47	-247.41	-241.19	-245.62	-243.41	-235.56
Log-likelihood ratio test		2.62*	35.03***	0.109	12.56***	3.68**	8.12***	23.80***

Robust standard errors for two-tailed tests clustered by the project manager. Year and regional dummies included. * significant at 10%; ** significant at 5%; *** significant at 1%. [a] Variable is standardized by subtracting the mean from the value and dividing by the standard deviation. [b] Compares model 2 (3) to model 1 (2), and models 4-8 to model 3.

Table 5. Selection of R&D capabilities: logit model (N=606)

	1	2	3	4	5	6	7	8	9	10
Size	-0.725	-0.732	-0.736	-0.737	-0.732	-0.75	-0.698	-0.76	-0.77	-0.779
	(0.166)***	(0.167)***	(0.176)***	(0.176)***	(0.176)***	(0.179)***	(0.181)***	(0.176)***	(0.175)***	(0.185)***
Length Proposal	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
	(0.002)*	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Unfavourable comments	-2.037	-2.031	-2.182	-2.203	-2.195	-2.25	-2.171	-2.206	-2.098	-2.184
	(0.431)***	(0.409)***	(0.505)***	(0.508)***	(0.513)***	(0.525)***	(0.519)***	(0.482)***	(0.466)***	(0.486)***
Tenure PM	0.039	0.039	0.023	0.023	0.023	0.023	0.022	0.023	0.021	0.021
	(0.015)**	(0.016)**	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.016)
HQ	0.142	0.141	-0.143	-0.161	-0.152	-0.163	-0.103	-0.125	-0.145	-0.124
	(0.265)	(0.268)	(0.262)	(0.264)	(0.261)	(0.264)	(0.266)	(0.262)	(0.264)	(0.274)
PD prominent	-0.198	-0.187	-0.277	-0.288	-0.283	-0.318	-0.266	-0.267	-0.278	-0.319
	(0.234)	(0.235)	(0.240)	(0.240)	(0.240)	(0.242)	(0.237)	(0.235)	(0.241)	(0.240)
Endorsements by business	0.58	0.57	0.716	0.814	0.718	0.416	0.722	0.704	0.664	0.492
	(0.262)**	(0.260)**	(0.340)**	(0.290)***	(0.337)**	(0.263)	(0.343)**	(0.350)**	(0.322)**	(0.273)*
Endorsements by technical	0.814	0.799	0.693	0.693	0.663	0.7	0.926	0.691	0.656	0.946
	(0.321)**	(0.315)**	(0.302)**	(0.303)**	(0.314)**	(0.305)**	(0.344)***	(0.302)**	(0.306)**	(0.368)**
External Collaboration	0.219	0.198	0.218	0.216	0.218	0.228	0.24	0.206	0.516	0.493
	(0.239)	(0.242)	(0.242)	(0.243)	(0.243)	(0.243)	(0.246)	(0.251)	(0.325)	(0.312)
Individual Cumulativeness[a]		0.243	0.297	0.276	0.356	0.312	0.297	0.485	0.3	0.489
		(0.145)*	(0.138)**	(0.137)**	(0.172)**	(0.140)**	(0.142)**	(0.168)***	(0.140)**	(0.201)**
Domain Cumulativeness[a]			0.769	0.779	0.77	0.672	0.693	0.775	0.559	0.408
			(0.176)***	(0.176)***	(0.175)***	(0.188)***	(0.183)***	(0.174)***	(0.194)***	(0.220)*
DomCum X Endorsements by Business Leaders				-0.23						-0.187
				(0.109)**						(0.108)*
DomCum X Endorsements by Technical Leaders					0.368					0.165
					(0.570)					(0.508)
IndCum X Endorsement by Business Leaders						-0.714				-0.595
						(0.569)				(0.603)
IndCum X Endorsement by Technical Leaders							-0.782			-0.878
							(0.293)***			(0.343)**
DomCum X External Collaboration								-0.469		-0.461
								(0.196)**		(0.208)**
IndCum X External Collaboration									0.879	0.786
									(0.440)**	(0.383)**
Constant	8.053	8.465	9.037	9.094	9.016	9.159	8.786	9.292	9.227	9.489
	(1.553)***	(1.580)***	(1.702)***	(1.709)***	(1.695)***	(1.738)***	(1.746)***	(1.700)***	(1.701)***	(1.773)***
Log-likelihood	-265.95	-264.65	-246.51	-246.08	-246.06	-245.35	-241.94	-244.73	-242.56	-234.95
Log-likelihood ratio test[b]		2.59*	36.28***	0.84	0.89	2.31*	9.12***	3.54**	7.88***	23.12***

Robust standard errors for two-tailed tests clustered by the project manager. Year and regional dummies included. * significant at 10%; ** significant at 5%; *** significant at 1%. [a] Variable is standardized by subtracting the mean from the value and dividing by the standard deviation. [b] Compares model 2 (3) to model 1 (2), and models 4-10 to model 3.

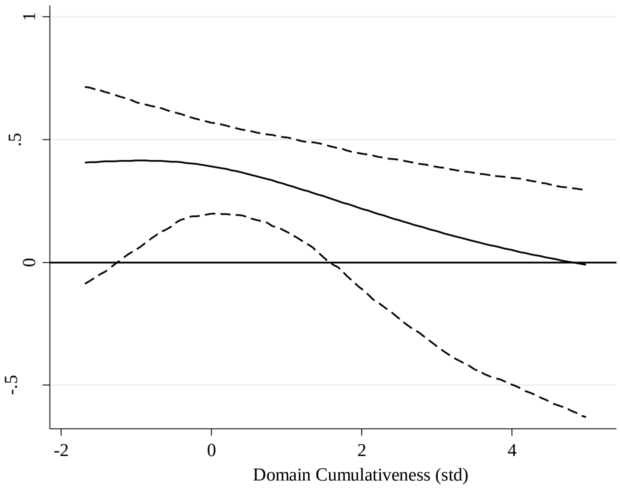

Figure 1. Moderation effect of endorsements on domain cumulativeness

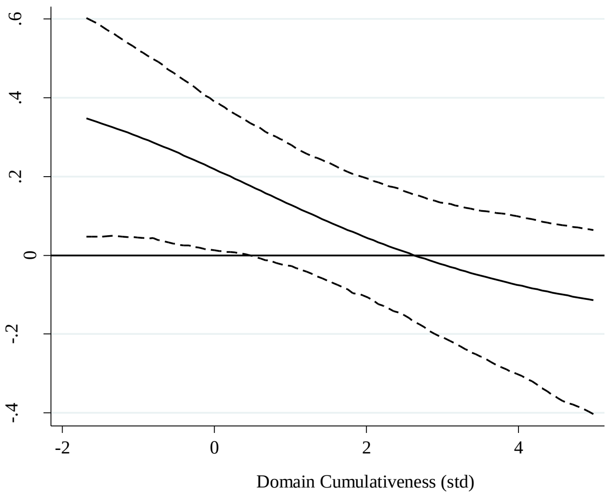

Figure 2 a. Moderation effect of endorsements by business leaders on domain cumulativeness

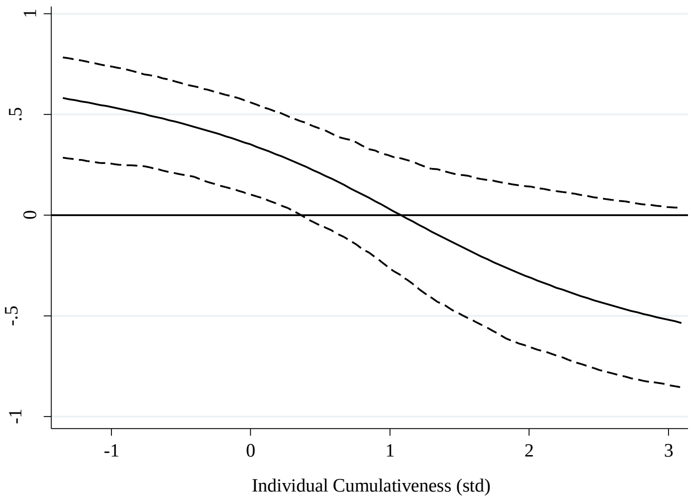

Figure 2b.Moderation effect of endorsements by technical leaders on individual cumulativeness

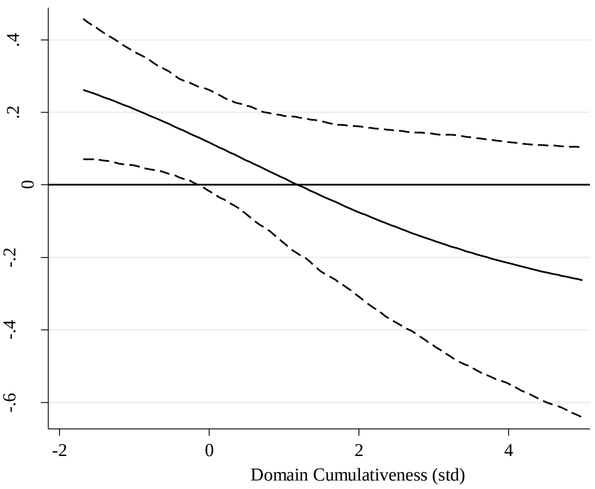

Figure 3a. Moderation effect of external collaboration on domain cumulativeness

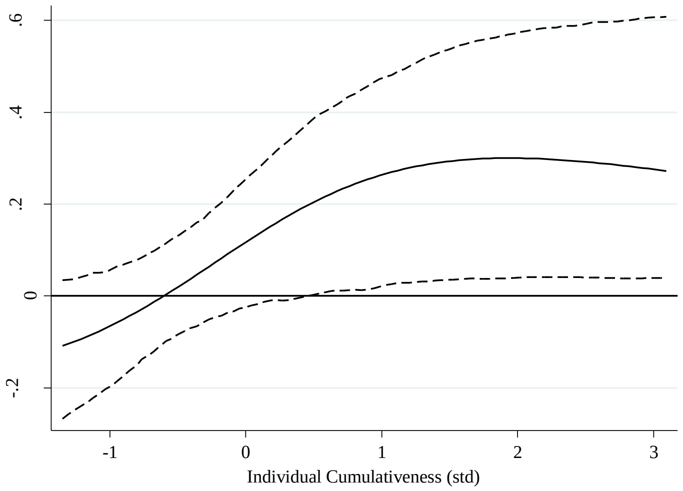

Figure 3b. Moderation effect of external collaboration on individual cumulativeness