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Patenting and Entrepreneurial Spawning: An Innovation Strategy Approach

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Patenting and Entrepreneurial Spawning: An Innovation Strategy Approach

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ABSTRACT:

This paper analyzes how different innovation-strategies of incumbent firms affect the quality of their entrepreneurial spawns. Using a novel data set that combines employer-employee micro data from Sweden with firm level patent application data files for the period 1997-2008, three types of incumbent firms are distinguished: firms that are engaged in innovation activities persistently, occasionally and not at all. The analysis shows only weak indication that the chance of survival for a new firm can be linked back to the innovation strategy of the parent firm. In contrast, there is strong evidence that employee start-ups from persistent innovators are more productive during their first five years on the market than other spin-offs, everything else equal.

Keywords: Innovation, Patent, Spinoff, Survival, Productivity

JEL-Codes: C24 L26, M13 O31, O32

1. INTRODUCTION

The past few years have seen an upsurge of the attention paid by researchers to a special group of entrants into industries, namely spinoffs. Entry into an industry via spinoff (entrepreneurial ventures founded by ex-employees of incumbent firms) is a widespread phenomenon in many industries such as semiconductors (Brittain and Freeman, 1986), disk drives (Christensen, 1993; Agarwal et al., 2004), lasers (Klepper and Sleeper, 2005), biotechnology (Mitton, 1990; Stuart and Sorenson, 2003), medical devices (Chatterji, 2009), and automobiles (Klepper, 2007).

The main theoretical line of thought in the literature goes back to biological theories of evolution where employees acquire valuable knowledge from their place of employment (Klepper and Sleeper, 2005). In this vein, firm characteristics such as size (Sorensen, 2007; Elfenbein, Hamilton, and Zenger, 2010), stock of knowledge (Gompers, Lerner, and Scharfstein, 2005; Klepper and Sleeper, 2005) and strategies for utilizing their knowledge in the market (Agarwal et al. 2004), is shown to influence employees' entrepreneurial behavior as well as the success of their entrepreneurial venture.

In contrast to the importance that is given in the literature to the firms' stock of knowledge in determining entrepreneurial spawning, relatively little attention has been paid to the relation between firms' knowledge-generation strategies and entrepreneurial spawning. One of the few exceptions is Andersson, Baltzopoulos and Lööf, (2012). Similar to them, we argue that firms which engage in continuous knowledge generation (persistently pursue innovation activities) versus those which occasionally engage in innovation and those which do not invest in R&D and other innovation activities are likely to generate different entrepreneurial potential in their employees. This paper utilizes a unique large sample database of firms

from Sweden matched with the EPO worldwide patent statistical database (PATSTAT) to investigate the relationship between the incumbent firms' innovation strategies and their entrepreneurial spawning.

The database contains information on all firms in Sweden over the period 1997-2008 and information on all employees in the country for the same period. Based on this data we are able to distinguish spinoff companies started by ex-employees of incumbent firms from other new firms.

Matching the PATSTAT data with the firm data, we first classify the parent firms into three different categories depending on the frequency of patent applications: persistent innovators, occasionally innovators and non-innovators. We then use information on about 2.4 million individuals working in the business sector in order to ascertain entrepreneurial start-ups by ex-employees. In total, we find 11,727 spinoffs that originated from 8,542 incumbents over the period 1998-2008.

In order to receive sufficient information on both the parent firms and their spinoff "descendants", we restrict the analysis to four cohorts of spinoffs that we can follow over a five year period after their birth, and where the parent firms are observed for four years before the spawning. Thus, the sample is constrained to the 4,077 unique spinoffs for which we use a nine year window when estimating whether the background of a new firm matters for survival and performance.

The incumbents in the final sample are classified as persistent innovators if they applied for a patent in at least three of the four years observed. Firms that applied for a patent in at least

one year, but not more than two years, are referred to as occasionally innovative. The remaining firms belong to the large group of non-innovators.

In an alternative specification, we compare the results of the estimation in which the parent firms are observed over four years, with 12 years of observation of the incumbents, i.e. including data for the period before and after the creation of the new firms. Our assumption is that the longer perspective might provide additional information about the characteristics of the firms.

In the empirical analysis we only exploit one set of characteristics for the incumbent firms: persistent innovation, non-innovator or occasional innovator. This categorical variable enters into the regressions for the spinoffs together with human capital, physical capital, size, age, ownership structure, productivity, exports, industry classification and year dummies.

We employ three different types of estimators. First we use a non-parametric approach to compare the survival rates of the three categories of spinoffs. Second, we estimate a complementary log log survival model showing the likelihood that the start-ups will stay alive the first five years on the market. Our estimator considers the quality of the surviving new firms in terms of productivity performance during the first five-year period on the market. Here, our panel data estimators allow for both observed and unobserved individual heterogeneity and the results are compared with pooled OLS estimates.

Our paper is part of a recent literature exploring spillovers between incumbent firms and their spinoffs. The paper contributes by showing that an innovation strategy approach provides increased understanding on performance heterogeneity among new entrepreneurial ventures. For each spinoff, we observe a nine-year window, where the first four year is the

innovation strategy of their parent firm in the period before the entrepreneurial spawning, and the next five year is new firm formation's initial period in the business.

The main findings can be summarized as follows. Spinoffs from firms that are persistently engaged in innovation over the four year preceding the start-up, are not likely to survive more than other firms. When the long-run innovation strategy of the incumbents over a 12 year period is considered, there is some indication that innovative parents spawn more viable offsprings. However the result is not statistically significant. In contrast, our results provide strong evidence that employee start-ups from persistent innovators are more productive than other new ex-employee start-ups, everything else equal.

The structure of the paper is as follows. First we briefly review the mounting theoretical and empirical literature on spinoffs by ex-employees of incumbent firms. In the same section we present our theoretical arguments for performance heterogeneity among spinoff firms whose lineage is traced back to parent firms with three types of innovation strategies. In section three we present our data and empirical strategy. The results of our empirical analysis is provided in section four. Finally we summarize our findings and conclude in the last section.

2. LITERATURE REVIEW AND HYPOTHESES

2.1 Theoretical and empirical literature

Existing theoretical and empirical literature on spinoffs takes a bipolar perspective when investigating the *antecedents* and *consequences* of entry via a spinoff (Agarwal et al., 2004; Klepper and Sleeper, 2005; Klepper, 2007). Regarding both the antecedents and causes of employees leaving to start their own venture, and the consequences in terms of performance

of the new firms, characteristics of the parent firm have proven to be crucial (Burton, Sorensen and Beckman, 2002; Phillips 2002; Gompers, Lerner and Scharfstein, 2005).

Incumbent firms differ from each other in various dimensions that create asymmetric contexts in which employees are embedded, and their entrepreneurial abilities are cultivated. Place of employment may serve as a training ground for employees enabling them to acquire certain types of skills required for entrepreneurship (Agarwal et al. 2004; Klepper and Sleeper, 2005; Franco and Filson, 2006; Elfenbein, Hamilton, and Zenger, 2010) or affect employees' perception towards entrepreneurship by providing an interactive social environment (Nanda and Sorensen, 2010).

In contrast, place of employment may even hinder employees from undertaking entrepreneurial behavior by influencing their entrepreneurial aptitude (Sorensen, 2007), limiting the breadth of their skill sets with narrowly defined jobs (Baron, Davis-Black and Bielby, 1986; Lazear, 2005; Sorensen, 2007), and increasing their opportunity cost of leaving (Andersson, Baltzopoulos, and Lööf, 2012) through enhancing employees' career stability by developing well defined internal labor markets (Doeringer and Poire, 1971) and elaborate promotional paths.

Among various reasons that affect the decision of employee to become entrepreneurs reviewing the prior literature reveals one dimension, namely knowledge inheritance, that is highly connected to the performance of entrepreneurial spawns as well (Phillips, 2002; Agarwal et al, 2004; Klepper and Sleeper, 2005; Klepper, 2007). Prior work suggests that firms with abundant stock of knowledge are likely to possess greater information about the technological opportunities in an industry (Agarwal et al. 2004; Klepper and Sleeper, 2005).

Although the boundary of a firm limits the appropriation of knowledge by individuals outside the organization, individuals inside the organization are positioned to actually do so.

The public good nature of the information (Arrow, 1962) makes incumbent firms imperfect repositories of knowledge (Agarwal et al. 2004), since once the knowledge is created it will be acquired by individuals inside the organization. Profit seeking individuals inside organizations are therefore likely to take advantage of their insider status and exploit that knowledge in the market (Venkataraman, 1997) by establishing new ventures. Klepper and Sleeper (2005) in fact show that individuals in firms that possessed specific knowledge about the laser industry (measured by retaining 10 or more patents) are likely to spinoff to produce lasers in a new venture. Similarly Gompers, Lerner, and Sharfstein (2005) show that a greater stock of knowledge corresponds to greater entrepreneurial spawning of venture capital backed firms in knowledge-intensive industries such as computers and medical devices.

Despite of the recurring theoretical theme that incumbent firms' investment in knowledge can create "knowledge corridors" (Venkataraman, 1997) through which employees can get exclusive access to entrepreneurial opportunities, transfer of incumbents' knowledge to entrepreneurial ventures through employee mobility gives competitive advantage to spinoffs relative to other entrepreneurial firms (Agarwal, Audretsch, and Sarkar, 2007) who start without such privileged access to incumbents' knowledge as well. In fact Agarwal et al. (2004) in their comparison of spinoffs with other entrepreneurial ventures entering the disk drive industry found that spinoffs outperform other entrants by having a greater likelihood of survival. Their analysis also shows that spinoffs have competitive edge over other entrepreneurial firms with respect to the inherited technological knowledge that they embody

in their products. Similar findings by Phillips (2002), Klepper and Sleeper (2005), Klepper, 2007, and Chatterji (2009) confirm the superior performance as well as higher survival rate of spinoffs relative to non-spinoff firms.

So far, with exception of the recent work of Andersson, Baltzopoulos, and Lööf (2012) and Ganco (2008), the emphasis of the prior literature on both the antecedents and consequences of entrepreneurial spawning has been on the stock of knowledge of the parent firms. What is less clear in the literature is the heterogeneity among incumbent firms with respect to their knowledge generating strategies or the structure of their knowledge base that may affect both the likelihood of entrepreneurial spawning and performance of spawned ventures.

In the following sub section we theorize about the relationship between knowledge generating strategies of incumbent firms and the performance of entrepreneurial spawns. We argue that firms which continuously engage in research and development will have a different impact on the performance of entrepreneurial spawns than firms which occasionally engage in knowledge generation and firms which simply do not invest in new knowledge at all.

2.2 Theory and Hypothesis

In this study, we distinguish between three types of firms with respect to their R&D behavior: firms that persistently invest in research and development, firms that occasionally invest in research and development, and firms that do not invest in research and development at all. The innovation strategy is associated with the issue of persistency of renewal efforts. This aspect refers to the argument that the continuity of development efforts facilitates the accumulation of knowledge, whereas disruptions of R&D engagement can cause the results

from previous efforts to be lost. Continuity ensures maintenance of both innovation routines and knowledge (Klette and Kortum, 2004).

One view of entrepreneurial spawning, as mentioned in the literature review, implies that continuous investments in new knowledge lead to a greater knowledge pool and therefore more entrepreneurial opportunities for employees. In other words, at least a portion of investments in new knowledge by incumbents will be exploited by their own employees in the form of entrepreneurial ventures.

Persistent investments in research and development will help employees to develop a "knowledge corridor" that will facilitate the recognition of entrepreneurial opportunities and enhance their ability to understand and assimilate valuable information regarding entrepreneurial opportunities (Roberts, 1991; Agarwal et al. 2004). This view is consistent with prior findings in the employee entrepreneurship literature (Gompers, Lerner and Scharfstein 2005, Franco and Filson, 2006, Klepper and Sleeper, 2007) that generally indicate a positive relationship between incumbents' investment in research and development and the performance of spinoff firms.

Firms that invest continuously in R&D are also likely to develop absorptive capacity (Cohen and Levinthal, 1990) which enables them to identify and utilize external knowledge of technological and market opportunities. Moreover, persistent innovators engage in repeated usage of their R&D capacity over time (Katila and Ahuja, 2002) which makes employees who are exposed to such repeated R&D practices to develop deeper understanding of knowledge elements and concepts, make connections among them, and combine in novel ways that may not be apparent to employees of firms that occasionally innovate. Such deep

understanding of knowledge elements and concepts not only make employees to identify lucrative entrepreneurial opportunities (Gomper, Lerner, and Scharfstein, 2005) but may also make them more successful as entrepreneurs. Repeated R&D practices of persistently innovative firms are likely to increase and refine their employees' human capital and expertise as well. Therefore, the likelihood of committing errors when spinning out to build on the inherited knowledge from their parents (Klepper and Sleeper, 2005) is likely to be reduced for employees of persistently innovative firms.

According to knowledge spillover theory of entrepreneurship, entrepreneurial activity is likely to be greater where investments in new knowledge are relatively high (Acs et al., 2009). However it is also likely that the selection of better entrepreneurial opportunities is improved when the stock of knowledge is large or alternatively when the frequency of knowledge generation is greater.

Nevertheless an opposing argument on the success rate of spinouts from persistently innovative firms may exist. Firms with greater absorptive capacity are likely to better evaluate the value and potential of opportunities and commercialize the inventions of their employees in new markets, thereby curbing the frustration and subsequent departures of employees. Agarwal et al. (2004) put forward a related argument by showing that firms which invest in technological know-how and simultaneously identify new markets for those inventions will have a low rate of spinoffs. Moreover, extant literature shows that firms which persistently invest in R&D and innovation exhibit higher performance (Cohen 1995, Sutton 1997) and greater market value (Hall, Jaffe, & Trajtenberg, 2005).

Geroski, Machine, and Van Reenen (1993) report substantial long-term differences in the profitability of innovating and non-innovating firms. Firms with higher performance are likely to pay higher wages to their employees and therefore reduce dissatisfaction and employee departure. In addition, the greater market value (which is a forward looking measure of firm performance) associated with these firms makes working for them even more attractive in the future.

Building on these arguments Anderson, Baltzoploulos, and Lööf (2012) argue that firms with continuous investments in R&D increase the opportunity cost of employees leaving, which should have a differential force upon employees with different levels of ability. Employees with the highest ability may incur a substantial cost of leaving, implying that spinoffs from incumbent firms that continuously invest in R&D might be formed by employees possessing the lowest ability (Anderson, Baltzoploulos, and Lööf, 2012). Hence, the performance of spinoffs from incumbent firms which continuously invest in R&D may be affected by the low ability of their founders.

Taken as a whole, the above arguments illustrate two opposing forces with respect to investment in knowledge generation and performance of entrepreneurial spinoffs. Therefore, we create the following sets of competing hypothesis with respect to the survival and productivity of spinoffs.

Spinoff survival

H1a: *descendants of firms that persistently invest in innovation are more likely to survive than other spinoffs.*

H1b: *descendants of firms that persistently invest in innovation are equal or less likely to survive than other spinoffs.*

Spinoff productivity

H2a: *descendants of firms that persistently invest in innovation are more productive than other spinoffs.*
H2b: *descendants of firms that persistently invest in innovation are equal or less productive than spinoffs.*

Our dual test of performance using survival and productivity is linked to the mounting empirical findings that survival and economic performance of firms may not necessarily coincide with each other (Meyer and Zucker, 1989; Gimeno et al. 1997). Some firms with relatively good economic performance don't survive and some firms survive albeit poor economic performance. Most of the empirical literature aiming at shedding light at the performance of spinoffs only does so by comparing their hazard of exit.

In fact Gimeno et al. (1997) argue that the underlying determinants of survival and economic performance are not always the same. By developing a threshold model of firm survival, Gimeno et al. (1997) argue that although entrepreneurs who carry greater human capital due to their experience may have greater economic performance, they may dissolve their business because the level of their human capital may warrant attractive alternative employment opportunities. Our distinction between survival and economic performance therefore paints a more complete picture of the performance and longevity of spinoff firms.

In the next section we will describe the data and introduce the empirical methodology used in the econometric analysis reported in section 4.

3. DATA AND THE EMPIRICAL STRATEGY

3.1 Data and Sample

Our data is assembled from several sources. The first is register information on firms provided by Statistics Sweden and constructed from audited information based on annual reports. The second data source is official information on people employed in the Swedish labor. The third data we use is patent applications from the EPO worldwide database PATSTAT. Patents, whether granted or not are assumed to be a proxy for innovation and knowledge generating activities within the firm.[1] Our original data set includes observations on virtually all Swedish manufacturing and service firms between 1997 and 2008 and information on all employees in these firms. From this data we identify new ventures directly tied to another firms through employment migration. Interchangeably, these firms are labeled as entrepreneurial spawns, employee start-ups and spinoffs.

Following Andersson and Klepper (2012), the employee start-ups are recognized by observing ex-employees in both the parent company and the new firm. If they were a minority in the parent firm the year before the transition to self-employment, but a majority in the new firm the year after the transition, we consider these firms entrepreneurial spawns or spinoffs. The method starts by identifying whether a majority of people in a new firm in a particular year were also a minority in another firm the year before. If the parent firm still exists in the same year as the new firms starts, and if the new firm is not a result of a merger-process, then the start-up firm is considered a spinoff. New firms with more than 10

[1] Klette and Kortum (2004) maintain that patents and R&D are related across firms.

employees the first year on market are dropped in order to restrict the sample to independent spinoffs and to avoid capturing the probable effect of outsourcing and mergers and acquisitions.

In total, 11,727 spinoffs were created from 8,542 incumbent firms over the period 1998-2008. In order to have sufficient information on both the parent firms and their descendants, we restrict the analysis to four cohorts in order to track the incumbents for four years before the spawning and the new firms over a five year period. Thus, we use a nine-year window of observations in the regressions. The first cohort consists of spinoffs in 2001 and the last cohort spinoffs entered the market in 2004. This procedure is illustrated in Table 1.

We also report results for the new firm when the incumbents are classified by the innovation strategy over the whole 12 year period. This means that spinoffs might change parents when the analysis switches from short-run to long run classification. The advantage with observing the innovation strategy of the incumbents over 12 year instead of only 4 is that we can identify the innovation strategy more distinct. The drawback, however, is that we have to assume that the innovation strategy is the same before and after the spawning. Another problem with the 12 year window is the non-symmetric background information about the parent-firms for the five cohorts of spinoffs. In the case of the 2001 spinoffs, we observe the innovation strategy of the incumbents 4 year before the ex-employee exit and 8 year after, while the corresponding figures are 7 years and 5 years for cohort number 4.

3.2 Variables

There are two dependent variables in this study, and both are recognized as performance measures of a business in the literature. The first is *survival,* measuring the duration that a

firm remains in the business. The second is *productivity*, which measures the amount of value added that a firm produces given a set of inputs.

The key explanatory variable in this study is the *innovation strategy* of the incumbent firm. With respect to innovation strategies the incumbent firms are categorized in the three groups: *persistent innovators*, *occasional innovators*, and *non-innovators*. We define a company as persistently innovative if it applied for patents in at least three years of a four-year period. Firms that applied for patents in at least 1 year but not more than 2 in the four-year period are classified as non-regular innovative firms, or occasionally innovative firms. Other companies are defined as non-innovative.

In the alternative specification, a company is required to apply for a patent in at least 6 years of a twelve-year period to be considered a persistent innovator. Companies that applied for patents for 1-5 years within a twelve-year period are considered occasionally innovative. An additional requirement is that the alternative specification should include incumbents observed both before and after the creation of the new firms.

Our control variables are related to the characteristics of the spinoffs. In particular we control for the level of the *human capital* of spin offs, expressed as the fraction of employees with at least 3 years of education, *physical capital*, measured as log annual investment in machineries, *size* which is measured with the number of their employees and ownership, which distinguishes between non-affiliate and member of a domestic group, a domestic multinational group or a foreign multinational group.

We also control for the particular *industry* that the new firms have entered by following the OECD-classification which distinguishes between high-tech, high-medium-tech, low-

medium-tech, and low tech manufacturing and knowledge intensive services and other services. All parametric regressions include *year* dummies.

3.3 Summary statistics

Table 2 reports the summary statistics for the new firms spawned by incumbents, and distributes the statistics according to the innovation strategy of the incumbent parent firms observed 4 years before the spawning. The statistics indicate that the descendants of innovative firms have a somewhat larger average size at birth (4 employees versus 3,5 in firms linked to occasional innovators, and 3 employees in firm started by people from non-innovative firms) and that this gap increase over time. The average firm size during the first five year on the market is 15 for descendants from persistent innovators compared to 6-7 for the two other categories on new firms. Not surprisingly, the more sizeable spinoffs from persistent innovators have also lager value added. In the productivity regression, we estimate the difference on value added controlling for size.

Moreover, firms started with the inherited knowledge from regularly innovative parents, are more human capital intense. It is also notable that around 40 percent of these firms belongs to multinational groups, compared to 20 percent of the firms associated with temporary innovators and less than 10 percent in the remaining group. The typical entrepreneurial venture cultivated in a milieu of persistent innovation can be found in the knowledge intense business service sector (38%). But somewhat unexpected, entrepreneurs from non-innovative are even more likely to start a knowledge business service firm (43%). The fraction of ex-employees from temporary innovators that enter this market is 31%.

One out of five spinoffs from innovative parents (persistent and temporary) have started their business in high technology or high medium technology manufacturing, compared to one out of 32 for the third group of spinoffs.

The summarizing finding from the descriptive statistics is that most spinoffs are service firms. Moreover, the stock of knowledge of the parent firms - indicated by patent – influences the market choice of the spinoffs. Considering high- and high medium technology manufacturing, and knowledge intense business services as the most knowledge demanding areas in the economy, the table shows a clear pattern: 61% of the descendants from persistent innovators have entered these markets, compared to 50% of the ex-employees from temporary innovators and 46% from non-innovative firms.

3.4 Empirical strategy

The objective of the study is to analyze how the particular innovation strategies or innovation activities of incumbents influence the performance of their 4,077 unique spinoffs. First, we explore survival rate of the new start-ups with the nonparametric Kaplan-Meier estimator. The estimates show probability of survival after year 2-5 for the three categories of firms, without taking any firm characteristics into account. We then continue this analysis by using the parametric complementary log-log model for discrete time. The complementary log-log is the preferred event duration model when events are measured in discrete time intervals. The model is well suited to the analysis of longitudinal datasets because it can accommodate both time-constant and time-varying independent variables (Jenkins 2004).

Our second focus is the influence of the parent firms on the productivity of the spinoff firms. The general model is a Cobb-Douglas production function. Three linear panel data

estimators are applied: pooled OLS, random effects and the Hausman-Taylor. Although the pooled OLS does not control for unobserved firm-specific fixed effects or potential endogeneity, we consider the OLS results to be a robust benchmark. The two other estimators accommodate both the individual heterogeneity, and the Hausman-Taylor is instrumental variable model which also control for endogeneity. A priori, we assume that the three estimators will give results with respect to the hypothesis on differences in spinoff productivity.

Formally, the empirical strategy employs the following three models:

$$\hat{S}(t) = \prod_{ti<t} \frac{n_i - d_i}{n_i} \qquad (1)$$

Equation (1) is the Kaplan-Meier nonparametric maximum likelihood of the probability that a spinoff will have a lifetime exiting *t*, S (t), and in our case t=2-5 years, n_i is number of firms prior to the time t_i, and d_i is number of deaths at time t_i.

$$\log\left[-\log(1-\lambda_{it})\right] = \alpha(t) + \beta' x_{it} \qquad (2)$$

Equation (2) describes the Complementary Log-Log model we use for testing the hypothesis that innovative firms spawn a larger fraction of survivors, where λ_{it} is the failure rate of a new firm *i* at time *t*, $\alpha(t)$ is the baseline failure rate as a faction of time, β is a vector of parameters measuring the influence of explanatory variables (x) on the baseline failure rate. The variable x includes dummy variables for the spinoffs from temporary and persistent innovators, and we use spinoffs from non-innovative firms as our reference group (baseline).

The coefficient estimates on the two dummy variables is odds ratios at failure at any point in time relative to the reference group.

$$y_{it} = \alpha_i + x_{it}^{'}\beta + \varepsilon_{it} \qquad (3)$$

Equation (3) is the panel data estimator, where y_{it} is the estimated (log) value added of firm *i* year *t*, α is the intercept and α_i indicates firm specific time invariant fixed effects, x_{it} is the explanatory variables which includes a categorical variable for the three groups of spinoffs that we consider, and e_{it} is the error term. We apply three different models for estimating equation (3), but only two account for the fixed effect.

4. RESULTS

In this section we present the results for the three different categories of employee spinoffs based on their parent firms' strategies. On average, these firms spawn about 1,000 new firms annually, and close to 75 percent survive the first critical five-year period. As noted earlier non-survival is not always a failure and companies may disappear from the market because of takeovers.

4.1 Survival analysis

Figures 1 and 2 present Kaplan-Meier survival curves for the 3 different types of spin offs based on the innovation strategies of their parent firms. Figure 1 observes the innovation-strategy of the incumbent during 4 years preceding the entrepreneurial spawning. Thus, for our first cohort, which is new firms started in year 2001, we classify their background based on observed patent applications by their parent firms between 1997 and 2000. The last

cohort of spinoffs in the paper entered the market in year 2004, and we consider the innovation activity of their parents between 2000 and 2003. Figure 2 reports survival estimates when the innovation strategy of the incumbents is observed over 12 years.

Each curve in the figures represents the fraction of each spinoff type surviving until a given age. While Figure 1 shows only small differences in survival rates, Figure 2 indicates that spinoffs with persistently innovating parents have a larger fraction of survivors. The difference between the two Kaplan-Meier estimates is associated with different parents in the short-run perspective and the long-run perspective on the innovation strategy.

In Table 3, we use a complementary log-log model and estimate hazard coefficients parametrically for the three categories of firms. In contrast to the Kaplan-Meier estimations, we now control for a set of firm characteristics. A lower hazard rate indicates that the firm is more competitive and more likely to survive. A hazard rate larger than one has the opposite interpretation. The left side of the table reports the results based on the short-period observation of firms' innovation strategies, while the right side uses observations of the parent firms over the 12 year period.

The complementary log-log estimates based on the short-run observation of incumbent innovation strategy, confirm the small difference in survival rates presented in Figure 2. The sizes of the estimates for spinoffs from both temporary and persistent incumbents are close to the reference group, and the small deviations are not significantly different from null. Thus, we reject the hypothesis that the descendants of firms that persistently invest in innovation are more likely to survive than other spinoffs. However, when the incumbents are identified by their 12 year innovation strategy, the size of the estimate for new ventures

associated with persistent innovators is 0.50, which indicates a larger likelihood of survival. This is also in accordance with Figure 2. But we consider this evidence weak since it is outside any acceptable level of significance. Moreover, the innovation strategy based on long-run observation of patent application implies that we consider the innovative milieu also after the exit of the ex-employees.

As could be expected, our results show survival is positively related to the spinoffs' level of value added, and their human capital intensity. More surprisingly is that independent firms are more likely to survive than new firms belonging to a group. One tentative explanation is that a larger fraction of group-members may disappear from the market because of takeover. The firm size is almost neutral to the chance of survival, while start-ups in low tech manufacturing have a significantly larger death-risk compare to firms in other sectors.

4.2 Productivity

Tables 4 and 5 test the hypothesis that firms spawn from milieus with a larger pool of knowledge are more productive entrepreneurs. The arguments include that these firms have better organizational capacity, more dense networks, and richer information about technological and market opportunities.

Using the short-period definition of the innovation strategies of the parent firms, Table 4 shows the labor productivity coefficients for five successive cohorts which survived the first five years.

The main message in Table 4 is that, on average, spinoffs from persistent innovators have 19-29 percent higher productivity than new ventures from non-innovative firms.[2] The size of the estimates for start-ups linked to temporary innovators is between 0.040-0.099, but not significant.

The results confirm the hypothesis that descendants of firms that persistently invest in innovation are more productive than other spinoffs. The result is consistent across the three models. Looking at Table 5 and the alternative long-run observation of the incumbents' innovation strategy, the main finding from Table 4 is confirmed. The only difference is that the coefficient estimates for firms started by employees from persistent innovators increases with a factor 2, approximately. Concerning firms linked to temporary innovators the coefficient estimates are almost the same in the two tables. Thus, in accordance with the survival results, the productivity estimates indicate a more important role of the innovation strategy of the father firm for the market success of the spinoffs when the innovation strategy is observed over a longer period. But our present database does not allow any clear conclusion on this issue.

5. CONCLUSIONS

Existing theoretical and empirical literature on the performance of spinoffs shows that the characteristics of the parent firms are crucial. The incumbent firm can be described as a womb which nourishes the employees with different kinds of knowledge. Depending on the particular organization of knowledge in the parent firm, and entrepreneurship among its

[2] Note that the point estimates for the innovations strategies should be interpreted as the exponential of the estimate.

employees, the latter may either be discouraged from exiting, or stimulated to exit and start a new venture.

While previous literature has explored the link between ex-employee start-ups and various aspects of managerial quality and knowledge within the incumbent firm, this paper explores the importance of persistence in innovation engagement. Our research builds on the literature documenting that firms that continuously engage in research, development and innovation will generate a greater pool of both codified information and complex, sticky and tacit knowledge. We argue that this distinguishes their impact on entrepreneurial spawning from firms that occasionally engage in knowledge-generation, and firms that simply do not invest in new knowledge-creation at all. However, there is no clear guidance from previous research on how this distinction influences survival and performance of the spinoffs.

This paper empirically examines a Swedish dataset that consists of four cohorts of about 4,100 spinoffs annually and their 3,300 parent firms. For each entrepreneurial venture, we observe the innovation strategy of the parent firm four years before the start-up, and we observe the performance of the new firm during the first five year in the business. The innovation strategy is defined by the frequency of patent applications during four years. In a comparison analysis, we extend the observation of patent applications to twelve years. But since this period covers innovation activities of the father firm also after the spinoff, we cannot draw any strong conclusions from the long-run innovation strategy.

The paper tests two dual hypotheses. The first is on survival and the other on productivity performance. The statistical test rejects the hypothesis that firms spawn by persistent innovators have a larger chance to survive during the first five years on the market,

compared to other spinoffs. No significant difference in survival rate between the three categories of spinoffs can be found, whether we apply the short-run or the long run observation of innovations by the incumbents. However, when identifying innovation strategy by 12 years of observations instead of 4, the size of estimate for spinoffs from persistent innovators gives some small support for the hypothesis that this group of firms has a greater survivability. Testing our second hypothesis, the result is quite clear: the descendants of sustainable innovative companies have a superior capacity to generate value added, controlling for employment, human capital, physical capital, ownership, industry classification and time-invariant fixed effects.

Earlier research has shown that spinoffs are a distinguished category of entrepreneurs. An increasing number of theoretical and empirical studies have linked the high quality of spinoffs to the knowledge pool of the father firms. Some recent studies have addressed the issue of correlation between variation in the size of this knowledge pool and the performance of the ex-employee start-ups. Our paper contributes to this literature by showing that the innovation strategy by the incumbents is crucial for the productivity performance of the spinoffs, but perhaps not for their survival. The knowledge spillover from persistent innovators to the economy through spinoffs is consistent with the learning and knowledge inheritance argument developed by earlier researchers.

How can we explain our inability to find significant survival difference among the three groups of spinoffs, when the productivity difference among the firms that have survived the first five years is substantial and highly significant? The success of both innovative and entrepreneurial activities includes a random component. One motivation for a spawn from an innovative milieu might be to test a new idea which does not fit into the core business of

the incumbent. If this idea holds for market testing, it can result in good earnings. Otherwise, it may lead to quick exit and another entrepreneurial attempt, or return to a more secure employment. In this case, the assumption is that the knowledge advantage that spinoffs have inherited from the parent is offset by the increased level of risk. Therefore, we won't see any differences in their survival rate.

Another reason might be related to data limitations. In particular with respect to survival of new ventures, we did not tease out different modes of exit. For instance it might be the case that highly productive spinoff firms, which according to our findings may come with greater knowledge assets, become a good target for acquisitions by large incumbent firms in the industry. We leave this issue for future research.

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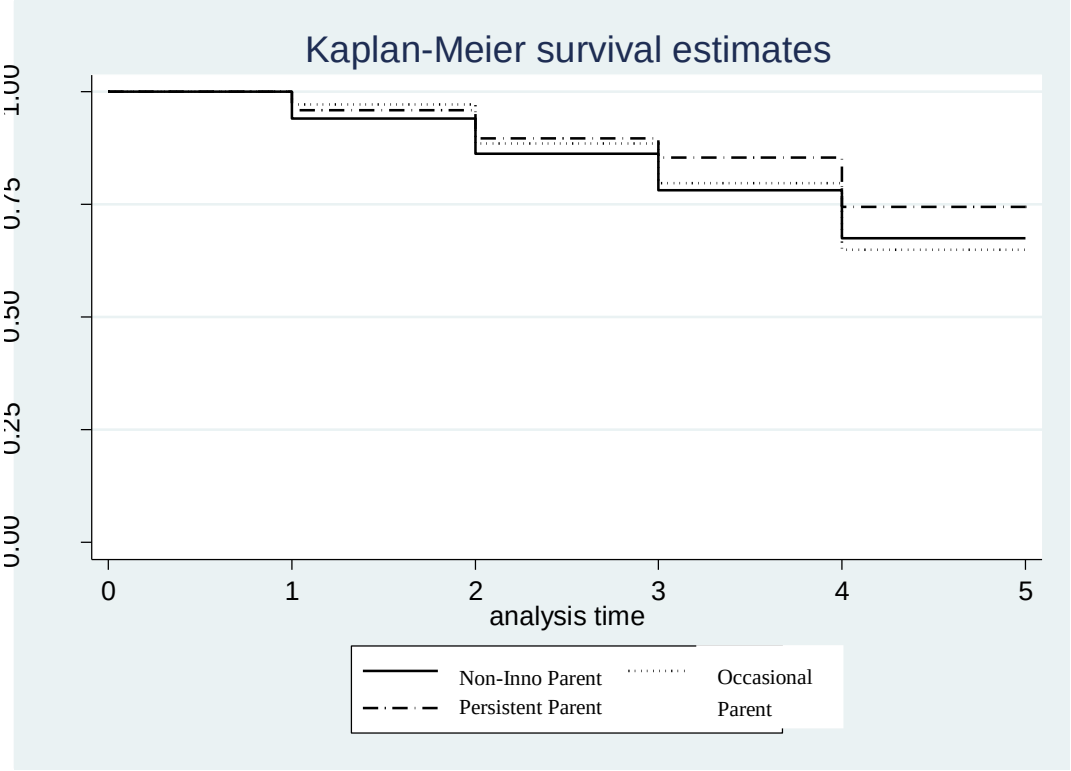
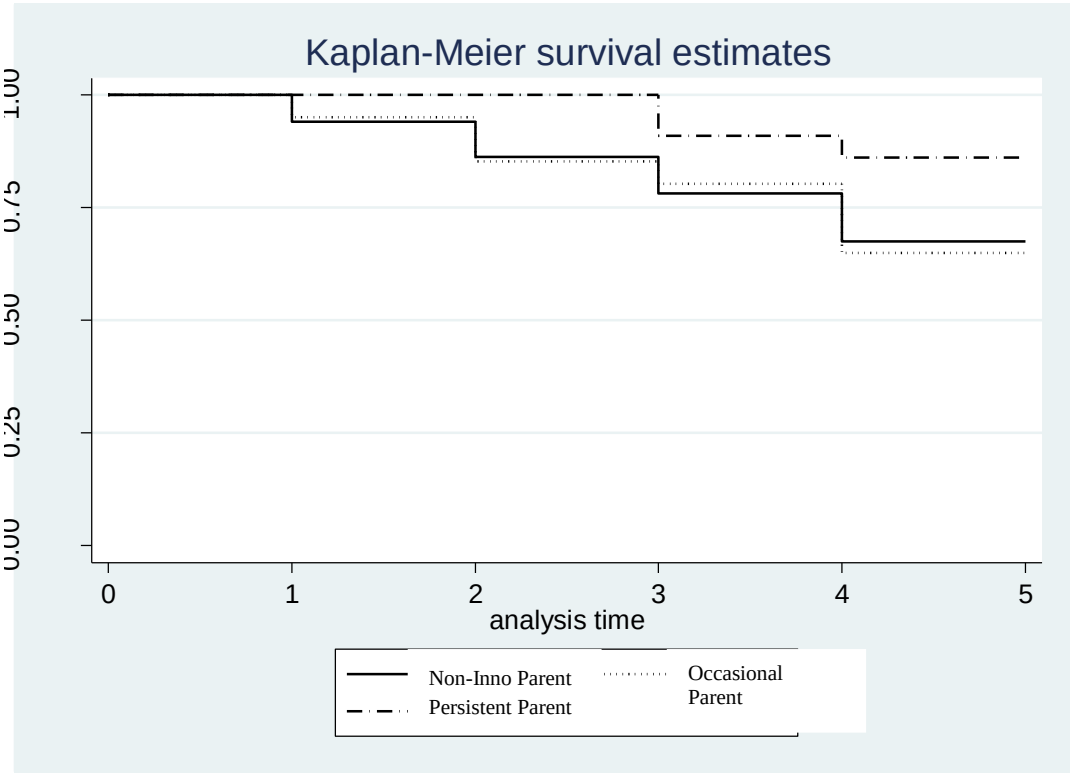
Figure 1



Note:

Kaplan-Meier survival curve of spinoffs, classified by the innovation strategy of the parent firms observed over four years preceding the start-up by ex-employees.

Figure 2



Note:

Kaplan-Meier survival curve of spinoffs, classified by the innovation strategy of the parent firms observed at 4-7 years preceding the start-up by ex-employees and 5-8 years after the start-up.

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Table 1: Cohorts of spinoffs created 1998-2008, survival and year of observation of incumbents and spinoffs in the study.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Surv
2001					***1038***	***999***	***922***	***828***	***783***				**0.75**
2002						***988***	***958***	***881***	***805***	***737***			**0.75**
2003							***1000***	***988***	***897***	***820***	***759***		**0.76**
2004								***1051***	***1020***	***939***	***858***	***793***	**0.75**

Note:

In total 11,727 spinoffs were created by 8,542 incumbent firms over the period 1998-2008. In order to have sufficient information on both the parent firms and their descendants, we restrict the analysis to four cohorts that we can follow over a five-year period. The first cohort consists of spinoffs in 2001 and the last cohort spinoffs in 2004. In total we have 4,077 unique spinoffs in the panel and 18, 064 observations.

We use 2 different methods for classifying the incumbent firms as persistent, temporary or non-innovative. The first is based on observations during the four-year period preceding the observed spinoff event, while the second is based on 12 years of observation, including a period before as well as after the spinoff event.

Table 2: Summary Statistics Spinoffs

Spinoffs	Persistent Innovator parents	Temporary innovator parents	Non-Innovator parents
Observations	183(38)	138(33)	17,743(4,011)
Log(Value added)	14.79	14.28	14.10
Firm size	14.82	6.83	5.56
Size at birth	4.08	3.46	3.01
Human capital	0.24	0.16	0.15
Log Physical capital	11.40	11.58	10.78
Uninational	13.66	20.29	15.57
Domestic MNE	16.93	8.70	3.67
Foreign owned MNE	22.95	11.59	4.14
Non-affiliate	46.45	59.42	76.61
Manufacturing: High tech	5.46	2.90	0.86
Manufacturing: High medium tech	17.49	15.94	2.25
Manufacturing: Low medium tech	12.02	13.04	3.97
Manufacturing: Low tech	3.82	7.25	4.46
Knowledge intense services	38.25	31.16	42.78
Other services	22.95	36.23	45.68
VA [a] (persistent)=VA(Occasional)	0.001[b]		
VA [a] (persistent)=VA(non-patening)	0.000[c]		
VA [a] (non-patenting)=VA(Occasional)	0.068[d]		

Note:

A firm is defined as having a persistent innovator parent if the parent firm has applied for a patent in at least three years over a four-year period.
(a) t-test, equality of means. Null hypothesis is that the means are equal. Rejected at the (b) 1% level, (c) 1% level and (d) 10% level.

Table 3: Complementary log-log survival model estimation results.

VARIABLES	Incumbents observed 4 years	Incumbents observed 12 years
Occasional[a]	1.092	1.166
	(0.319)	(0.260)
Persistent[a]	0.920	0.502
	(0.270)	(0.291)
Value added(log)	0.716***	0.716***
	(0.014)	(0.014)
Firm size	1.003***	1.003***
	(0.001)	(0.001)
Human capital	0.558***	0.560***
	(0.072)	(0.072)
Physical capital	0.981***	0.980***
	(0.006)	(0.006)
Domestic MNE[b]	1.299**	1.296**
	(0.171)	(0.170)
Foreign owned MNE[b]	1.260*	1.260*
	(0.163)	(0.163)
Non-affiliate[b]	0.642***	0.641***
	(0.044)	(0.044)
Manufacturing: High tech[c]	1.252	1.232
	(0.318)	(0.313)
Manufacturing: High medium tech[c]	0.729	0.724
	(0.155)	(0.154)
Manufacturing: Low medium tech[c]	0.996	0.990
	(0.140)	(0.139)
Manufacturing: Low tech[c]	1.487***	1.488***
	(0.170)	(0.170)
Knowledge intense services[c]	1.097	1.097
	(0.067)	(0.067)
Observations	14,992	14,992
Number of unique firms	4,077	4,077

Note:

*** p<0.01, ** p<0.05, * p<0.1, Standard errors in parentheses, Hazard ratios are reported.
Coefficient estimates >1 increased the likelihood of not surviving
Coefficient estimates <1 increases the likelihood of surviving

a) Reference group is non-patenting parent firms,
b) Reference group is firms belonging to a domestic group
c) Reference group is other services

Table 4: Productivity, spinoff firms. Innovation strategy by incumbents based on 4 years of observations

VARIABLES	(1) Pooled	(2) Random	(3) Hausman-Taylor
Occasional[a]	0.040	0.095	0.099
	(0.081)	(0.185)	(0.179)
Persistent[a]	0.176**	0.247**	0.252**
	(0.073)	(0.123)	(0.106)
Firm size (log emp)	0.067***	0.067***	0.067***
	(0.010)	(0.016)	(0.013)
Human capital	0.542***	0.541***	0.543***
	(0.039)	(0.066)	(0.103)
Physical capital	0.036***	0.026***	0.025***
	(0.002)	(0.004)	(0.003)
Domestic MNE[b]	0.325***	0.227***	0.222***
	(0.030)	(0.034)	(0.034)
Foreign owned MNE[b]	0.648***	0.499***	0.492***
	(0.063)	(0.094)	(0.078)
Non-affiliate[b]	0.788***	0.554***	0.540***
	(0.039)	(0.057)	(0.057)
Manufacturing: High tech[c]	0.097	0.078	0.076
	(0.095)	(0.131)	(0.147)
Manufacturing: High medium tech[c]	0.245***	0.178**	0.172*
	(0.040)	(0.084)	(0.092)
Manufacturing: Low medium tech[c]	0.061*	0.077	0.078
	(0.036)	(0.056)	(0.061)
Manufacturing: Low tech[c]	0.101***	0.109*	0.110**
	(0.036)	(0.061)	(0.053)
Knowledge intense services[c]	0.089***	0.090***	0.090**
	(0.017)	(0.031)	(0.035)
Observations	13,720	13,720	13,720
Breusch-Pagan LM test p-value		0.00	
Number of unique firms	2,744	2,744	2,744

Note:

*** p<0.01, ** p<0.05, * p<0.1, Standard errors in parentheses

a) Reference group is non-patenting parent firms,
b) Reference group is firms belonging to a domestic group
c) Reference group is other services

Table 5: Productivity, spinoff firms. Innovation strategy by incumbents based on 12 years of observations

VARIABLES	(1) Pooled	(2) Random	(3) Hausman-Taylor
Occasional[a]	0.032	0.083	0.087
	(0.078)	(0.124)	(0.117)
Persistent[a]	0.432***	0.543***	0.550***
	(0.119)	(0.170)	(0.212)
Firm size (log emp)	0.067***	0.067***	0.067***
	(0.010)	(0.017)	(0.001)
Human capital	0.540***	0.540***	0.542***
	(0.032)	(0.053)	(0.057)
Physical capital	0.036***	0.026***	0.025***
	(0.003)	(0.004)	(0.002)
Domestic MNE[b]	0.324***	0.227***	0.222***
	(0.032)	(0.031)	(0.025)
Foreign owned MNE[b]	0.644***	0.497***	0.489***
	(0.066)	(0.088)	(0.052)
Non-affiliate[b]	0.782***	0.549***	0.536***
	(0.057)	(0.062)	(0.050)
Manufacturing: High tech[c]	0.110	0.091	0.089
	(0.083)	(0.124)	(0.127)
Manufacturing: High medium tech[c]	0.249***	0.181**	0.175**
	(0.042)	(0.081)	(0.072)
Manufacturing: Low medium tech[c]	0.064*	0.081*	0.082
	(0.034)	(0.047)	(0.061)
Manufacturing: Low tech[c]	0.100***	0.108	0.108*
	(0.031)	(0.066)	(0.060)
Knowledge intense services[c]	0.089***	0.090***	0.090***
	(0.014)	(0.030)	(0.029)
Observations	13,720	13,720	13,720
Breusch-Pagan LM test p-value		0.00	
Number of unique firms	2,744	2,744	2,744

Note:

*** p<0.01, ** p<0.05, * p<0.1, Standard errors in parentheses

a) Reference group is non-patenting parent firms,
b) Reference group is firms belonging to a domestic group
c) Reference group is other services