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Implementing an R&D Strategy without Prior R&D-Experience

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Abstract

Evolutionary economic theorizing and related approaches explain persistent heterogeneity in R&D activities between firms with persistent inter-firm differences in R&D-related routines and capabilities. Emphasizing the importance of experiential learning leading to path-dependence of R&D strategies, this raises the question of how firms can organize strategy transitions towards continuous R&D, in particular, if they had not been R&D active before. Building on a growing literature trying to identify the micro-foundations of organizational routines and capabilities, we argue that recruitment of experienced R&D workers is an important means by which firms without prior internal R&D experience can build routines and capabilities needed to implement and sustain an R&D strategy shift. We test our predictions using rich matched employer-employee panel data for Sweden, which allows for the identification of firms that implement a strategy of continuous R&D activities without prior R&D experience. Our findings confirm recruitment of experienced R&D workers as an important mechanism by which firms prepare and sustain a transition towards persistent R&D.

Implementing an R&D Strategy without Prior R&D-Experience

Recruitment as a Source of R&D-related Routines and Capabilities?

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ABSTRACT

Evolutionary economic theorizing and related approaches in the management literature explain persistent heterogeneity in R&D activities between firms with persistent inter-firm differences in R&D-related routines and capabilities. Emphasizing the importance experiential learning leading to path-dependence of R&D strategies, this raises the question of how previously R&D-inactive firms, can deliberately organize strategy transitions towards continuous R&D. Building on a growing literature trying to identify the micro-foundations of organizational routines and capabilities, we argue that recruitment of experienced R&D workers is an important means by which firms without prior internal R&D experience can build routines and capabilities needed to implement and sustain an R&D strategy shift. We test our predictions using rich matched employer-employee panel data for Sweden, which allows for the identification of firms implementing a strategy of continuous R&D activities without prior R&D experience alongside the associated recruitments of R&D personnel. Our findings confirm recruitment of experienced R&D workers as an important mechanism by which firms prepare and sustain a transition towards persistent R&D.

Keywords: routines, capabilities, R&D strategy, micro-foundations, recruitment

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1. INTRODUCTION

Inter-firm heterogeneity in R&D efforts is a dominant characteristic in many, even narrowly defined, sectors. In most sectors we observe a small core of systematically R&D performing firms and a larger number of firms without R&D activities (Bottazzi et al. 2001, Cefis 2003, Malerba and Orsenigo 1996). Transition rates between the groups of R&D active and inactive firms are low, which imply persistent heterogeneity in R&D strategies across firms.

Evolutionary economics and the derived organizational routines and capability¹ approaches explain these phenomena by the presence or absence of firm-internal R&D-related routines and capabilities (Nelson and Winter 1982), which firms need to develop in order to engage in R&D activities (Dosi and Nelson 2010). Many authors have emphasized the importance of experiential learning in capability development. Yet, as Nelson and Winter (2002) note, this view is silent about whether firms can take measures to implement novel tasks, for which, by definition, they lack internal experience. As Felin and Foss (2011) note, the prescriptive recommendation from experiential learning, to the degree there is any, is to have good experience.

In this paper we focus on firms starting R&D activities without prior R&D experience. The experiential learning perspective suggests that these firms need to create their own organizational stock of experience to be successful, i.e. they have to start and learn from trial and error as well as repetition. However, relevant experience is not necessarily only bound within the organization, but may be stored in other ‘media’ (e.g. in individuals, machinery, blueprints). In view of this, we ask: can newly R&D active firms compensate their lack of internal organizational experience and, if yes, how? Are there ways to increase the chances of sustainable transitions to R&D?

Building on earlier contributions (Song et al. 2003, Almeida and Kogut 1999) argue that recruitment of experienced R&D personnel is a means by which firms can develop these routines and capabilities necessary to implement and sustain an R&D strategy shift.

Using unique longitudinal matched employer-employee data for Sweden for the years 2004, 2006, and 2008, we focus on firms that switched from no to persistent R&D in 2006 and compare them to firms that remained R&D-inactive over the whole period. The sustainability of the R&D strategy shift is assessed by observing whether this transition was sustained in 2008.

¹ Albeit the fact that capabilities are usually defined as a collection of routines (e.g. Winter 2000) it has been pointed out that differences between routines and capabilities exist (Felin et al. 2012). Nonetheless these differences are not of prime importance for our argument. Therefore, throughout the text we will treat routines and capabilities rather synonymously.

We analyze whether the firms that undertake a transition from none to continuous R&D are more likely to recruit R&D workers than firms that remained R&D-inactive during the whole period. We also analyze whether higher rates of recruitment increase the likelihood of sustaining this strategy shift. The results support both hypotheses: While controlling for potential confounders, we find that firms undertaking an R&D strategy shift from none to persistent R&D activities are significantly more likely to recruit experienced R&D personnel from other R&D intensive firms. We also find that among the group of firms undertaking a strategy shift, firms with higher rates of recruitment of R&D personnel are more likely to sustain their strategy shift to R&D over time. We interpret this as evidence of the importance of recruitment as way to acquire individual skills and experiences as antecedents to the creation of internal R&D-related routines and capabilities, in particular when firms lack prior experience with R&D.

The question of how firms can build routines and capabilities for R&D is important for several reasons. First, it has bearings on theorizing about the micro-foundations of organizational routines, which several authors have identified as a gap in the literature (cf. Murmann et al. 2003). Also Zollo and Winter (2003) emphasize this by saying: “[...] the literature does not contain any attempt at a straightforward answer to the question of how routines – much less dynamic capabilities – are generated and evolve.” While the literature on micro-foundations is now growing rapidly and most authors would agree that the micro-foundations should somehow relate to individuals, a commonly accepted theory framework has not yet emerged. In this paper we do not only empirically show that recruitment matters, but also propose theoretical mechanisms that explain how individual skills and organizational capabilities are linked, showing that experiential learning is complemented by “learning by hiring” (Song et al. 2003). We go theoretically beyond these earlier contributions, because we establish our arguments explicitly within the emerging micro-foundations framework (Felin and Foss 2005, Teece et al. 2008, Abell et al. 2008, Felin et al. 2011, cf. also the special issue in the *Journal of Management Studies*, Vol. 49, Issue 8, 2012).

Second, the earlier contributions on learning by hiring (cf. Song et al. 2003, Almeida and Kogut, 1999) have usually focused on learning in more or less routine R&D contexts. Our contribution is different, because we focus on a radical strategy shift towards R&D. Our results therefore refer to strategy implementation and learning rather than learning of more or less routine tasks. In this respect our paper represents a first attempt to link routines not only to their lower-level antecedents but also to upper-level constructs, among them strategy, which has been identified by Salvato and Rerup (2011) as a major gap in the literature.

Third and in a more general perspective putting emphasis on recruitment and individual skills opens up perspectives for an increased interaction with other more individual-centered literatures inside

management theory (e.g. HRM, team management, or managerial psychology), where the need for a micro-macro-integration in management has been extensively discussed (c.f. the special issue “Bridging Micro and Macro Domains” in the Journal of Management 2011).

The rest of the paper is organized as follows: In Section 2 we present our theoretical framework, developing arguments for hiring as a source of R&D related routines and capabilities. We also derive testable hypotheses about the role of recruitment of experienced R&D workers in implementing and sustaining an R&D strategy shift. Section 3 presents the data, defines variables and explains our identification strategy. Section 4 presents the results, whereas Section 5 concludes and discusses the implications of our findings.

2. THEORY

The literature has shown that the majority of R&D-related activities are conducted by only a minority of firms (Bottazzi et al. 2001, Cefis 2003, Malerba and Orsenigo 1996). Given that there are enormous financial benefits associated with R&D activities (Löf et al. 2012, Hall et al 2010, Andersson et al. 2012), this is somewhat surprising from a basic economic perspective, because under rational decision making, homogeneity in factor endowment, and equal access to investment opportunities all firms should behave identically.

The concept of organizational routines and capabilities has been used by Nelson and Winter (1982) as a way to explain this empirically observable lack of convergence, where routines are understood as “recurrent patterns of interaction” (Becker 2004).² In this theoretical framework non-R&D active firms are unable to imitate the R&D behavior because the dominant source of routines and capabilities is R&D experience gathered in the past (cf. Zollo and Winter 2002).

While this explains quite well the rigidity and persistency of firm behavior, it does little to explain whether strategic management can contribute anything to support transitions towards R&D, which, given their profitability, should always be a topic on the agenda of strategic management. Before we explain alternative sources for the development of routines and capabilities we will now shortly review the some features of the experiential learning perspective that is deemed so pertinent to routine development.

2.1 Routines and capabilities as a result from past experience

² We note that numerous to some degree differing definitions exist as well.

Following behavioral traditions of thought organizational routines and capabilities are assumed to find their ultimate origins in past experience and repetition (Cyert and March, 1963, cf. also Felin and Foss 2011). As Zollo and Winter (2002) emphasize this holds both for operational routines and for higher order routines/dynamic capabilities (Teece et al. 1997, Eisenhardt and Martin 2000, Helfat et al. 2007), because eventually also these higher order capabilities must derive from an external source.³

Since it is often at least implicitly assumed that organizational routines are based on internally acquired experience, experiential learning explains well high performance of organizations in repetitive situations, but is largely silent about whether or how firms can organize new tasks (Nelson and Winter 2002). Nonetheless, as Feldman and Pentland (2003) note, there exist numerous examples of successful organizational change, some of it quite radical. They explain this by agency, thereby introducing decision-making actors into the routines models that can adapt routines to their needs. Zollo and Winter (2002) also allow for ad hoc, i.e. non-routine, problem solving. So indeed, following the notion that the primary source of knowledge (of which experience is a special instance) lies in the interaction at the level of individuals (Grant 1996, Simon 1991), attempts have been made to reinject the individual into the routines and capability approach. Yet, a clear cut explanation of how precisely organizational routines/capabilities and individual skills relate, has not yet emerged.

In the next section we will therefore argue that individuals and their skills can be seen as important antecedents of organizational routines. This also raises a question about the possibilities of recruitment as an intentional measure to foster the creation of routines. Using the knowledge reservoir concept by Argote and Darr (2000) and Argote and Ingram (2000) we explore the theoretical potentials of recruitment as a source of capability development in the next subsection. However, we also pay explicit attention to the subtleties and problems recruitment in order to avoid the tempting but simplistic notion that all necessary skills can be found within individuals. We thereby also contribute to a better understanding of how organizational routines and individual skills relate.

2.2 Recruitment as a source of new routines?

Because all firm activities are eventually executed by individuals, it seems natural to assume that recruitment is a means to create new organizational capabilities. For example, Aldrich (1979) suggests that hiring allows firms to fulfill tasks they have not performed before. More broadly, Mansfield (1988) stated that, if capabilities are too costly to develop internally, firms may choose to acquire them on the market. Hardly surprising also the management literature has analyzed the role of recruitment in

³It has been argued that explaining capabilities by higher order capabilities leads to infinite recursiveness and tautology in the concepts (Butler and Priem 1997, Williamson 1999).

several respects: Almeida and Kogut (1999) and Rosenkopf and Almeida (2003) show that significant knowledge flows are associated with mobility. Song et al. (2003) and Maliranta et al. (2008) give evidence for “learning-by-hiring”. The arguments are also supported by Rao and Drazin (2002), who show that younger or poorly connected firms from the US mutual fund industry are more likely to use hiring from experienced firms in order to compensate the absence age-dependent competences. Conceptually related to our question of new strategy implementation, Cockburn et al. (2000) analyze the role of recruitment in the development of new technological capabilities. They show that firms in the chemical industry intending to move from randomized drug development towards science driven techniques can do so by recruitment.

Despite these results it has been complicated to link up recruitment to the prevailing capabilities approach in strategic management and organization science because of a lack of knowledge of how organizational routines and individuals skills relate to each other (Salvato and Rerup 2011). Particularly problematic is recruitment argument because it seems to suggest that organizational capabilities can be transferred between firms by hiring. Noting that capabilities are not simply the sum of individual skills (Nelson and Winter 1982), it is generally agreed that routines and capabilities are specific to their origin of creation in terms of history (Barney 1991, Reynaud 1996, Hodgson 2001), location (Simon 1976) and relation (Dyer and Singh 1998). Additionally, they incorporate tacit knowledge (Nonaka 1991). For these reasons capabilities are neither directly tradable on factor markets nor completely incorporated in any tradable factor (including labor).

While we agree with that, the skepticism about the idea that organizational capabilities are *completely* incorporated in tradable factors, does not preclude the possibility that the factors might still carry certain antecedents. In fact, recruitment of R&D workers might be a route to create capabilities if R&D workers possess, amongst other, relevant individual experience that can be integrated into the organizational experience. In order to fully develop this argument we now make use of the knowledge reservoir concept developed by Argote and Darr (2000) and Argote and Ingram (2000).

They propose that (the knowledge assets relating to) routines and capabilities are stored in members, tasks, and tools as well as the various sub-networks thereof, e.g. member-member, member-task networks, and so forth.⁴ The usefulness in this concept is that it is able to explain not only why capability transfer is difficult, but also why it still may be a promising venue for firms to hire personnel in order to create new routines and capabilities.

⁴ A familiar reasoning is found in Felin et al. (2012) that assume that routines emerge as a result of the interaction of individuals, processes, and structure.

In the knowledge reservoir concept transferring a routine or capability from one firm to the next implies that all components together with their networks are transferred and adapted to local specificities. While the market is unlikely to contribute to adaptation, even the transfer will be incomplete. For instance, while we may buy the embodiment of a technology (e.g. machinery) we might not be able to make it work because we lack the members that know how to do it. If we recruit a member (e.g. hiring an R&D worker), this is not necessarily sufficient, because he might lack either the tools (lack of a member-tool network) or his colleagues (lack of a member-member network).

The acquisition of individual components of this full network may nonetheless support the creation of routines and capabilities, because either of the components is a reservoir of knowledge. Even if it might contain less of the knowledge that is contained in conjunction with the other components, transferring a component will also transfer parts of the knowledge that it initially related to in the original network.

Additionally and with respect to adaptation of routines Allen (1977) highlights that members are able to reshape knowledge and adapt it to new contexts. Likewise individuals possess forward looking capacities allowing them to create novel solutions (Felin and Zenger 2009, Gavetti and Levinthal 2000) as well to adapt routines while running them (Feldman and Pentland 2003). According to this, recruitment can be a powerful way to create a specific capability. It transfers tacit and codified knowledge embodied in people (Galbraith 1990, Rothwell 1978), as well as skills to recreate the missing parts and to adapt them to the new contextual requirements. The direct implications for our question of recruitment and R&D strategy transitions will be outlaid in the next subsection.

2.3 Hypotheses

Doing something new requires the creation of new routines and capabilities. We have argued in the preceding section that recruitment is a means to support the implementation of new activities because it allows firms to substitute internal experience by recruitment of new employees. This argument clearly is generic in the sense that it could be applied to a multitude of situations in which firms do something that they have never done before, but we will focus in this paper on firms without prior R&D experience starting R&D. If firms are aware of this mechanism, we should observe higher recruitment rates alongside the implementation of a strategy shift.

H1: Firms that change their R&D strategy from no R&D to persistent R&D increase their recruitment of R&D-related personnel.

R&D workers are not homogenous, neither in terms of skills nor in terms of function. Firms starting to perform R&D are likely to lack both technological as well as organizational skills relating to R&D. A comparable distinction on the level of the knowledge underpinning such skills has been made by Anderson (1983) and Kogut and Zander (1992) who differentiate between declarative (technology-related “know-what”) and procedural knowledge (process-related “know how”). As Miller et al. (2012) point out procedural knowledge contains elements of skillful action as well as capabilities that relate to interpersonal coordination. Declarative knowledge defines the ability to observe a problem and propose solutions for it. In that respect, this distinction seems to imply duality in tasks as well, which could be labeled ‘coordination’ (related to procedural knowledge) and ‘problem solving’ (related to declarative knowledge). Both tasks are necessary in the establishment of R&D teams within a firm but, supposedly, performed by different types of employees. In particular, the former relates to managers while the second to R&D workers. We conclude:

H2: Firms that change their R&D strategy from no to continuous R&D significantly increase their recruitment of both managers with R&D experience as well as R&D workers.

The distinction between declarative and procedural knowledge has implications for the timing of recruitment decisions. In particular, the procedural routines are critical to a successful organization of new R&D activities. However, they are also among the most difficult to create requiring the preparatory recruitment of managers. This is for several reasons. First, new procedures in a firm will likely conflict with already existing ones. Suppose, for example R&D activities lead to new product development, this will have severe impacts on other parts of the firm (sales, production, marketing,...) creating tensions with already existing ways of doing things. As Feldman and Pentland (2003) rightly point out this necessitates the consideration of power within organizations, which is usually exerted by managers. Second, team production is subject to externalities that introduce a need for coordinative efforts (Abell et al. 2008). We note that this coordination is once again built on power that managers possess, though this time it is a power internally directed towards the R&D team rather than the wider context of the firm. In summary, firms are expected to hire managers before hiring R&D workers because the former possess the power necessary to enforce the changes that R&D activities both within the team and within the company.

H3: Firms that change their R&D strategy from no to continuous R&D recruit managers with R&D experience before they recruit R&D workers.

As highlighted by empirical observations and the discussion above, changing R&D strategy is subject to frequent failure. We hypothesize therefore that most of the firms attempting to do so fail. Nonetheless, if recruitment can substitute lack of experience, we should expect that firms putting

above average emphasis on recruitment initially are more likely to sustain the strategy shift also in later periods.

H4: A significant share of all firms changing to an R&D strategy fails and return to a non R&D based strategies in later periods.

H5: Firms that hire more R&D workers and managers are (conditionally on the firm characteristics) more likely to remain R&D active in later periods.

3. DATA, VARIABLES AND IDENTIFICATION STRATEGY

3.1. Data

We employ matched employer-employee panel data covering firms in three waves of the Swedish Community Innovation Survey (CIS), i.e. 2004, 2006 and 2008. The Swedish CIS is part of the CIS performed in all EU member states, being a harmonized survey of firms' innovation activities. The survey contains most sectors from services and manufacturing, i.e. from NACE 10 to 72.⁵ While it is by construction a moving cross-section, many firms are surveyed in consecutive periods. This allows us to construct a panel data set including firms that are part of all three waves of the CIS.

The original Swedish data consists of 3,126 (response rate 66%), 3,247 (63%), and 4,624 (85%) firms of which 1,113 firms are in all three surveys. Statistics Sweden creates a stratified, random sample based on firms with 10-249 employees, whereas all firms with 250 or more employees are always included in the survey.⁶ The survey is then sent to the top managers of the firms.

We add information from several other sources to the original CIS data through common firm identifiers in different sets of data. These other data sources include employment structure, balance-sheet data, ownership structure, international trade involvement and location. The final dataset comprises information from the following data sources:

- CIS (Community innovation survey 2004, 2006 and 2008, innovation information)

⁵ See *inter alia* Laursen and Salter (2005) for details of the CIS and its antecedents.

⁶Some potential sources of bias need to be addressed: the stratification Statistics Sweden employs in the CIS may work towards larger firms being included (as all Swedish firms with 250 or more employees are included as long as they are in CIS-relevant sectors). To circumvent problems of identifying firms, we have disregarded those firms that may have changed ownership structure, since that would also imply changing organizational identifier.

- LISA (Integrated database for labor market research 2002-2008, employees and regional variables)
- FEK (Business database 2004, 2006 and 2008, value added and business-related information)
- Database of business groups (2004, 2006 and 2008, states foreign vs. Swedish ownership)
- Export- and import-database (2002-2008, exporting experience)

A main novelty of the data is that the firms included in all three waves of the CIS are identified in the LISA-database. This database include *all* individuals of age 16 and above in Sweden, which allows us to identify which employees are employed in each firm, and the longitudinal structure of LISA then enables us to trace these back in time, i.e. how long they have worked in the firm, other personal characteristics (age, education), and, in particular, the characteristics of their previous employer and their position there, etc. In our empirical context, the main benefit of these data is that it makes it possible to identify new hires of R&D-experienced workers and relate these hires to changes in firms' R&D strategies.

3.2. Defining changes in R&D strategy and recruitment of R&D experienced workers

The main variables of interest in our analysis are an indicator of change in R&D strategy and recruitment of R&D experienced personnel. Changes in R&D strategies are derived from firms switching from none to persistent R&D activities between waves one (2004) and two (2006) of the CIS. Recruitments are identified as new hires of highly qualified employees previously working at R&D-active firms. We provide a more detailed account of these variables below.

Identification of firms' changing R&D strategy

We define a strategy shift as firms that in the first wave of the CIS (2004) report no R&D but in the second wave (2006) reports persistent R&D. We interpret this as underlying shift in R&D strategy. In practice, this means that the firms satisfy the following criteria:

- Answer “no” to the question: “*During the three years 2002 to 2004, did your enterprise engage in the following innovation activities: Intramural R&D?*”, and
- Answer “yes” to the question: “*During the three years 2004 to 2006, did your enterprise engage in the following innovation activities: Intramural R&D?*”, and

- Answer “continuously” to the follow-up question in CIS (2006): “*If yes, did your firm perform R&D during 2004 to 2006 continuously or occasionally*”

Firms satisfying these criteria are considered as having implemented a R&D strategy shift between waves one and two of CIS as they have gone from undertaking none to continuously engage in R&D-activities.⁷

We construct an implicit “control group” that consists of firms that answered the questions with no. We thus leave out firms that engage in continuous R&D in all waves or firms that have either in 2004 or 2006 been only temporary R&D performers. We regard this as a particular strength of our setting, because we compare firms that at least in 2004 did not differ in their R&D strategy. This design allows a cleaner identification, because it reduces the distorting potential of confounding factors.

Identification recruitments of R&D experienced personnel

We define three different types of experienced R&D workers:

1. R&D managers: *employees that worked as R&D managers at their previous employer. This corresponds to classification “1237” according to the four-digit level of the ISCO-88 in the LISA-database. Managers of this type are directly involved in R&D-related decisions.*
2. Other managers at R&D intensive firms: *employees that had a management position at their previous employer, according to the 1-digit ISCO-88. The employer was conducting R&D. These managers are generally the top- or middle-managers who are involved in decision-making and development of strategies and organization.*
3. Knowledge workers: *employees having a qualified (but not management) position at their previous employer according to the 1-digit ISCO-88. The employer was conducting R&D. A further requirement is that these employees have at least a university bachelor’s degree.*

⁷ It should be noted that this interpretation identifies such a shift in strategy instead of directly observing it. However, because Statistics Sweden sends these surveys only to top-level managers and, if possible, always to the same contact person, a switch from not-R&D-active to persistent R&D should reflect some degree of strategic decision making.

In the empirical analysis that follows, we aggregate R&D workers of type 1 and 2 into one single group. This leaves us with two categories of experienced R&D workers which we define for the sake of easier labeling as (i) R&D managers and (ii) Knowledge workers. These two differ in the sense that the managers should possess R&D-related knowledge of organization and processes, in the wording of Kogut and Zander (1992) procedural knowledge, while the knowledge workers can be considered as holders of declarative knowledge.

The CIS is conducted every two years. Therefore, we create annually available variables not coming from CIS as an average over the two years in question. Thus, in characterizing firms' employees, we merge individual data for two consecutive years and then create employee and other characteristics based on averages across t and $t-1$.⁸ We construct inflow, outflow and common workers for each respective group of R&D workers.

3.3. Identification strategy

Our ability to infer a role played by recruitment of experienced R&D workers in implementing and sustaining an R&D strategy shift hinges crucially on our identification strategy. Below we describe our main strategy to identify the role played recruitment of R&D workers, as well as the main confounding factors for which we control.

Testing recruitment as means to implement a shift of R&D strategy

Based on the methods explained in the previous sections, we define two sets of firms: one with firms undertaking an R&D strategy shift and one with firms that do not. For both sets of firms, we identify recruitment of experienced R&D workers. There are 401 firms that do not report any R&D spending in all consecutive periods, and 41 firms undertaking an R&D strategy shift between waves one and two. This leaves us with 442 firms in total. In order reduce issues of unobserved heterogeneity we drop all other firms. We emphasize that this is a selection on an exogenous variable (see Model (1)) and therefore will *not* induce selection bias.

If recruitment of experienced R&D personnel is a means by which firms acquire routines and capabilities for R&D, we should observe that those firms that do undertake an R&D strategy shift, all else equal, are more likely to recruit than firms with no observed change in R&D strategy.⁹ Our baseline empirical model for testing this proposition is as follows:

⁸To measure newly recruited R&D managers in each firm in a year, say 2004, this means that we first create an interaction variable of “new R&D managers” and “inflow” for both 2003 and 2004. We then sum this, by year, for each firm and merge the datasets on the firm level. Assume that for firm j , it recruits 1 in 2003 and 2 in 2004, respectively. For firm j , this value would be 1.5 (since $(1+2)/2=1.5$).

⁹Note that the fact that we have longitudinal data on firms that do undertake an R&D strategy shift as well as those that do not allows for a cleaner identification than e.g. exploitation of pure cross-sectional variance. An

$$(1) \quad R_{it}^g = \alpha + \gamma IS_{it} + \mathbf{X}_{it}' \boldsymbol{\lambda} + \sum_{s=1}^S \theta_s D_s + \sum_{t=1}^T \delta_t D_t + \varepsilon_{it}$$

where R_{it}^g denotes a measure recruitment of experienced R&D workers of type g (managers or knowledge worker) by firm i in year t . The matrix \mathbf{X}_{it} contains the confounding factors and control variables discussed below.¹⁰ D_s and D_t are sector and time dummies, respectively. IS_{it} is a dummy variable which is 1 for firms that shift from none to persistent R&D in CIS (2006), and 0 otherwise.

For each firm and time period, R_{it}^g is defined as recruitment of R&D workers of group g as a fraction of all recruitments to the firm. It is thus expressed as a recruitment rate bounded between 0 and 1, and we employ a Panel-Tobit estimator with corresponding left- and right-censoring limits. The parameter of main interest is γ . This parameter informs whether switching to persistent R&D influence recruitment of experienced R&D workers of different types g .

To test H1 and H2, then, we estimate the model in (1) for the total recruitment rate of experienced R&D workers, as well as separately for R&D managers and knowledge workers (see Section 3.2). This allows us to test the relationship between R&D strategy shifts and total recruitment of R&D workers (H1), as well as hires of different kinds of experienced R&D workers (H2).

With regard to the timing of hires, our theoretical framework suggests that recruitment of R&D workers is the result of a preceding (unobserved) decision to engage in persistent R&D; hence our focus on recruitment as a means to *implement* a shift of R&D strategy.¹¹ By this argument, we expect that the hires of experienced R&D managers should primarily occur before we observe a firm's R&D strategy shift in the data (compare H3).

We test this proposition by introducing a lag structure in the model in (1).¹² We then test, for R&D managers and knowledge workers respectively, whether R&D strategy change primarily influence

alternative identification strategy would be to simply compare R&D-active with non R&D active firms, and then study the experiences of their stock of workers. This would however entail significant simultaneity and endogeneity problems. Here we exploit variance over time in the R&D strategy of each firms and its recruitment of R&D personnel.

¹⁰ Basic descriptives for all variables in the analyses are reported in Appendix A.

¹¹To be clear, the theoretical arguments developed in the paper suggests that a realized R&D strategy shift of a firm in the data is the outcome of a preceding management decision to undertake such a shift, followed by a successful strategy to build routines and capabilities to enforce the new R&D strategy. Firms with no observed change in R&D strategy may still have decided to try to shift strategy, but failed even before anything was observable.

¹² We implement this using forward and backward lags of the IS_{it} variable.

recruitment before or in the same period as the R&D strategy change takes place. A verification of H3 would imply that the recruitment of R&D managers primarily takes place before the R&D strategy change is implemented, and that this is followed by recruitment of more general knowledge workers with R&D experience.

Testing whether recruitment helps to sustain a shift of R&D strategy

We also test whether recruitment of R&D workers has an influence on the probability that a firm sustains its R&D strategy shift into as indicated in CIS 2008, i.e. two years after the observed strategy shift. Among the set of firms shifting R&D strategy between waves one and two, only a subset continues with a persistent R&D strategy throughout wave three. We argue that those firms that sustain their R&D strategy should have been more successful in establishing R&D routines and capabilities. We assume that firms conditional on their characteristics have recruited more R&D workers in 2006 (we use the error term in Model (1) as a measure) has a positive effect on the likelihood to stay R&D active in 2008. Using a Probit model, the estimating equation is:

$$\Pr(Sustain_i = 1 | \mathbf{Z}_i) = \Phi(\mathbf{Z}_i' \Gamma)$$

(2)

$$\mathbf{Z}_i' \Gamma = \alpha + \sigma \hat{\varepsilon}_{i2006} + \mathbf{X}_i' \boldsymbol{\lambda} + \sum_{s=1}^S \theta_s D_s + u_i$$

Firm fixed effects and dynamics?

To estimate Model (1), we employ both rely on panel-robust pooled Tobit estimator as well as a more complicated model allowing for state dependence and using and fixed effects. The pooled Tobit estimator is not as efficient as the full Random Effects estimator, but is consistent under a variety of situations when the Random Effects estimator is not anymore. However, like the random effects estimator it rules out correlated unobserved heterogeneity as well as dynamics capturing the history of the process that is agreed to be of great importance in routine formation.

While fixed effects estimators can usually account for that, no fixed effects estimator is available for the Tobit model. A way convenient alternative to control for fixed effects is, however, to use parametric specifications for them. As Mundlak (1978) has highlighted, it is possible to approximate the individual fixed effects by individual specific time averages of the explained variables. It requires additional assumptions on the distribution of the fixed effects, the most restrictive of which is that the fixed effects can expressed in terms of observables. In practice, this may or may not be true. We therefore additionally allow for a lagged dependent variable. A second reason for this is that routines are conceived as path dependent introducing dynamics in the model.

This state dependence can be captured by the inclusion of a lagged dependent variable. Lately Wooldridge (2005) has proposed a method for the estimation of parametrically specified fixed effects in dynamical non-linear Panel-Tobit models, which consists of a specification using the initial condition of the dependent variable as a control additional to the Mundlak correction terms.

Confounding factors

There are several reasons why a firm may hire R&D experienced workers. Additional to some other factors (listed below), we account for the four main confounding factors: (i) exports, (ii) sales growth, (iii) location characteristics and (iv) product innovation.

A large literature shows that there are significant costs of entering foreign markets. Exports are associated with entry costs, which imply productivity thresholds that only more productive firms can overcome (Wagner 2007). Foreign markets may also be more competitive, requiring refinements of product lines and production processes as well as reductions of X-inefficiencies (Andersson and Lööf 2009, Schubert and Simar 2011). This implies that firms active on international markets may be more inclined to recruit highly qualified workers with experience from R&D-active (and presumably more productive) firms. If exports or initiation of exports coincide with a shift of R&D strategy, then there is a risk of spurious identification of the effect of R&D strategy shift on recruitment.¹³ We thus include two dummy variables reflecting firms' export strategy in the empirical model.

Firms' recruitment patterns are linked to their growth (Faberman and Nagypal 2008). Stronger recruitment can thus simply be the result of growth in sales. Firms shifting from no to persistent R&D may also be more likely to experience sales growth, precisely because of the same arguments as above for exports – incentives for R&D become larger as sales increase. This suggests that sales growth may be an important confounding factor and we include a control for growth in sales in the empirical model.

The third confounding factor is location. The reason why location matters are the following: First, labor market mobility is subject to significant spatial transaction costs and is therefore highly localized (Andersson and Thulin 2013). Second, different regions offer different access to R&D experienced workers.¹⁴ Firms located in regions with density of R&D workers in incumbents are thus in a better position to hire R&D workers because there are more potential recruits. To verify that our estimated relationship between recruitments of R&D workers and change in R&D strategy is not caused by an

¹³ In fact, the incentives for R&D may increase with expanding markets, the reason being that the fixed costs of R&D may be spread over larger sales (cf. Aw et al 2008).

¹⁴ Inter-firm job-switching is significantly less frequent between firms located in different regions as between firms located in the same region. Andersson and Thulin (2013) show that about 80% of all inter-firm job-switching takes place between firms located in the same local labor market region.

underlying location pattern of firms, we control for location. We do this by including the size of the region in which they have their main activity as well as the pool of each respective group of R&D workers. The former account for general agglomeration phenomena and the latter measures the directly observable pool of R&D workers.

The fourth confounding factor is product innovation. Product innovation in the form of the development of improved or new products in the firm does not necessarily require persistent R&D activity. Such innovation activity may yet trigger recruitment of experienced R&D workers. Based on these arguments, we control for product innovation activity in each firm. We measure this as the fraction of sales due to new or improved products, which is a standard measure of product innovation employed in studies using CIS data (Kleinknecht et al 2002, Robin and Schubert 2012).

We also control for a number of other factors. First, we include measures of the existing stock as well as outflow of R&D workers. Both these variables may explain recruitment of new experienced R&D workers. Second, we also control for firm-level productivity, as proxied by value-added per employee. Third we use absolute turnover as a general control for size of the firm. Last, we account for sector heterogeneity and time effects using industry and year dummies. Summary statistics of the main variables can be found in Table 1.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Relative inflow total R&D personnel	1329	0.0465	0.1117	0.0000	1.0000
Relative inflow knowledge workers	1329	0.0180	0.0660	0.0000	0.9333
Relative inflow managers	1329	0.0285	0.0848	0.0000	1.0000
Share common R&D personnel	1325	0.0505	0.0502	0.0000	0.4643
Share common knowledge workers	1325	0.0115	0.0343	0.0000	0.4286
Share common managers	1325	0.0395	0.0355	0.0000	0.2619
Relative outflow total R&D personnel	1329	0.0296	0.0868	0.0000	1.0000
Relative outflow knowledge workers	1329	0.0085	0.0414	0.0000	0.6000
Relative outflow managers	1329	0.0214	0.0752	0.0000	1.0000
Turnover	1327	343000000.0000	1520000000.0000	0.0000	2810000000.0000
Serving world market	1329	0.2114	0.4085	0.0000	1.0000
Exporter	1329	0.0722	0.2590	0.0000	1.0000
R&D strategy shift	1329	0.0677	0.2514	0.0000	1.0000
Labor productivity	1325	2556956.0000	5342092.0000	0.0000	103000000.0000
Turnover change	884	0.0067	0.0490	-0.0900	0.8981
Share turnover due to new products	1329	0.0108	0.0546	0.0000	0.9000
R&D upheld in 2008	1329	0.0181	0.1332	0.0000	1.0000
R&D intensity	1324	24145.4900	335620.9000	0.0000	11000000.0000
Log region size	1329	12.0945	1.5058	7.2869	14.0402
Regional labor supply total R&D personnel	1329	0.1427	0.0960	0.0027	0.3770
Regional labor supply knowledge workers	1329	0.0931	0.0657	0.0017	0.2560
Regional labor supply managers	1329	0.0495	0.0311	0.0009	0.1210
High-tech manufacturing	1329	0.0384	0.1922	0.0000	1.0000
Medium-high-tech manufacturing	1329	0.1189	0.3238	0.0000	1.0000
Medium-low-tech manufacturing	1329	0.1460	0.3532	0.0000	1.0000
Low-tech manufacturing	1329	0.4041	0.4909	0.0000	1.0000
Knowledge-intensive services	1329	0.1369	0.3439	0.0000	1.0000
Other services	1329	0.1558	0.3628	0.0000	1.0000

4. RESULTS

Recruitment rate of R&D workers and shift of R&D strategy

We will see that the timing of recruitment (before and during strategy shift) differs by R&D worker group. We begin with our baseline specification in equation (1) with no lag structure, where Table 2 presents the estimated parameters. These results inform whether an R&D strategy shift influence the recruitment frequency of R&D workers in the same period as the R&D strategy shift is realized. The first model refers to recruitment of all types of R&D workers, whereas the second and third model present results for R&D managers and knowledge workers with R&D experience, respectively. We have argued that managers will mainly possess procedural knowledge while knowledge workers will embody declarative knowledge. This should be kept in mind because we hypothesized that managers are likely to be hired before the strategy shift (the results to be presented in Table 3).

Firms changing R&D strategy have indeed a higher recruitment rate of knowledge workers with experience that possess the task-related declarative knowledge. In line with our theory, the rate of recruitment of managers is not higher during the period of the strategy shift. This suggests that the periods during which a strategy shift from none to persistent R&D is realized are primarily associated with higher recruitment rates of knowledge workers.

Looking at the confounding factors, we see that outflow and relative stock of employee category, labor productivity as well as regional size are statistically significant in most specifications. That firms experiencing an outflow of R&D workers tend to have higher recruitment of R&D workers is in line with our expectations. Outflow of workers, either caused by exits or retirement, should induce hires to replace those leaving the firm. Nonetheless this result primarily applies to managers.¹⁵ This may be appreciated as managers being more central for the organization and therefore more important to replace. For knowledge workers it is instead the relative stock of workers inducing higher rates of recruitment of knowledge workers, reflecting that larger stocks are associated with generally higher churning. In line with expectations, firms with higher labor productivity are in general more inclined to hire managers. Moreover, the size of the region in which a firm is located induces a higher rate of recruitment of all types of R&D workers. This is consistent with the general finding that availability of skilled workers as well as the overall rate of inter-firm job switching is higher in larger regions (cf. Andersson and Thulin 2012).

Table 2. The influence of R&D strategy change on recruitment of R&D workers, no lag structure.

¹⁵For knowledge workers with R&D experience, the estimated coefficient is positive but not statistically significant.

	(1) Relative inflow total R&D personnel	(2) Relative inflow knowledge workers	(3) Relative inflow managers
R&D strategy shift	0.054531 (1.51)	0.079516** (2.16)	0.029802 (1.05)
Turnover	0.000000 (1.31)	0.000000*** (2.62)	0.000000 (1.03)
Serving world market	0.012867 (0.67)	-0.009685 (-0.45)	0.022714 (1.26)
Exporter	-0.003597 (-0.10)	-0.093058* (-1.72)	0.024730 (0.83)
Labor productivity	0.000000** (2.02)	-0.000000 (-0.91)	0.000000* (1.82)
Turnover change	-0.509716** (-2.03)	-0.452152** (-2.05)	-0.343901 (-1.64)
Share of turnover due to new products	0.275743*** (2.60)	0.120938 (0.82)	0.284420*** (2.94)
Log region size	0.022118*** (3.40)	0.020936*** (2.74)	0.020425*** (3.41)
Regional labor supply total R&D personnel	0.071561* (1.82)		
Regional labor supply knowledge workers		0.010162 (0.16)	
Regional labor supply managers			0.178840 (1.54)
Share common total R&D personnel	0.926929*** (5.30)		
Share common knowledge workers		2.074770*** (6.61)	
Share common managers			0.557682** (2.34)
Relative outflow total R&D personnel	0.279387** (2.55)		
Relative outflow knowledge workers		-0.006662 (-0.02)	
Relative outflow managers			0.317877*** (2.93)
Constant	-0.476735*** (-5.38)	-0.490936*** (-4.46)	-0.425120*** (-5.06)
Sector dummies	YES	YES	YES
Year dummies	YES	YES	YES
Observations	883	883	883
Number of groups	442.000000	442.000000	442.000000
Pseudo R2	0.290294	0.500785	0.203301

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Turning to H3 we have argued that managers are likely to be recruited before the strategy shift because of the fact that procedural knowledge should primarily be acquired before declarative knowledge. Firms are therefore expected to first recruit experienced R&D managers.

In order to test, if recruitment of R&D managers occurs before hiring of knowledge workers, we lag the indicator of R&D strategy shift forward and re-estimate the model in Table 1.¹⁶ A significant estimate of the parameter associated with R&D strategy shift indicator will in this case imply that firms shifting to persistent R&D have a higher recruitment rate of R&D workers in the period *before* the R&D strategy shift is realized. This would correspond to the idea that firms ‘prepare’ an R&D strategy shift by recruiting experienced R&D managers.¹⁷ The results of this undertaking are presented in Table 2.

The results support our hypothesis. Firms initiating a strategy of persistent R&D do show higher recruitment rates of total R&D personnel than the reference group of firms in the period *before* the strategy shift is realized, and this result is driven by a higher recruitment rate of R&D managers. In contrast, we find no statistically significant effect on recruitment of knowledge workers. These patterns are supportive for the idea that firms first hire R&D managers to build procedural knowledge associated with R&D, and then build up declarative knowledge as captured by knowledge workers with R&D experience.

Table 3. The influence of R&D strategy change on recruitment of R&D workers, forward lag structure.

¹⁶ Naturally, we also lag the confounding factors reflecting changes in the firm.

¹⁷ We note that it would be consistent also with a view that the hiring of manager with R&D experience was causal for the strategy shift instead of the other way around. But practically this is unimportant for our argument.

	(4) Relative inflow total R&D personnel	(5) Relative inflow knowledge workers	(6) Relative inflow managers
F.R&D strategy shift	0.113520** (2.54)	0.067011 (1.42)	0.084705** (1.96)
Turnover	0.000000*** (2.84)	0.000000*** (3.53)	0.000000*** (2.89)
Serving world market	0.029412 (1.06)	0.037383 (1.07)	0.024421 (1.04)
F.Exporter	0.039173 (0.94)	-0.015297 (-0.29)	0.054785 (1.45)
Labor productivity	0.000000*** (5.88)	0.000000 (0.47)	0.000000*** (4.51)
F.Turnover change	-0.381466** (-2.01)	-0.234036 (-1.13)	-0.313963 (-1.45)
Share of turnover due to new products	-0.112738 (-0.72)	0.097902 (0.65)	0.056702 (0.36)
Log region size	0.029366*** (3.13)	0.036027*** (3.78)	0.022457** (2.53)
Share common total R&D personnel	0.759194*** (3.53)		
Share common knowledge workers		2.104585*** (4.94)	
Share common managers			0.396974 (1.22)
Regional labor supply total R&D personnel	0.074169 (1.28)		
Regional labor supply knowledge workers		0.094305 (0.95)	
Regional labor supply managers			0.140689 (0.94)
Relative outflow total R&D personnel	0.403183* (1.72)		
Relative outflow knowledge workers		0.750499** (2.18)	
Relative outflow managers			0.203202 (0.87)
Constant	-0.612682*** (-4.90)	-0.737991*** (-5.38)	-0.522825*** (-4.37)
Sector dummies	YES	YES	YES
Year dummies	YES	YES	YES
Observations	883	883	883
Number of groups	442.000000	442.000000	442.000000
Pseudo R2	0.147656	0.411794	0.094274

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The estimates of the influence of the confounding factors are similar to Table 1, where results emphasize the relevance of firms' local environment in that the size as well as the pool of the pertinent workers in the region firms are located in has a positive impact on recruitment rates.

In summary we find our hypotheses H1-H3 supported. Yet, in Section 3 we argued that it might be important to account for possible unobserved heterogeneity as well as dynamics despite the fact that our selection of sample should erase much of the heterogeneity issues. As said we adopted a double strategy by controlling for including Mundlak correction terms and a lagged dependent variable alongside the initial condition as proposed by Wooldridge (2005). The results are presented in Table 4 and largely confirm the results that we have achieved using the regular pooled Tobit estimators.¹⁸ Thus we conclude that the results obtained so far are relatively robust and not caused by unobserved heterogeneity across firms.

¹⁸ The same control variables were used as in Table 2 and 3 but are not explicitly shown.

Table 4: The influence of R&D strategy change on recruitment of R&D workers, allowing for state dependence

	(7) Relative inflow total R&D personnel	(8) Relative inflow know- ledge workers	(9) Relative inflow managers	(10) Relative inflow total R&D personnel	(11) Relative inflow know- ledge workers	(12) Relative inflow man- agers
F.R&D strategy shift	0.197951** (2.17)	0.157531* (1.69)	0.118304* (1.77)			
R&D strategy shift				0.054929 (1.53)	0.079192** (2.27)	0.032139 (1.13)
L.Relative inflow total R&D personnel	0.049891 (0.46)			0.106780 (1.08)		
L.Relative inflow knowledge workers		0.113755 (0.63)			0.312417** (2.36)	
L.Relative inflow managers			-0.230418 (-1.23)			-0.081064 (-0.74)
Other controls	YES	YES	YES	YES	YES	YES
Initial condition	YES	YES	YES	YES	YES	YES
Mundlak corrections	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES	YES	YES
Observations	442	442	442	883	883	883
Number of groups	442.000000	442.000000	442.000000	442.000000	442.000000	442.000000
Pseudo R2	0.379159	0.685819	0.303286	0.293971	0.524927	0.206098

t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The effect of recruitment of R&D workers on the probability of sustaining an R&D strategy shift.

As explained in the preceding section, we also assess whether firms with higher recruitment rates are more likely to sustain the R&D strategy shift throughout the third wave. The basic idea is that firms sustaining their new R&D strategy should have been more successful in establishing new R&D routines and capabilities and we test whether this could be explained by their recruitment rate of R&D workers.

Our fourth hypothesis (H4) stated that a large fraction of firms lacking experience of R&D activity should fail in their endeavor to shift R&D strategy due to the difficulty in building up new routines and capabilities. Without going into details, simple descriptive statistics support this. Out of the 41 firms shifting from none to persistent R&D between waves one and two, only about 22% sustain their strategy of persistent R&D throughout wave three. Do the firms sustaining their R&D show higher rates of recruitment of R&D workers?

We estimate for each employment category one model. In of the three the dependent variable is a dummy variable taking the value 1 for firms sustaining their new R&D strategy in period three and 0 otherwise. The independent variable of main interest is here a dummy variable which is 1 if the firm recruited employees in the respective category at a rate higher than predicted by the model in Table 1 and 0 otherwise.¹⁹ In this way we can estimate the influence on recruitment on the probability of sustaining an R&D strategy shift. Note that we dropped the other employment related variables but included the lagged R&D expenditures as a fraction of sales as a primary input into the R&D process.

The results are reported in Table 4. There are two main messages from the table. First, we find that firms with a higher recruitment rate of both R&D managers and knowledge workers are more likely to keep their strategy of persistent R&D throughout the third wave. The estimated parameters are positive and significant at the 5%.²⁰ Second, we find that firms with larger R&D spending as a fraction of sales are consistently more likely to sustain their R&D strategy.

These patterns support our fifth hypothesis (H5). A higher rate of recruitment of R&D workers has a positive influence on the probability that firms continue with persistent R&D activity. Firms continuing with their new R&D strategy are expected to have been more successful in establishing

¹⁹ We identify such firms by re-estimating the model in equation (1) with no lag structure and then save the predicted recruitment rate of these firms. Those firms whose actual recruitment rate is above the predicted one are then assigned the value 1 and 0 otherwise.

²⁰Note there are few firms sustaining their R&D strategy in the third wave. Only about 22% of the 41 firms initiating a strategy of persistent R&D do so. A statistically weak significance may thus be explained by the few numbers of observations following this pattern.

routines and capabilities for R&D, and our results are consistent with a higher rate of recruitment of R&D workers being one reason for this.

Table 4. The influence on recruitment of R&D workers on the probability of sustaining an R&D strategy shift.

	(13) Total R&D personnel	(14) Knowledge workers	(15) Managers
Above average hires in 2006	1.479582** (2.00)	1.727232** (2.35)	1.702948** (2.56)
Turnover	0.000000 (1.60)	0.000000 (1.45)	0.000000* (1.77)
Serving world market	0.377004 (0.89)	0.194301 (0.43)	0.353432 (0.80)
Exporter	-0.289099 (-0.36)	-0.253758 (-0.30)	-0.296773 (-0.35)
Turnover change	-15.620820 (-1.45)	-11.976544 (-0.95)	-17.021084 (-1.55)
Labor productivity	-0.000000 (-0.26)	-0.000000 (-0.22)	-0.000000 (-0.28)
L.R&D intensity	0.007669*** (3.93)	0.007419*** (3.60)	0.008299*** (3.91)
Log region size	0.095813 (0.67)	0.035850 (0.26)	0.087457 (0.59)
Regional labor supply total R&D personnel	0.173576 (0.10)		
Regional labor supply knowledge workers		0.178794 (0.07)	
Regional labor supply managers			0.214790 (0.03)
Constant	-4.126814** (-2.12)	-3.622983* (-1.90)	-4.111005** (-2.06)
Sector dummies	YES	YES	YES
Observations	391	391	391
Pseudo R2	0.365257	0.386396	0.398646
Model significance	0.004651	0.002639	0.001889

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

To further probe our assessment of the influence of recruitment of R&D workers on the likelihood of sustaining a shift of R&D strategy we estimated a second model with a restricted sample of firms, where the sample is only the 41 firms that did undertake a strategy shift in between waves one and two. The dependent variable was the same as before. We thus asked the following question: among the group of firms shifting from none to persistent R&D, do the firms continuing with persistent R&D throughout wave three show higher recruitment rates of R&D workers? The results gave evidence of an increased probability to remain R&D performer also in 2008 when the recruitment rate in 2006 was

higher. Because the results basically corroborate the findings in Table 4, we do not report the regression table, which is, however, available upon request.

5. DISCUSSION AND CONCLUSIONS

Investments in R&D and innovation activity are typically considered key for sustained long-term competitiveness of firms. Analyses of the private returns to R&D show that they are significant and positive (Hall et al 2010), and R&D is also essential for firms' absorptive capacity, i.e. their capacity to recognize and assimilate new information and knowledge (Cohen and Levinthal 1990). Despite this, surprisingly few firms undertake R&D activity. In most sectors there are a small number of systematically innovating firms and a larger number of firms without any observable R&D and innovation activity. The rigidity in this pattern over time is often explained by R&D requiring routines and capabilities that firms without R&D experience lack (Dosi and Nelson 2010). This explanation is static in the sense that it explains 'lack of change' in the heterogeneity in firms' R&D activity, and devotes less attention to the question from where routines and capabilities for R&D come as well as how (if at all) they can be deliberately developed to sustain firms' transition towards R&D activity. To deepen our understanding of these issues, this paper has focused on one specific source of routines and capabilities for R&D activity: recruitment of experienced R&D workers. We show that recruitment of experienced R&D managers and knowledge workers is a way in which firms can create new routines and capabilities to enforce and sustain a strategy shift from none to persistent R&D spending despite a lack of internal experience with this task.

These analyses and results link up to the general discussion of the origins of routines and capabilities (Murmman et al. 2003, Zollo and Winter 2003). By suggesting an explicit source of new routines and capabilities in firms that lies outside the routines and capabilities themselves, our results take into account the critique of tautology and infinite recursiveness of routines (Mosakowski and McKelvey 1997, Priem and Butler 2000, Williamson 1999). The issue whether routines and capabilities reside at the individual or the organization level is indeed embedded in the overall critique of the lack of micro-foundations for routines in the organization and management literature (Abell et al 2008, Felin and Foss 2004, Felin et al. 2012). We do not go as far as Felin and Foss (2004, p. 22) who argue that "... capabilities can [...] be brought in as a function of certain, key individuals, which implies that capabilities in the first place may reside in individuals vs. the organization". This would essentially imply that the organizational capabilities are fictitious in the sense that the differences in them are just reflections of differences on the individual level. But we argue that the origins of the collective lie in the individual level. These are fundamental issues for management, because practical advice for management requires us to understand where routines, capabilities, and dynamic capabilities come

from and the extent to which management can influence or “orchestrate” the process of their creation (Teece 2007).

This offers new perspectives not only for the capabilities approaches in strategic management but also for evolutionary theorizing itself, which has sometimes quite explicitly expressed its agnosticism about the abilities to manage organizational change because of inertia (Hanna and Freeman, 1977). The organizational ecology approach explicitly emphasized the importance of new firm entry rather than incumbent adaptation as a source of novelty in the relevant population (Hannan and Freeman, 1984). While being more Lamarckian than Darwinistic, also the routine-focused evolutionary approaches regard change as incremental and path dependent, implying that firms will find it hard to adapt in the light of environmental turbulence and to start new activities. Our results show that successful adaptation is possible and therefore deserves more attention in evolutionary models. This is particularly true, if they are used in the context of strategic management, whose very *raison d'être* is the analysis of strategic organizational adaption.

The findings in the paper also associate to the broader literature on inter-firm labor mobility and knowledge transfer emphasizing labor markets as conduits for knowledge flows (Almeida and Kogut 1999, Agrawal et al 2006). Almeida and Phene (2012, p27) argue that “... most research does no more than simply suggest a connection between mobility and knowledge flows, offering at best indirect evidence”. The analyses in the paper take a further step by empirically verifying a direct link between changes in firms’ R&D strategies and recruitment of R&D workers.

Furthermore, the analyses highlight the importance of interactions between firms and their external local environment. Location has long been a rather neglected factor in strategy and management research (Porter 1990, 1994). Yet, in the advent of globally distributed production activities, it has gained increased interest in the last years. In the context of our research, location is implicit in any research linking mobility of labor to inter-firms transfers of knowledge and routines, because labor market mobility is subject to significant spatial transaction costs and is therefore highly localized (Andersson and Thulin 2013, Almeida and Kogut 1999). As a consequence, local conditions matter: For example firms in locations with a high density of R&D performing firms have a greater pool of experienced R&D labor to recruit. Our analyses controlled for the local pool of R&D workers as well as the size of the region in which a firm is located, and we found that recruitment was indeed higher for firms located in larger regions with and also depended on larger pools of R&D workers. Our findings point in this sense to a potential synergy between the management literature on inter-firm capability transfer and the emerging literature on evolutionary economic geography which puts the spatial dimension of routine replication and creation at center stage (Boschma and Frenken 2006, Frenken and Boschma 2007). In accordance with our paper, EEG highlights the importance of labor

mobility as a prime mechanism of routine replication and diffusion in space. Yet, this literature seldom studies strategy and management consequences despite the important implications: since locational decisions are very long-lasting, they are certainly among the most strategic choices a firm can make, even more so, if recruitment is locally bound and an important means to create new capabilities. Because of this we believe that there is considerable room for cross-fertilization between EEG and various literatures in strategic management such as analyses of outsourcing and off-shoring decisions. The shared theoretical basis should facilitate a fruitful exchange.

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