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Spin-off:
Individual, Firm, Industry and Regional Determinants

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Spin-offs

Individual, Firm, Industry and Regional Determinants[1]

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Abstract

The extent and importance of spin-offs for industrial dynamics have been analysed in a number of previous studies, yet knowledge is surprisingly scarce about the determinants that trigger such entrepreneurial ventures. In the current analysis we use unique and detailed Swedish data to comprehensively explore how individual, firm, regional, and industry variables influence spin-offs during 1999-2005. In addition to the expected general positive impact of regional size and entrepreneurial culture, we find specific features for knowledge intensive manufacturing and service production on the propensity of employees to spin off a new venture. Moreover, we use an entropy measure to disentangle unrelated and related variety, and find that the former has a significantly negative impact while the latter a significantly positive effect on the propensity of the individual to start a spin-off.

Keywords: Spin-offs, entrepreneurship, industries, regions

JEL classification: D01, O12, O18, R10

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1. Introduction

Among several different types of entrepreneurial start-ups spin-offs, firms started by employees leaving a surviving incumbents, have been shown to have a higher survival rate, grow faster, generate more radical innovations, and to be critically important for cluster growth and dynamics. In short, spin-offs seem to perform considerably better than other start-ups.[5] Notwithstanding these insights and the potential societal value of spin-offs, knowledge concerning the underlying factors that trigger this particular type of entrepreneurial entry is surprisingly scarce. Previous research contributions often lack a coherent theoretical framework, while empirical studies apply a plethora of different methods and data at different levels of aggregation.

Our starting point is the work by Low and MacMillan (1988), who stressed that entrepreneurship is the outcome of actions of individuals being influenced by a combination of factors, particularly the organizational and regional context in which they operate. Hence, entrepreneurship analysis should combine multiple levels of data (Gartner 1985; Aldrich and Zimmer 1986).[6] This insight was basically neglected until recently when an empirically oriented research vein has emerged implementing data at different levels of aggregation.[7] Perhaps the most ambitious (in terms of scope) attempt to conduct a multi-level analysis of spin-offs is presented by Hyytinen and Maliranta (2008). Drawing on individual and firm level characteristics in the analysis, they show that in the case of the Finnish economy, small firms with low R&D intensity seem to spawn entrepreneurs more frequently than their larger R&D intensive counterparts. Elfenbein et al. (2010) provide further validation of these findings by suggesting a theory to explain the “small firm effect”.

We extend previous work by implementing data at the levels of the individual, the firm, the industry and the region. In particular, earlier analyses on spin-offs have disregarded how regional size, its knowledge endowments and the degree of regional industry specialization/diversity influence an individual’s decision to spin off a new venture from an existing incumbent. We implement a comprehensive micro-dataset which completely

[5] See Walsh et al (1996), Klepper (1996; 2001; 2005; 2007), Gompers et al (2005), Klepper and Sleeper (2005), Hellman (2006), Romanelli and Feldman (2006), Buenstorf and Klepper (2009) and Lerner (2009).
[6] More than a decade later Davidsson and Wiklund (2001) assessed whether Low and MacMillan’s (1988) call for micro/aggregate mix approaches has been heeded and found rather disappointing results, difficulties in gathering appropriate data being the main obstacle for such analyses.
[7] See Braunerhjelm (2011) for a survey.

describes the Swedish economy by linking all individuals to their place of work. Hence, we examine spin-offs across all industries of the economy rather than for a selected number of industries.

Another aspect that sets this paper apart from past studies is that it considers the decision of the individual by implementing highly detailed micro-level data. This approach allows controlling for characteristics of both the founder of the new firm and the incumbent firm when examining spin-offs, while simultaneously considering the regional context. Moreover, our approach implies that the decision to become an entrepreneur can be contrasted with the counterfactual. Prior studies that focus on the incidence of spin-offs alone fail to take into consideration people of similar backgrounds and characteristics that choose to stay in their current job, or switch to a different employer, rather than start a new venture.

Besides extending previous work we also add value by using a more straightforward measure of entrepreneurship. In the case of the Finnish study, entrepreneurs are identified indirectly by their participation in an insurance scheme for self-employed individuals. In the current study, firm ownership and entrepreneurial venture as opposed to employment can be directly observed in the Swedish data. The information available includes the exact type and location at the individual level, which allows for a multi-level analysis.

Our results suggest that the size of the region and local entrepreneurial culture have a positive effect on the propensity of the individual to set up a new venture. Implementing an entropy measure following Frenken et al (2007), we also show how local related industrial diversity exerts a positive impact on spin-offs while no such effect could be detected for diversity in general. The contrast is stark with respect to unrelated diversity, which is shown to have a statistically negative impact on spin-offs. Similarly, industrial specialization is shown to have a positive impact on spin-offs, however only in high-tech manufacturing and in knowledge intensive business service sectors. Hence, for less specialized and less knowledge intensive products the size of the market seems critical for entrepreneurial spin-offs, while it may be more important to carve out a specialized niche in knowledge intensive production.

Furthermore, corroborating the results of Hyytinen and Marinta (2008), smaller firms are shown to be more likely to spawn entrepreneurs. In general, individuals predominantly tend to leave less productive firms to become self-employed, with the exception of high-tech industries and more knowledge intensive firms where productivity of the incumbent plays no significant role. Our interpretation is that in low-productive firms employees make an active choice to become entrepreneurs based on perceived future pay-offs. In the knowledge intensive and high-tech industries, other factors dominate the decision to set up a new venture. Finally, and in contrast to the Finnish study, our measure of the incumbents' innovativeness (knowledge intensity of the firms' employees) is found to have a positive effect on the likelihood of individual spin-offs.

The rest of the paper is organized as follows. Section 2 outlines the theoretical framework while data, definitions and econometric method is presented in section 3. The following section 4 introduces the explanatory variables and section 5 presents the results. Section 6 summarizes and concludes.

2. Entry through spin-offs – A theoretical framework

An interesting theoretical framework to model spin-offs has been suggested by Klepper and Thompson (2010). The model builds on employees having limited but distinct influence on the strategies taken by a firm, that they receive noisy information resulting in heterogeneous learning among employees concerning the conditions in which the firm operates, and an individual strife to do what is "right" for the firm. However, as pointed out by Klepper and Thompson, Bayesian learning where individuals reveal their posterior means and fully incorporate them to each other's beliefs, would lead to identical revised posteriors across individuals. To allow for heterogeneity and disagreement as regards what is "right" for the firms, the authors assume that individuals are overconfident and that they tend to put more weight on private as compared to public signals.[8] Hence, disagreements may occur and trigger spin-offs in order to put the firm on the "right" track.

Even though the model is explicitly designed to capture individual differences and disagreement, it is also well designed to more generally structure the factors that influence spin-off decisions. It relates to the occupational choice model insofar as entry is determined by profit-maximizing agents, but it is a better designed and more comprehensive vehicle to explain spin-offs, and it extends the model beyond contractual arrangements.[9]

[8] Both of these assumptions have received considerable empirical support as accounted for in Klepper and Thompson (2010).

[9] For the full model , see Klepper and Thompson's (2007). Alternative theoretical explanations of entry through spin-offs related to contract theory, asymmetric information and adverse selection are presented by Anton and Yao (1995), Jovanovic and Nyarko (1995), Pakes and Nitzan (1983) , Amador and Landier (2003), Klepper and

Following Klepper and Thomson, the basic theoretical structure to depict entrepreneurial entry through spin-offs is as follows. By definition a spin-off occur from an already existing firm enrolling n employees, where the firm is undertaking activity *y*. Based on individual heterogenous abilities (Lucas 1978), originating in *i's* experience and education, *i* believes that *y* is the optimal strategy at time *t* for the firm to reach a target θ_{it}, $y = \theta_{it}$. Employees aim at maximizing the value (ν) of the firm, where $\nu = -(\theta - y)^2$. Thus, if the number of employees exceeds one, the actual activity undertaken by the firm is a weighted average of all employees' beliefs, $y = \bar{\theta}_t = \sum_{i=1}^{n} \varphi_i \theta_{it}$ where φ_i are the employee's decision weights assumed invariant over time, $\sum_{i=1}^{n} \varphi_i = 1$. The target at time *t* is unknown to all *n* employees but assumed to be drawn from a normal distribution with mean θ_t and variance σ^2. Hence, based on the respective employee's beliefs, the expected pay-off from a strategy $y = \theta_{it}$ is $\nu_{it} = -\sigma_{it}^2$. Taking into account the other *n* employees expected value of the firm yields the following expression for employee *i*,

$$E_{it} = -E_{it}[(\theta - \theta_{it})^2] = -E_{it}[((\theta - \theta_{it}) + (\theta_{it} - \bar{\theta}_t))^2]$$
$$= -E_{it}[(\theta - \theta_{it})^2] - (\theta_{it} - \bar{\theta}_t)^2 = -\sigma_{it}^2 - (\theta_{it} - \theta_t)^2 \qquad (1)$$

using the fact that any Bayesian posterior is unbiased, i.e. $E_{it}(\theta - \theta_{it}) = 0$.

If employee *i's* optimal strategy deviates from the weighed actual strategy decision taken by the firm, the likelihood of a spin-off increases. But disagreement with regard to strategies is not sufficient for a spin-off to take place, entry costs *c* must also be taken into account. For simplicity, Klepper and Thomson assume that employee *i* is considering to set up her own firm, either alone or together with individuals that have been identified to share the exact same beliefs. If the expected value of the spin-off (*w*), $E_{it}(w) = -c - \sigma_{it}^2$, exceeds the start-up costs *c*, a new firm will be spun off from an incumbent,

$$so_{it}^2 = (\theta_{it} - \bar{\theta}_t)^2 \geq c \qquad (2)$$

Sleeper (2005) and Chatterjee and Ross-Hansberg (2007), while Agarwal et al (2004) and Franko and Filson (2006) deal with effects of employee learning and imitation on spin-off activities.

Hence, the launching of a new spin-off (*so*) depends on the subjective evaluations of future pay-off and costs by individuals. Dynamics are introduced as heterogeneous individuals receive noisy information that will alter their expectations over time.[10]

Expected future prospects of existing firms are likely to be influenced by past performance at both the industry and firm level, i.e. whether the firm belongs to a declining industry as well as its position within an industry. Also individual characteristics such as level of education, tenure and wage level are likely to influence the evaluation of future performance of the firm as well as future prospects for a spin-off. With regard to expected costs (*c*) of starting a new venture, obviously the size and structure of the market can be expected to influence costs, as well as access to accurate inputs, entrepreneurial culture and specialization of local markets. These variables will be explained in detail in section 4 below and grouped at the regional, industrial, firm and individual levels.

3. Data and empirical design

Data and definitions

An unbalanced panel database compiled by Statistics Sweden and based on census data, tax declarations and firm registries is implemented. It is unique insofar as it covers all individuals and firms in the Swedish economy. It contains linked information on all firms, establishments and working individuals, as well as information on individuals' education, occupation, places of origin and residence together with organizational and financial data for firms and establishments.

What makes the Swedish data special is however the precise linkage among individuals and their working place allowing for highly detailed labour mobility analyses. Isolating the information on a single individual and comparing the information available at year t and $t+1$, it is possible to identify whether she has remained at the same job, switched into a different task in an already existing establishment within the same firm, taken up a position in an altogether different firm, founded her own firm or stopped working. Thus we can trace the incumbents that spawned all spin-offs in the economy. Similarly, we can compare the

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[10] More precisely, $i_{it} \equiv \theta + \varepsilon_{it}$ $(\varepsilon_{it} = N(o, \sigma_{\varepsilon}^{2}))$, where each individual believes that received information have the variance $\gamma\sigma_{\varepsilon}^{2}$ while other individuals' information have variance $\gamma\zeta\sigma_{\varepsilon}^{2}$.

founders of those to the individuals in similar environments that chose a different strategy, e.g. stay with the current employer or move to another. Moreover, the location of all firms is known, making it possible to include variables at different levels of aggregation.

The level of industrial aggregation implemented in the paper is at the 2-digit SNI-codes.[11] At the regional dimension we consider the 81 functional labour market regions in Sweden. These represent groupings of municipalities characterized by a high degree of self-contained flows of commuting workers. We will thus combine regional data on industrial structure and market size with data at the firm and individual levels.[12] The analysis is carried out for the period 1999-2005 and the focus of the research is on individuals that were employed at a firm at time *t* that still existed at time *t+1* and the change (or lack thereof) in their occupation between the two time periods. This approach is meant to exclude individuals from the population that were pushed into founding start-ups as an alternative to unemployment.

Exiting the workforce is quite straightforward; individuals not employed at a certain time period are not included in the database so people exiting from the panel from one time period to the next are classified as choosing to *Exit*. Individuals who stay in the same working position are surprisingly difficult to identify, even though this is the most common occupational choice and should be relatively simple to recognize. However, splits, merges, buy-outs, and internal reorganizing of firms introduce considerable turbulence in the identification codes of firms and establishments even if such changes have no or little effect on the employment of most individuals in the firms involved in these processes. We do not consider an individual to have left his previous employment unless both the establishment, and the firm in which the individual was previously employed, have changed taking into consideration both the location and the identification code of her working place. The cases in which establishments where an individual was working were bought, or acquired by a different firm, are identified as *Stay* since not much has changed from the point of view of the individual. Any change that might have come about was enforced rather than being the result of an individual choice. *Switching* is simply the act of going from being employed in a certain establishment in a certain firm to being employed in an entirely different one.

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[11] The SNI – Swedish Standard Industrial Classification codes used by Statistics Sweden correspond almost perfectly to the NACE -- Classification of Economic Activities in the European Community codes.

[12] See Davidsson et al. (1994); Malecki (1997); Casson (2003); Agarwal et al. (2004); Klepper and Sleeper (2005).

Spin-offs are the main focus of this paper. The use of individual-level data allows observing directly the transition of individuals from employment to entrepreneurship instead of using proxies.[13] We describe as *Spin-offs* the cases of individuals that go from being employees in a firm at time *t* to becoming owners of their own firm at time *t+1*[14]. Several drawbacks inherent in previous measures of entrepreneurship are overcome in this way. First of all, using rates of self-employment or business-ownership irrespective of timing grossly overestimates rates of entrepreneurship. For how long after having established a corporation can the founders still be considered to be of an entrepreneurial nature (if ever)? At which point of its cycle does a firm mature enough to be considered an incumbent rather than a starting firm? Second, linking start-ups to the founders and comparing them to their peers that chose a path different than the one of the entrepreneur, sets this study apart from all the rest that only consider one side of the story.

We do not include in the category of *Spin-offs* people becoming the owners of firms that were the result of splits from incumbent firms. A split is characterized by a significant number of employees leaving their former employment to form together a new firm. This phenomenon is rather rare and its significance rather doubtful. Firms will often choose to separate part of their operations from their core business creating new legal entities as part of their corporate strategy (i.e. outsourcing and off-shoring activities). Another explanation would be that a branch of a corporation chooses (and also manages, which is not always an easy feat) to sever the ties to the mother company and to pursue to offer its specific services to multiple clients. Either way, a split is the result of corporate strategy or group dynamics and may not be considered compatible with individual choices.

In Table 1 the employment choices of all working individuals at each time period are portrayed. When it comes to the issue of timing we assume that at the end of each year the individual decides his course of action for the following year. The choice made is then identified by comparing his employment status at year *t* and *t+1*. Therefore, the column labelled "1999" in Table 1 describes the choice of employment for 2000 of the 1720364

[13] Measuring entrepreneurship has proven to be no easy task and a variety of proxies have been used in the past by many studies. See for instance Audretsch (2002) who identifies some of the most commonly used proxy measures, i.e. self-employment rates, business-ownership rates, new-firm births or other measures of industry demographics.

[14] The term *spin-off*, just like that of entrepreneurship, has been defined in several different ways in relevant literature. Most notably in Klepper's work the term is used to describe groups of employees that break off from an incumbent to start a new firm in the same industry. Here, we impose no such restrictions, the size and growth performance of the new start-ups is a relevant question that goes however beyond the scope of the current paper.

people that were employed in a firm in 1999; 79.3% of those remained in the same job position, 14.1% switched to being employees in a different firm, 6.4% stopped working, and 0.3% (i.e. slightly more than 5000) started their own venture.

Considering the percentages in Table 1 no strong temporal trends seem to emerge. The incidence of spinning-off exhibits a clear increase in the last two years, although it remains a relatively rare occurrence at an average of 0.4%. The percentage of people choosing to *Switch* to different forms of employment exhibits an almost steady decline until 2003 only to slightly rise again in 2004. The ratio of people deciding to *Stay* is slightly higher after 2001 than before while the ratio of those *Exiting* seems to fluctuate around 7 per cent.

Table 2 summarizes the choices of the pooled sample per industry category and size of the originating firm. Although the actual values of the percentages change between industry categories, certain tendencies can be identified. The percentage of employees choosing to *Spin-off* consistently declines as the size of the firm increases, in all sectors. So does the percentage of people *Exiting* although the decline is not that pronounced in the third and fourth category. The propensity to *Stay* in the same firm increases with the size of the firm in all cases but that of the knowledge intensive business services (KIBS) firms.[15] The propensity to *Switch* seems to exhibit the greatest variance among the different industry sectors, dropping in some cases while the size of the firm increases and following the exact opposite trend in some others. Finally, it is worth noting that although large firms of more than 501 employees seem to deviate from most of the other trends, whether those are upward or downward ones, they fail to do so in the case of the choice to *Spin-off*. Entrepreneurial spin-offs seem to be a lot more likely to originate in small rather than large firms in all four industry sectors considered, which corroborates Glaeser and Kerr’s (2009) and Hyytinen and Maliranta’s (2008) findings.

Econometric models

Following Hyytinen and Maliranta (2008), at the end of each time period *t*, each employee, labelled *n*, is assumed to face the choice of what form of employment she would like to have in the next time period. She can decide to *Stay* in her current employment, *Switch* to a different employer, *Exit* from the workforce, or *Spin-off* and start her own firm. These four

[15] KIBS refers to NACE 72-74.

mutually exclusive alternatives make up the choice set of all employees, $C = \{stay, switch, exit, spin\ off\}$. In order to estimate the effect of the explanatory variables (elaborated in the following sections) on the choice of alternative $i \in C$, we need to formulate a discrete choice model.

Assuming that, by choosing alternative i, individual n obtains utility U_{ni}, the choice probability for this alternative is: $P_n(i) = P(U_{ni} \geq U_{nj}, \forall j \in C, j \neq i)$. We can assume further that this utility can be decomposed into an observed and unobserved part, i.e.: $U_{ni} = V_{ni}(a_i + \boldsymbol{x}_n; \boldsymbol{\beta}_i) + \varepsilon_{ni}$, where V_{ni} is a function of the alternative specific constant α_i, a vector of *case (individual) specific variables* $\boldsymbol{x}_n$, a vector of alternative-specific parameters $\boldsymbol{\beta}_i$ used to generate utility differences across alternatives, and ε_{ni} is the unobserved portion of utility, i.e. omitted factors and measurement errors. Under a linear-in-parameter specification, the choice probability of i becomes: $P_n(i) = P(\varepsilon_{nj} - \varepsilon_{ni} \leq a_i + \boldsymbol{x}_n{}'\boldsymbol{\beta}_i - a_j - \boldsymbol{x}_n{}'\boldsymbol{\beta}_j,\ \forall j \in C,\ j \neq i)$. In order to compute this probability for any value of the expression, $a_i + \boldsymbol{x}_n{}'\boldsymbol{\beta}_i - a_j - \boldsymbol{x}_n{}'\boldsymbol{\beta}_j$, we need to make an assumption on the distribution of the error terms.

A convenient solution with low computational cost is to assume that the error terms are distributed i.i.d. extreme value type I. This gives rise to logistically distributed error differences $\varepsilon_{nj} - \varepsilon_{ni}$ and a *multinomial logit* (MNL) choice probability:

$$P_n(i) = \frac{\exp(a_i + \boldsymbol{x}_n{}'\boldsymbol{\beta}_i)}{\sum_{j \in C} \exp(a_j + \boldsymbol{x}_n{}'\boldsymbol{\beta}_j)} \qquad (3)$$

The likelihood that the observed sample is realized is:

$$L_n(\boldsymbol{\alpha}, \boldsymbol{\beta}) = \prod_n \prod_{i \in C} \{\frac{\exp(a_i + \boldsymbol{x}_n{}'\boldsymbol{\beta}_i)}{\sum_{j \in C} \exp(a_j + \boldsymbol{x}_n{}'\boldsymbol{\beta}_j)}\}^{y_{ni}} \qquad (4)$$

where $y_{ni} = 1$ if individual n has chosen alternative i and zero otherwise. Since the model contains solely *alternative specific constants* ($\boldsymbol{\alpha} = \alpha_{stay}, \alpha_{switch}, \alpha_{exit}, \alpha_{spin}$) and alternative specific parameters ($\boldsymbol{\beta} = \boldsymbol{\beta}_{stay}, \boldsymbol{\beta}_{switch}, \boldsymbol{\beta}_{exit}, \boldsymbol{\beta}_{spin}$), it suffices to set $\alpha_{stay} = 0$, $\boldsymbol{\beta}_{stay} = \boldsymbol{0}$, and normalize the scale of utility (i.e. set $Var(\varepsilon_{ni}) = \frac{\pi^2}{6}$) in order for the MNL model to be identified.

The MNL model is however associated with certain drawbacks (Train, 2002); among others, the above model postulates a very strict substitution pattern between alternatives which is summarized by the property of *Independence from Irrelevant Alternatives (IIA)*. IIA dictates that choice probability ratio,

$$\frac{P_n(i)}{P_n(j)} = \frac{\exp(\boldsymbol{x}_n{}'\boldsymbol{\beta}_i)}{\exp(\boldsymbol{x}_n{}'\boldsymbol{\beta}_j)} \qquad (5)$$

between any pair of arbitrary alternatives $(i, j) \in C$ is independent of any alternatives other than i and j; consequently, when adding an alternative k in C the decrease in the choice probabilities of i and j will be such that the ratio $P_n(i)/P_n(j)$ will be unaffected.

This substitution pattern might appear unrealistic in the context of this study; for instance the probability ratio between *stay* and *spin* might be disturbed if the option *switch* is present in the worker's choice set. This issue is non-trivial and a recurring problem of discrete choice estimations which is why considerable space is devoted to addressing it.

Testing for the IIA assumption

First we carry out a series of IIA tests which have been performed to address how realistic the IIA assumption is in our case.The Hausman-McFadden (1984) test is based on repeating the MNL estimation for each choice subset $C_R = \{\alpha_1, \alpha_2, \alpha_3\}$, with alternatives $\alpha_1 \neq \alpha_2 \neq \alpha_3$ chosen from C. The restricted MNL estimation in each of these subsets yields a vector of ML estimators, $\breve{\boldsymbol{\beta}}_R = (\boldsymbol{\alpha}_R, \boldsymbol{\beta}_R)$, and a covariance matrix, $\boldsymbol{\Sigma}_R$. The Hausman-McFadden test statistic (MFH) is the quadratic form,

$$MFH = [\breve{\boldsymbol{\beta}}_U - \breve{\boldsymbol{\beta}}_R]'[\boldsymbol{\Sigma}_U - \boldsymbol{\Sigma}_R]^{-1}[\breve{\boldsymbol{\beta}}_U - \breve{\boldsymbol{\beta}}_R] \qquad (6)$$

where $\breve{\boldsymbol{\beta}}_U = (\boldsymbol{\alpha}, \boldsymbol{\beta}_U)$, $\boldsymbol{\beta}_U$ refers to the MLE sub-vector that can be obtained by dropping from the full model the elements (estimators) that correspond to the restricted model's excluded estimators, and $\boldsymbol{\Sigma}_U$ is derived from the covariance matrix of the full model, $\boldsymbol{\Sigma}$, by dropping the rows and columns that correspond to excluded parameters in the restricted model. It can be shown that, asymptotically, the MFH test statistic follows the χ^2 distribution with $r(\boldsymbol{\Sigma}) - r(\boldsymbol{\Sigma}_R)$ degrees of freedom, where r stands for the rank of the covariance matrix. However, there is no guarantee that the finite sample distribution of MFH is χ^2; actually, MFH can achieve negative values in finite samples. Despite negative values support IIA, the test results must be supported by an additional test, the suest-based Hausman (SBH) in order to reach safer conclusions.

We also perform the IIA test suggested by Small and Hsiao (1985). The test divides randomly the data set into two subsamples of roughly equal size; applying ML estimation under the MNL assumptions in the two full models yields two estimator vectors of equal size, $\widehat{\boldsymbol{\beta}}_{1F} = (\boldsymbol{\alpha}_{1F}, \boldsymbol{\beta}_{1F})$ and $\widehat{\boldsymbol{\beta}}_{2F} = (\boldsymbol{\alpha}_{2F}, \boldsymbol{\beta}_{2F})$. The estimation can be repeated in the second sample for each choice subset $C_R = \{\alpha_1, \alpha_2, \alpha_3\}$, with alternatives $\alpha_1 \neq \alpha_2 \neq \alpha_3$ chosen from C. For each restricted choice set we obtain $\widehat{\boldsymbol{\beta}}_{2R} = (\boldsymbol{\alpha}_{2R}, \boldsymbol{\beta}_{2R})$ and construct the Small-Hsiao (SH) test statistic,

$$SH = -2\left[L_R\left(\widehat{\boldsymbol{\beta}}_{12U}\right) - L_R\left(\widehat{\boldsymbol{\beta}}_{2R}\right)\right] \qquad (7)$$

where $\widehat{\boldsymbol{\beta}}_{12U}$ is obtained from $\widehat{\boldsymbol{\beta}}_{12F} = \frac{1}{\sqrt{2}}\widehat{\boldsymbol{\beta}}_{1F} + [1 - \frac{1}{\sqrt{2}}]\widehat{\boldsymbol{\beta}}_{2F}$ by dropping the estimators that correspond to the restricted model's excluded estimators, and L_R is the likelihood function of the restricted model.

The suitability of such formal tests based on restricted choice sets for applied work has received some criticism (Cheng and Long, 2007). The main argument against them is they often yield contradicting results. Since this is also the case for our specification (the IIA tests provide result no universal acceptance or rejection, see section 5) we also report the results from a Nested Logit (NL) structure[16] where, by construction, some correlation of the unobserved factors in the choice subset $C_A = \{stay, switch, exit\}$ is permitted. The rationale behind this modeling choice is that the error terms of these alternatives might contain a common characteristic, i.e. *the lack of entrepreneurial risk*. On the other hand, the alternative in the degenerate nest $C_B = \{spin\ off\}$ involves financial and perhaps legal risk not present in the other three decisions. This NL model assumes a more flexible Generalized Extreme Value (GEV) distribution for the error terms, which gives rise to the choice probability,

[16] The results of the NL estimation are available upon request.

$$P_n(i \in C_A) = \frac{\exp(V_{ni}/\lambda_A)[\exp(V_{n,stay}/\lambda_A)+\exp(V_{n,switch}/\lambda_A)+\exp(V_{n,exit}/\lambda_A)]^{\lambda_A-1}}{[\exp\left(\frac{V_{n,stay}}{\lambda_A}\right)+\exp\left(\frac{V_{n,switch}}{\lambda_A}\right)+\exp\left(\frac{V_{n,exit}}{\lambda_A}\right)]^{\lambda_A}+\exp(V_{n,spin\,off})} \quad (8)$$

for any $i \in C_B$ and:

$$P_n(spin\ off) = \frac{\exp(V_{n,spin\,off})}{[\exp\left(\frac{V_{n,stay}}{\lambda_A}\right)+\exp\left(\frac{V_{n,switch}}{\lambda_A}\right)+\exp\left(\frac{V_{n,exit}}{\lambda_A}\right)]^{\lambda_A}+\exp(V_{n,spin\,off})} \quad (9)$$

for the spin-off alternative. Note that it is possible to rewrite the choice probabilities of nest *A* as products of a marginal probability of choosing nest *A*, i.e. the probability of choosing a non-risky behavior, times the conditional probability of choosing a specific alternative given this non-risky behavior. Train (2002) suggests that $(1 - \lambda_A)$ is a measure of the strength of correlation of errors in the C_A nest. That is, if $\lambda_A = 1$, this correlation becomes zero and the above NL choice probabilities collapse to logit.[17] Since MNL is a special case of NL, testing MNL is intrinsic to the estimation of an NL model. The results of the test based on λ_A appear also in the result section, together with the NL parameter estimates. The p-value of this test suggests that, for a wide range of significance the NL structure we proposed above is superior to the respective MNL one.

The rest of MNL limitations discussed in Train (2002) are: i) the inability to capture random taste variation or ii) to handle dynamics in the unobserved factors. The first one is highly relevant in choice situations that involve *attributes* of the alternatives (alternative specific variables) which are not available in this study; although random taste variation can be handled with a more advanced (e.g. mixed logit) model, its presence is assumed away here.

Access to panel data allows the use of dynamic modelling approaches that incorporate the time dimension explicitly. However, Rhody (1998) and Dunn and Holtz-Eakin (2000) suggest limited gains from such methods. We therefore pool the data from all years and stick to the two traditional approaches discussed above: i) a straightforward MNL estimation with the inclusion of time dummies and ii) a NL consistent with Random Utility Maximization to account for the effects of entrepreneurial risk as an unobserved factor.

[17] For details on the NL normalization and identification, and a thorough investigation of the special case of partial degeneracy (a nest contains a sole alternative), see Hunt (2000).

4. Explanatory variables and hypotheses

As outlined in the theoretical framework, the determinants of spin-offs can be expected to appear at several levels. Below we will present and motivate the regional, industrial, firm and individual variables implemented in the analysis.

Regional level variables

Both non-pecuniary and pecuniary effects are associated with regions. As regards the latter, more sizeable markets implies a larger pool of potential customers, exploitation of economies of scale and allowing sunk costs to be spread over larger volumes of production. In addition, the probability of identifying unexplored market niches that target a particular segment of the markets increases.[18]

Regarding non-pecuniary aspects, an impressive number of studies support the allegation that knowledge spillovers are geographically bounded, pointing to the importance of spatial proximity and that knowledge is embedded in regionally immobile agents (Griliches 1979; Jaffe 1989; Audretsch and Feldman 1996; Audretsch and Stephan 1996; Keller 2002). Knowledge is thus partly tied to certain geographic entities and the size of the market has a direct effect on both the supply of opportunities and the feasibility of exploiting them. More recently, the knowledge spillover theory of entrepreneurship attempts to bridge these previous insights by making the supply of opportunities endogenous, stressing that the accumulation of new knowledge constitutes a potential source of opportunities that can be exploited by entrepreneurial individuals (Acs et al. 2009). The measure used to control for the size of the region is the log of the number of active workers in the region.

This particular conditioning variable however contains a lot more information than just the effect of the size of the market. Most importantly, the size of the region is assumed to capture the effect that the regional knowledge sources play on the propensity of the individual to become self-employed. There are two different measures of regional knowledge resources considered in the present research: First, the region’s knowledge intensity, measured as the ratio of employees with a tertiary education over the total number employees in the region,

[18] Urbanization/agglomeration is one of two processes found to have a consistently positive effect on regional start-up rates, the presence of small firms and economic specialization being the other (Reynolds et al.1994; Henderson and Thisse, 2004). Moreover, larger markets protect new ventures from hold-up costs of customer-specific customizations (McLaren, 2000).

and, second, R&D investments by private firms and universities. Both measures of knowledge resources are found to be highly correlated with the size of the region (ρ=0.87 and ρ=0.94 respectively) and their addition failed to improve the fit of the model[19].

A more specific aspect of non-pecuniary regional effects is related to the importance of a local entrepreneurial culture. Glaeser and Kerr (2009) conclude that environments dominated by smaller and independent firms are more conducive to entrepreneurship than environments hosting large monopolists. Rosenthal and Strange (2009) find a strong correlation between local average establishment size and subsequent employment growth through startups. Building on these findings, where the share of small firms is claimed to illustrate the attitudes towards small businesses, we implement an average firm size index (ASIZE),

$$ASIZE_{ij} = \frac{S_{ij}/E_{ij}}{\sum_j S_{ij}/\sum_j E_{ij}} \qquad (10)$$

where *S* refers to the numbers of firms and E is employment while – just as above - *i* is associated with the industry in region *j*. The ASIZE index could also be argued to control for scale effects, i.e. technology, in the respective industry. High values of the ASIZE index are indicative of a local industry populated by many small firms, while low values are indicative of fewer but larger firms that enjoy more market power.

Industry structure: Specialization versus diversity

Whether specialization or diversity of industries best promotes entry (and growth) is a topic of an ongoing debate (Baptista and Swann 1999; Feldman and Audretsch, 1999; Paci and Usai, 1999; Duranton and Puga, 2000; Klepper 2002; Rosenthal and Strange 2003; van Ort and Atzema 2004; van der Panne and van Beers, 2006).[20] Going back to Marshall (1890), and further emphasized by Arrow (1962) and Romer (1986), knowledge spillovers are suggested to be industry-specific and may hence only be appropriated in regions of high industry-specific concentrations (so called MAR externalities). Jacobs (1969) forwarded the opposite

[19] Note that the R&D data is only available for the period 2001 and temporal extrapolations are seldom trustworthy. Considering relative knowledge endowments (R&D per inhabitant) mitigates but does not extinguish the problem since correlation remains higher than 0.5 (at 0.69).

[20] Most trying to disentangle the effect of the different externalities have focused on either overall employment growth (Glaeser et al. 1992; Henderson et al. 1995; Dumais et al. 2002) or innovation output (Feldman and Audretsch 1999; van der Panne and van Beers 2006) overlooking the role of spatial externalities in entrepreneurial activity.

view, advocating that it is the knowledge exchange among a diverse spectrum of industries that facilitates experimentation and innovation by implementing established methods in novel ways.

Empirical analyses support both of these hypotheses albeit the evidence give slightly more weight to specialized regions in explaining entrepreneurship while the opposite seems to prevail for innovative activities[21]. We adopt a location-quotient as our measure of specialization. The production specialization index (PS) captures the relative specialization of each industry at the 2-digit NACE level in the respective region,

$$PS_{ij} = \frac{E_{ij}/\sum_j E_{ij}}{\sum_j E_{ij}/\sum_i \sum_j E_{ij}} \qquad (11)$$

where $i = 1, \ldots, 43$ for each industry branch, $j = 1, \ldots, 81$ for each functional labour market region and E = employment. A common normalization is to calculate the ratio $\frac{PS-1}{PS+1}$ which unlike (5) is balanced and restricted between -1 and 1.[22] Values of this corrected PS index larger than zero indicate a higher degree of industrial specialization compared to the national industrial composition, while values smaller than zero indicate the exact opposite.

Turning to diversity, it is important to distinguish between related and unrelated variety when considering the significance of Jacobs externalities. Although it is easy to picture technological breakthroughs in the manufacture of motorbikes finding their way into being applied in the manufacture of automobiles such, crossovers are hard to imagine between industries as unrelated as e.g. manufacture of wood pulp and knowledge intensive business services. Indexes that measure the local industrial diversity in general fail to capture the relatedness of the fields. Following Frenken et al (2007), we apply an entropy measure to capture related versus unrelated variety. The latter variety in each region is indicated by the entropy of the two-digit distribution, while related variety is indicated by the weighted sum of the entropy at the five-digit level within each two-digit class. Formally, if all five-digit sectors g fall exclusively under a two-digit sector i, then the entropy at the two-digit level, or unrelated variety (UV), (suppressing the regional subscript j for the moment) is given by,

[21] See Glaeser et al. (1992); Feldman and Audretsch (1999); Henderson and Thisse (2004); van Oort and Atzema (2004); van der Panne and van Beers (2006); Desrochers and Sautet (2008); Beaudry and Schiffauerova (2009).
[22] We apply the same standardization in the case of the ASIZE-index.

$$UV = \sum_{i=1}^{43} P_i \ln(\frac{1}{P_i}) \quad (12)$$

where P_i is the two-digit local employment share. Related variety (RV) as the weighted sum of entropy within each two-digit sector is given by,

$$RV = \sum_{i=1}^{43} P_i H_i \quad (13)$$

where

$$H_i = \sum_{g \in i} \frac{P_g}{P_i} \ln\left(\frac{1}{P_g / P_i}\right) \quad (14)$$

and Pg refers to the five-digit local employment shares. The two indexes increase with local unrelated and related variety, respectively.

Firm level variables

Hyyitinen and Maliranta (2008) discuss the literature on the effects of a firm's size and innovativeness on the probability to spawn entrepreneurs. Two contrasting views concerning the effect of the size of the firm are identified. On the one hand, according to Gompers et al. (2005), individuals working in small firms have more opportunities to develop entrepreneurial skills and build connections to networks of suppliers and customers by being involved in multiple processes within the firm. On the other, large firms are more prone to spawn entrepreneurs because they are incapable to identify, or unwilling to diversify on opportunities too far away from their main line of business or that constitute too radical innovations. A firm's innovativeness is also theorized to play an ambiguous role since individuals employed in R&D intensive firms stand better chances of identifying new technologies they may commercialize independently, but large firms are also more likely to take legal actions in order to prevent leakages of this sort and internalize any potential profits (Kim and Marschke, 2005).

In the following we construct six dummy variables to split the firm population into size classes. Ideally one would like to control for both innovative input and output. Input variables would include a description of a firm's investments in R&D as well as the number of researchers dedicated in the development of new products and processes. The output side would include the introduction of new products and/or processes in the market. Data of such fine detail, in particular a good measure of innovative output, is unfortunately extremely hard to obtain. The most commonly used measure of innovative output is the number of patents issued from a firm, an approach that despite some drawbacks (Pavitt, 1982; Schankerman 1998) has proven to be an acceptable way of measuring innovative output (Griliches, 1990). Unfortunately, such data is not available in the data set implemented. As a proxy for the innovativeness we therefore use the knowledge intensity of the firm, defined as the ratio of employees with a tertiary education over total firm employment.

In addition, controls for the age of the firm[23], the log of productivity defined as value added per employee, and four different industry dummies (manufacturing, low end services and KIBS), are also implemented in the analysis.[24] Two dummy variables capture whether the employment and/or the sales of the firm have been declining over the past two years. The Declining Employment dummy equals one if there has been a drop in a firm's employment between time *t* and *t-2* and the Declining Sales dummy equals one if there has been a drop in the sales of the firm between *t* and *t-2*. These two dummies are rather important controls that help capture any push-out effects caused by a decline in the business of the incumbent firm. Especially the choice to *Exit* can very often be involuntary and this is a way to control for whether the firm is downsizing or not.

Individual level variables

Finally we present the controls for the individual determinants most commonly referred to in the literature of entrepreneurship: tenure, age, age squared, sex (equal one if male, zero otherwise), wages and education (Berglann et al 2009). The individual's education level is capture by a set of seven dummy variables corresponding to the highest educational level attained as categorized by Statistics Sweden. The seven levels are: 1. primary and lower

[23] The age of the firm, similarly to individuals' tenure mentioned later, are left-truncated since the point of reference is the birth of the database in 1985 when observations were started been collected rather than when firms were created. The longest period attainable is therefore 18 years but adding a dummy variable to distinguish truncated firms did not improve the fit of the model.

[24] The 43 industry branches were grouped into these four categories in order to limit the number of controls.

secondary education, shorter than 9 years, 2. primary and lower secondary education, 9 (10) years, 3. upper secondary education 2 years or shorter, 4. upper secondary education, longer than 2 years but max 3 years. 5. post secondary education, shorter than 3 year, 6. post secondary education, 3 years or longer (excluding PhD), 7. PhD.

The independent variables included in the econometric analysis are summarized in Table 3. Roughly 15% of the population as described in Tables 1 and 2 had to be excluded due to missing data for certain variables[25]. Note that the summary statistics were taken after pooling the data in the period 1999-2004. Approximately 70% of the individuals included in the study are males; about a third of the individuals were employed in a firm exhibiting declining sales/employment; around a third of the population works in firms of fewer than 50 employees, a third in firms employing between 51 and 500 individuals and the remaining third in firms of more than 501 employees; the majority of the individuals (83.5%) work either in manufacturing or in low-end services.

5. Estimation results

In order to determine how the characteristics of the region and the firm in which an individual is employed affect the choice to become an entrepreneur, a MLN estimation is run on a matched employees-firms dataset describing the Swedish economy in the period 1999-2005. The dependent variable is the choice of one of the following alternatives: stay in the same job, switch to a new job, stop working, or become an entrepreneur (spin-off).

Carrying out the MNL estimation requires that one of the alternatives is used as the base outcome for normalization (here the base outcome was taken to be *Stay*). The parameter estimates can be used to compute the effect of changes in the case-specific variables on the choice probabilities, i.e. the marginal effect on the propensity to choose each one of the four alternatives considered.

All in all, choosing to *Spin-off* remains a rare occurrence and being able to explain even the slightest variations in the individual's propensity to choose that path is important. Table 4 reports these marginal effects along with their standard errors. Tables 5 and 6 present the

[25] Missing values were mainly due to imperfect reporting of the financial variables of some firms. After comparing kernel densities no pattern emerged distinguishing these firms in any way leading us to the assumption that there is no selection bias.

results of two important robustness checks. Table 5 also presents the marginal effects on the decision to *Spin-off* of the MNL regression applied on the set of individual, firm and regional level controls separately (models I, II, and III respectively) and compares them to the marginal effects of the complete model (model IV in Table 5 is a copy of the last column of Table 4). Table 6 reports the results of an alternative specification where: i) only two instead of seven education dummies are included, splitting the population in those with long university education (more than 3 years) and those without; ii) the log of the number of employees in a firm is used as a firm size control instead of the six size category dummies; iii) the knowledge intensity of the firm was excluded as a control. Presented in Tables 7 to 9 are the results of repeating the same steps as in tables 4 to 6 for the subgroup of individuals employed in high tech manufacturing and knowledge intensive business services in order to assess different tendencies in this group of entrepreneurs of potentially higher impact. Tables 10, 11 and 12 present the Hausman-McFadden, suest-based Hausman, and Small-Hsiao test results respectively. Table 13 presents the estimation results of the NL model, and Table 14 compares the marginal effects from the NL model to the respective estimates from MNL.

Notwithstanding that the focus of this paper is on the propensity of individuals to transcend into entrepreneurship - therefore the marginal effects reported in the fourth and last column of tables 4 and 7 - one can derive a host of observations from the rest of the analysis. The results of the MNL estimation on the effect of regional size on the propensity of individuals to *Spin-off* coincide with those from studies looking into aggregate firm birth rates, despite the novelty of the approach. The effect is positive and significant across all specifications and population groups. Together with the positive influence on *Switching* and the negative effect on *Staying* and *Exiting* the results suggest a much more mobile work force in large and dense markets. Urbanization externalities are thus found to have a strong positive effect on an individual's choice to become an entrepreneur even controlling for individual and firm heterogeneity.

Turning to the effect of the regional industrial composition it appears that MAR externalities have a positive effect on the propensity of the individual to *Spin-off* in the case of high-tech manufacturing and knowledge intensive business services but the effect vanishes when considering the entire economy. As for the effect of Jacobs externalities the findings are robust across all industry sectors. Unrelated variety may also capture the negative aspects of dense agglomerations such as congestion and high rents, has a negative effect on the propensity of the individual to choose to *Spin-off*. Related variety, assumed to capture knowledge externalities between diverse but related industries, is shown to have a positive and significant effect on the propensity to *Spin-off*. These results are partly in line with those of Baptista and Swann (1999) and Swann and Prevezer (1996), that find a positive effect of specialization on particular high-tech industries but mostly corroborate the findings of van Oort and Atzema (2004) that report a positive effect on ICT firm formation from both MAR and Jacobs externalities.[26]

Furthermore, it is interesting to note the consistently significant and positive effect of the ASIZE index on the propensity of the individual to become an entrepreneur. Even controlling for the size of the incumbents from where new firms are spawned, the regional average firm size still has a positive effect on local entrepreneurship. Similarly to Glaeser and Kerr (2009), a strong local entrepreneurial climate mirrored in the presence of many small firms increases the likelihood of employees starting their own firms, irrespective of the size of the firm they are employed in.

As regards the firm-level control variables, the results to some extents confirm those of Hyytinen and Maliranta (2008) but again a difference can be observed between entrepreneurs in general as compared to entrepreneurs in high tech sectors. Similarly to the Finnish study smaller firms are found to be more likely to spawn spin-offs since the marginal effect on *Spin-off* diminishes significantly as the size of the firm increases. As for the other choices there does not appear to exist any other consistent trend connected to the size of the firm. In the case of the Finnish data less productive and less innovative firms seem to be consistently more likely to spawn entrepreneurs, but this is not entirely the case in Sweden.

When considering the economy as a whole productivity has a negative effect on the choice to *Spin-off* but that is not the case in high-tech manufacturing and knowledge intensive business services. A firm's innovativeness, measured by its knowledge intensity, has a positive effect on the propensity to *Spin-off* across all industry sectors. These results partly corroborate those of Hyytinen and Maliranta (2008), and partly those of Gompers et al. (2005) who suggest that

[26] From an economic geographical point of view these results also seem to contradict previous findings claiming that the location choices of new firms play a de-agglomerating role since they are more likely to start away from current geographic centers of that particular industry (e.g. Dumais et al. 2002).

more productive high-tech firms, exhibiting a higher degree of knowledge intensity, are more likely to spawn entrepreneurs. Note that in both the current and in Hyytinen and Maliranta's (2008) study a direct measure of firms' innovativeness was not available. Here a firm's knowledge intensity was implemented as a proxy of innovativeness while in the Finnish study an R&D-dummy (equal to one if the ratio of R&D expenditures to turnover exceeded 3.5%, zero otherwise) was used instead. [27]

The age of the incumbent firm seems to play a very weak but negative effect on the propensity to *Spin-off* but only when considering the economy as a whole. Employees tend to remain in older firms rather than taking up positions in other firms (or stop working). When focusing on high-tech manufacturing and KIBS firms no such age effect is detected. Declining employment and sales obviously have a strong, negative effect on *Staying*. This push-out effect has, as expected, a positive and significant effect on all three other occupation choices.

As for the marginal effects of changes in the control variables of the individual characteristics the results are along the lines of previous findings and are also robust across all specifications and both groups of employees. Better educated males with shorter tenure exhibit the highest propensity to become entrepreneurs. Long tenure has a significantly positive effect on the probability of staying in one's current employment. These results could be influenced by the relatively strict Swedish legislation on work protection, i.e. those who have stayed in a firm for a long time enjoy a stronger protection as compare to those recently employed. The current wage of the individual, representing the opportunity cost of any change, has a naturally positive effect on *Staying* and a negative effect on all three other choices, including the transition to entrepreneurship[28]. Age has a non-linear impact on all four choices. Furthermore, men are a lot more likely to leave their current job and are more likely than women to *Switch*, *Exit*, or *Spin-off*. It is also interesting to note how the chance of *Staying* in the same position drops as the level of education increases. Instead *Switching* and *Spining-off* become more likely.

[27] However, as noted by Machin and van Reenen (1998), an industry's R&D intensity may determine the demand for skilled labor, which raises the question whether it is possible to disentangle the two effects when controlling simultaneously for the education level (skill) of the individual employee and the innovativeness of the firm.

[28] Although both an individual's current wage and the incumbent's productivity may be considered measures of one's opportunity cost they are not highly correlated (0.07).

Robustness of the IIA assumption

Turning next to the testing of the IIA hypothesis, the results of the formal tests described above are presented in Tables 10 to 12. These do not point to either universal acceptance or universal rejection of the IIA hypothesis (in accordance with the warnings of Cheng and Long, 2007). The balance does favour a rejection of the IIA. As a further test the NL specification described earlier is also estimated on a 10 percent sample of the population.[29] The results presented in Table 13 are followed by an LR test that strongly rejects the IIA assumption. Finally, Table 14 compares the marginal effects of the MNL and NL estimations. These are found mostly similar in direction, significance and magnitude. Noticeable differences concern the effect of related variety on *Switching* and of the incumbent's knowledge intensity on *Exiting* but the results on *Spinnig-off* that remain the focus of our attention are unchanged.

6. Conclusions

In this paper we sought out to examine the underlying factors that trigger spin-offs by considering three different levels of data aggregation; the region, the firm and the individual. A unique micro-dataset describing the Swedish economy in the period 1999-2005 made this analysis possible. The unit of analysis is the decision of the individual to leave her current wage-job in order start a spin-off in contrast to other employment alternatives, controlling for characteristics of the individual, of the firm she is currently employed in, and of the region she is currently living and working in.

Spin-offs are found to be a rare event; the probability that individuals will choose such a path is 0.43 percent, or somewhat higher (0.48 percent) if the analysis is confined to high tech manufacturing and knowledge intensive business services. In summary, the main findings of the empirical analysis are that individuals working in larger regions, characterized by sizeable markets, higher accumulation of knowledge resources and higher population density are more likely to venture into entrepreneurship. Industrial specialization seems to matter only in the case of high tech sectors while for the economy as a whole the strength of the entrepreneurial culture of the region has a positive influence on the propensity of the individual to become an

[29] The main reason the NL specification was not chosen as the main estimation technique for the analysis is the fact that it is extremely demanding in terms of computer memory and processing time and making it very unwieldy and impossible to apply to the complete dataset. The 10 percent sample implies approximately one million observations.

entrepreneur. Moreover, although past empirical studies have mostly found no significant benefits for entrepreneurship from Jacobs externalities, in this study, when an entropy measure was used to disentangle related and unrelated variety, the former was found to be positively correlated with increased chances of spin-off formation while the latter was shown to be negatively correlated.

The results partly coincide with a previous study by Hyytinen and Maliranta (2008) implementing Finnish data that however was limited to the characteristics of the individual and the firm, whereas no regional data was used. In the case of both Sweden and Finland the size of the incumbent firm is found to have an inverse effect on the probability that its employees will transcend into entrepreneurship. However, while the Finnish study reports that a firm's productivity and innovativeness are inversely related to the probability that it will spawn spin-offs this is not exactly shown to be the case for Sweden. When considering the whole economy we find that the productivity of the firm is indeed negatively related with the probability of spawning spin-offs but, interestingly enough, no such effect is found in the case of high-tech manufacturing and knowledge intensive business services. Finally, an incumbent's innovativeness, measured by the knowledge intensity of its labor force, has always a positive effect on the likelihood that its employees will choose to start a spin-off.

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Tables

Table 1. *Annual distribution of individuals' occupational choice for next time period*

Choice	**Year**						**Total**
	1999	*2000*	*2001*	*2002*	*2003*	*2004*	
Stay	1363365	1414839	1478238	1519827	1538078	1513636	8827983
	79.25%	78.63%	81.16%	81.44%	82.70%	81.70%	80.85%
Switch	241946	250991	225125	201530	192250	203500	1315342
	14.06%	13.95%	12.36%	10.80%	10.34%	10.98%	12.05%
Exit	109939	128411	112083	138534	121216	125746	735929
	6.39%	7.14%	6.15%	7.42%	6.52%	6.79%	6.74%
Spin-off	5114	5044	5939	6191	8241	9723	40252
	0.30%	0.28%	0.33%	0.33%	0.44%	0.52%	0.37%
Total	1720364	1799285	1821385	1866082	1859785	1852605	10919506

Table 2. *Distribution of individuals' occupational choice for next time period per industry sector and size of the originating firm*

(SNI 15 - 37) Manufacturing					
Size of the firm	Status Next Year				
	Exit	*Stay*	*Switch*	*Spin-off*	*Total*
0-10 employees	24667	268439	34515	1582	329203
	(7.49)	(81.54)	(10.48)	(0.48)	(100.00)
11-50 employees	40726	500495	64016	1901	607138
	(6.71)	(82.44)	(10.54)	(0.31)	(100.00)
51-100 employees	23342	322857	35682	856	382737
	(6.10)	(84.35)	(9.32)	(0.22)	(100.00)
101-250 employees	31297	466159	46525	935	544916
	(5.74)	(85.55)	(8.54)	(0.17)	(100.00)
250-500 employees	23785	370157	33998	666	428606
	(5.55)	(86.36)	(7.93)	(0.16)	(100.00)
501+ employees	89924	1442143	125773	2155	1659995
	(5.42)	(86.88)	(7.58)	(0.13)	(100.00)
Total	233741	3370250	340509	8095	3952595
	(5.91)	(85.27)	(8.61)	(0.20)	(100.00)

(SNI 38 - 64) Low-end services					
Size of the firm	Status Next Year				
	Exit	*Stay*	*Switch*	*Spin-off*	*Total*
0-10 employees	100542	933493	163695	8289	1206019
	(8.34)	(77.40)	(13.57)	(0.69)	(100.00
11-50 employees	88942	953365	174102	5444	1221853
	(7.28)	(78.03)	(14.25)	(0.45)	(100.00
51-100 employees	27833	316550	55962	1319	401664
	(6.93)	(78.81)	(13.93)	(0.33)	(100.00
101-250 employees	27915	348689	56899	1351	434854
	(6.42)	(80.19)	(13.08)	(0.31)	(100.00
250-500 employees	17914	229923	37306	725	285868
	(6.27)	(80.43)	(13.05)	(0.25)	(100.00
501+ employees	91665	1077903	153027	3020	1325615
	(6.91)	(81.31)	(11.54)	(0.23)	(100.00
Total	354811	3859923	640991	20148	4875873
	(7.28)	(79.16)	(13.15)	(0.41)	(100.00

Notes: Percentages in parentheses

Table 2. *(continued)*

(SNI 65 - 71) Financial and real-estate services					
Size of the firm	Status Next Year				
	Exit	*Stay*	*Switch*	*Spin-off*	*Total*
0-10 employees	6069	67828	9764	595	84256
	(7.20)	(80.50)	(11.59)	(0.71)	(100.00)
11-50 employees	4892	58909	9536	314	73651
	(6.64)	(79.98)	(12.95)	(0.43)	(100.00)
51-100 employees	2765	34732	4377	126	42000
	(6.58)	(82.70)	(10.42)	(0.30)	(100.00)
101-250 employees	3467	46653	6221	120	56461
	(6.14)	(82.63)	(11.02)	(0.21)	(100.00)
250-500 employees	1492	26442	2531	84	30549
	(4.88)	(86.56)	(8.29)	(0.27)	(100.00)
501+ employees	2483	30485	4189	93	37250
	(6.67)	(81.84)	(11.25)	(0.25)	(100.00)
Total	21168	265049	36618	1332	324167
	(6.53)	(81.76)	(11.30)	(0.41)	(100.00)

(SNI 72 - 74) Knowledge intensive business services					
Size of the firm	Status Next Year				
	Exit	*Stay*	*Switch*	*Spin-off*	*Total*
0-10 employees	25434	285059	51093	3341	364927
	(6.97)	(78.11)	(14.00)	(0.92)	(100.00)
11-50 employees	27272	281560	69137	3153	381122
	(7.16)	(73.88)	(18.14)	(0.83)	(100.00)
51-100 employees	12001	114376	30768	994	158139
	(7.59)	(72.33)	(19.46)	(0.63)	(100.00)
101-250 employees	14365	146102	35578	974	197019
	(7.29)	(74.16)	(18.06)	(0.49)	(100.00)
250-500 employees	9748	112260	27090	603	149701
	(6.51)	(74.99)	(18.10)	(0.40)	(100.00)
501+ employees	37389	393404	83558	1612	515963
	(7.25)	(76.25)	(16.19)	(0.31)	(100.00)
Total	126209	1332761	297224	10677	1766871
	(7.14)	(75.43)	(16.82)	(0.60)	(100.00)

Notes: Percentages in parentheses

Table 3. *Summary statistics of explanatory variables, 8566321 observations.*

	Mean	**SD**	**Min**	**Max**
Tenure	5.85	5.49	0	18
Age	40.39	12.31	16	99
Age^2	1782.99	1028.27	256	9801
Male	0.69	0.46	0	1
Log of wage†	12.25	0.66	4.60	17.07
Age of firm	10.48	5.21	2	18
Declining Employment	0.37	0.48	0	1
Declining Sales	0.28	0.45	0	1
Education lvl 1	0.08	0.27	0	1
Education lvl 2	0.14	0.35	0	1
Education lvl 3	0.32	0.47	0	1
Education lvl 4	0.24	0.43	0	1
Education lvl 5	0.12	0.32	0	1
Education lvl 6	0.10	0.30	0	1
Education lvl 7	0.004	0.07	0	1
Size 1-10	0.15	0.35	0	1
Size 11-50	0.20	0.40	0	1
Size 51-100	0.10	0.29	0	1
Size 101-250	0.12	0.33	0	1
Size 251-500	0.09	0.28	0	1
Size 501 +	0.34	0.47	0	1
Industry category 1	0.40	0.49	0	1
Industry category 2	0.44	0.50	0	1
Industry category 3	0.03	0.17	0	1
Industry category 4	0.13	0.34	0	1
Knowledge intensity*	0.10	0.15	0	1
Log of productivity**	6.12	1.10	-2.30	12.15
Log of regional size	11.00	1.41	5.78	12.98
PS index	0.09	0.28	-0.99	0.97
UV index	3.01	0.10	2.10	3.18
RV index	1.86	0.23	0.88	2.18
ASIZE index	-0.14	0.40	-0.98	0.78

**Number of observations: 8565090, **number of observations: 8529729 (due to loss of observations when taking ratios where the denominator equals zero or taking logs of negative numbers), †wage in 1000s of Swedish Kronas.*

Table 4. *MNL Estimation. Marginal effects*

Variable	**Stay**	**Switch**	**Exit**	**Spin-off**
Tenure	1.009***	-0.796***	-0.183***	-0.029***
	[0.003]	[0.003]	[0.002]	[0.001]
Age	1.073***	-0.309***	-0.819***	0.055***
	[0.007]	[0.006]	[0.004]	[0.001]
Age2	-0.012***	0.001***	0.010***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Male†	-1.420***	0.864	0.286***	0.272***
	[0.024]	[0.020]	[0.014]	[0.004]
Log of wage	7.038***	-2.293***	-4.444***	-0.301***
	[0.022]	[0.017]	[0.011]	[0.003]
Education lvl 2†	-1.551***	2.360***	-0.914***	0.104***
	[0.068]	[0.064]	[0.022]	[0.012]
Education lvl 3†	-2.084***	2.471***	-0.556***	0.168***
	[0.061]	[0.057]	[0.022]	[0.011]
Education lvl 4†	-2.725***	2.709***	-0.215***	0.231***
	[0.065]	[0.061]	[0.024]	[0.013]
Education lvl 5†	-4.581***	3.939***	-0.279***	0.363***
	[0.079]	[0.074]	[0.030]	[0.018]
Education lvl 6†	-5.734***	5.540***	-2.370***	0.431***
	[0.092]	[0.087]	[0.034]	[0.022]
Education lvl 7†	-6.903***	5.473***	-0.876***	0.544***
	[0.252]	[0.220]	[0.139]	[0.063]
Age of firm	0.146***	-0.106***	-0.039***	-0.0001**
	[0.002]	[0.002]	[0.001]	[0.000]
Declining Employment†	-1.348***	0.840***	0.464***	0.044***
	[0.026]	[0.021]	[0.015]	[0.005]
Declining Sales†	-2.705***	2.020***	0.633***	0.052***
	[0.029]	[0.024]	[0.016]	[0.005]
Log of Productivity	0.754***	-0.521***	-0.224***	-0.008***
	[0.009]	[0.007]	[0.005]	[0.002]
Knowledge intensity	-0.870***	0.432***	0.274***	0.163***
	[0.095]	[0.075]	[0.058]	[0.014]
Size 11-50†	-1.646***	1.290***	0.443	-0.088***
	[0.040]	[0.033]	[0.023]	[0.005]
Size 51-100†	-2.274***	1.635***	0.784***	-0.144***
	[0.051]	[0.043]	[0.030]	[0.006]
Size 101-250†	-2.183***	1.625***	0.743***	-0.184***
	[0.049]	[0.041]	[0.028]	[0.005]
Size 251-500†	-2.191***	1.557***	0.818***	-0.200***
	[0.055]	[0.046]	[0.032]	[0.006]
Size 501 +†	-1.384***	0.950***	0.724***	-0.290***
	[0.038]	[0.031]	[0.022]	[0.005]
Log of regional size	-0.414***	0.308***	0.081***	0.025***
	[0.015]	[0.007]	[0.005]	[0.003]
PS index	0.553***	-0.371***	-0.196***	0.014
	[0.050]	[0.041]	[0.027]	[0.010]
UV index	3.479***	-2.810***	-0.379***	-0.290***
	[0.134]	[0.110]	[0.075]	[0.024]
RV index	-0.821***	-0.343***	0.338***	0.140***
	[0.100]	[0.082]	[0.056]	[0.018]
ASIZE index	-1.705***	1.642***	-0.171***	0.234***
	[0.054]	[0.044]	[0.030]	[0.011]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*
Y = Pr(Choice = 1)	*0.86897*	*0.08559*	*0.04117*	*0.00425*

*Notes: ***significant at 0.1%, **significant at 1%, *significant at 5%, †dummy variable, number of obs: 8527145, marginal effects and standard errors (in brackets) have been multiplied by 100.*

Table 5. *MNL estimation for individual-, firm-, and regional- level controls. Marginal effects.*

Variable	**Spin-off (I)**	**Spin-off (II)**	**Spin-off (III)**	**Spin-off (IV)**
Tenure	-0.035*** [0.001]	-	-	-0.029*** [0.001]
Age	0.061*** [0.001]	-	-	0.055*** [0.001]
Age2	-0.000*** [0.000]	-	-	-0.000*** [0.000]
Male†	0.301*** [0.004]	-	-	0.272*** [0.004]
Log of wage	-0.328*** [0.003]	-	-	-0.301*** [0.003]
Education lvl 2†	0.127*** [0.013]	-	-	0.104*** [0.012]
Education lvl 3†	0.181*** [0.012]	-	-	0.168*** [0.011]
Education lvl 4†	0.251*** [0.014]	-	-	0.231*** [0.013]
Education lvl 5†	0.375*** [0.019]	-	-	0.363*** [0.018]
Education lvl 6†	0.517*** [0.022]	-	-	0.431*** [0.022]
Education lvl 7†	0.595*** [0.066]	-	-	0.544*** [0.063]
Age of firm	-	-0.008*** [0.000]	-	-0.0001** [0.000]
Declining Employment†	-	0.028*** [0.005]	-	0.044*** [0.005]
Declining Sales†	-	0.048*** [0.005]	-	0.052*** [0.005]
Log of Productivity	-	-0.017*** [0.002]	-	-0.008*** [0.002]
Knowledge intensity	-	0.197*** [0.013]	-	0.163*** [0.014]
Size 11-50†	-	-0.142*** [0.005]	-	-0.088*** [0.005]
Size 51-100†	-	-0.212*** [0.006]	-	-0.144*** [0.006]
Size 101-250†	-	-0.265*** [0.005]	-	-0.184*** [0.005]
Size 251-500†	-	-0.289*** [0.005]	-	-0.200*** [0.006]
Size 501 +†	-	-0.425*** [0.005]	-	-0.290*** [0.005]
Log of regional size	-	-	0.024*** [0.003]	0.025*** [0.003]
PS index	-	-	-0.012*** [0.011]	0.014 [0.010]
UV index	-	-	-0.362*** [0.003]	-0.290*** [0.024]
RV index	-	-	0.182*** [0.002]	0.140*** [0.018]
ASIZE index	-	-	0.483*** [0.012]	0.234*** [0.011]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*

*Notes: ***significant at 0.1%, **significant at 1%, *significant at 5%, †dummy variable, marginal effects and standard errors (in brackets) have been multiplied by 100.*

Table 6. *Alternative specification (robustness check) MNL Estimation – marginal effects*

Variable	**Stay**	**Switch**	**Exit**	**Spin-off**
Tenure	1.030***	-0.811***	-0.188***	-0.031***
	[0.003]	[0.003]	[0.002]	[0.001]
Age	1.044***	-0.273***	-0.828***	0.057***
	[.007]	[0.006]	[0.003]	[0.001]
Age2	-0.011***	0.000***	0.011***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Male†	-1.342***	0.812***	0.263***	0.267***
	[0.024]	[0.020]	[0.014]	[0.004]
Log of wage	6.794***	-2.109***	-4.397***	-0.288***
	[0.021]	[0.017]	[0.011]	[0.003]
Educational Group 2†	-2.657***	2.245***	0.205***	0.207***
	[0.043]	[0.035]	[0.026]	[0.009]
Age of firm	0.126***	-0.091***	-0.033***	-0.002***
	[0.002]	[0.002]	[0.001]	[0.000]
Declining Employment†	-1.431***	0.895***	0.493***	0.043***
	[0.026]	[0.021]	[0.015]	[0.005]
Declining Sales†	-2.689***	2.012***	0.623***	0.054***
	[0.029]	[0.024]	[0.016]	[0.005]
Log of Productivity	0.731***	-0.508***	-0.214***	-0.010***
	[0.009]	[0.007]	[0.006]	[0.002]
Log of size of firm	-0.080***	0.051***	0.082***	-0.053***
	[0.005]	[0.004]	[0.003]	[0.001]
Log of regional size	-0.421***	0.313***	0.078***	0.030***
	[0.015]	[0.012]	[0.008]	[0.003]
PS index	0.618***	-0.418***	-0.205***	0.005
	[0.005]	[0.041]	[0.028]	[0.009]
UV index	3.484***	-2.825***	-0.372***	-0.288***
	[0.135]	[0.111]	[0.075]	[0.025]
RV index	-1.061***	0.504***	0.424***	0.133***
	[0.100]	[0.082]	[0.056]	[0.020]
ASIZE index	-1.370***	1.445***	-0.278***	0.199***
	[0.053]	[0.044]	[0.030]	[0.011]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*
Y = Pr(Choice = 1)	*0.86846*	*0.08582*	*0.04145*	*0.00427*

Notes: ***significant at 0.1%, **significant at 1%, *significant at 5%, †dummy variable, number of obs: *8524918, marginal effects and standard errors (in brackets) have been multiplied by 100.*

Table 7. *MNL estimation on high tech manufacturing and knowledge intensive services (SNI 29-33 and 72-74). Marginal effects*

Variable	Stay	Switch	Exit	Spin-off
Tenure	1.064***	-0.851***	-0.178***	-0.034***
	[0.007]	[0.006]	[0.003]	[0.001]
Age	1.249***	-0.403***	-0.895***	0.049***
	[0.016]	[0.014]	[0.007]	[0.003]
Age2	-0.014***	0.002***	0.012***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Male†	-1.037***	0.525***	0.242***	0.270***
	[0.053]	[0.045]	[0.027]	[0.009]
Log of wage	5.794***	-1.5381***	-4.010***	-0.246***
	[0.043]	[0.040]	[0.021]	[0.006]
Education lvl 2†	-2.519***	3.117***	-0.750***	0.152***
	[0.181]	[0.175]	[0.051]	[0.037]
Education lvl 3†	-2.725***	3.236***	-0.720***	0.209***
	[0.159]	[0.153]	[0.047]	[0.033]
Education lvl 4†	-3.455***	3.659***	-0.527***	0.323***
	[0.164]	[0.158]	[0.050]	[0.038]
Education lvl 5†	-4.662***	4.644***	-0.445***	0.463***
	[0.181]	[0.173]	[0.055]	[0.045]
Education lvl 6†	-4.858***	5.214***	-0.800***	0.444***
	[0.184]	[0.177]	[0.059]	[0.045]
Education lvl 7†	-5.892***	4.949***	0.355*	0.587***
	[0.363]	[0.334]	[0.11]	[0.100]
Age of firm	0.352***	-0.271***	-0.078***	-0.000
	[0.005]	[0.004]	[0.003]	[0.001]
Declining Employment†	-2.385***	1.711***	0.609***	0.065***
	[0.059]	[0.051]	[0.031]	[0.010]
Declining Sales†	-2.747***	2.132***	0.544***	0.071***
	[0.062]	[0.052]	[0.033]	[0.010]
Log of Productivity	0.577***	-0.437***	-0.141***	0.000
	[0.014]	[0.011]	[0.008]	[0.003]
Knowledge intensity	0.108	0.008	-0.228**	0.112***
	[0.140]	[0.116]	[0.080]	[0.021]
Size 11-50†	-2.610***	1.802***	0.848***	-0.039***
	[0.010]	[0.085]	[0.056]	[0.012]
Size 51-100†	-3.247***	2.229***	1.131***	-0.114***
	[0.123]	[0.106]	[0.071]	[0.013]
Size 101-250†	-2.936***	2.085***	1.053***	-0.204***
	[0.113]	[0.097]	[0.064]	[0.012]
Size 251-500†	-4.088***	2.972***	1.392***	-0.276***
	[0.125]	[0.108]	[0.071]	[0.011]
Size 501 +†	-2.729***	1.981***	1.108***	-0.359***
	[0.088]	[0.076]	[0.048]	[0.012]
Log of regional size	-0.835***	0.645***	0.176***	0.014*
	[0.034]	[0.029]	[0.018]	[0.006]
PS index	0.738***	-0.631***	-0.196***	0.089***
	[0.114]	[0.098]	[0.060]	[0.023]
UV index	4.292***	-3.218***	-0.653***	-0.421***
	[0.299]	[0.026]	[0.151]	[0.006]
RV index	0.598***	-0.821***	0.012	0.210***
	[0.230]	[0.198]	[0.120]	[0.004]
ASIZE index	2.025***	-0.969***	-1.294***	0.238***
	[0.148]	[0.123]	[0.081]	[0.027]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*
Y = Pr(Choice = 1)	*0.85362*	*0.10105*	*0.04052*	*0.00476*

*Notes: ***significant at 0.1%, **significant at 1%, *significant at 5%, †dummy variable, number of obs: 2019483, marginal effects and standard errors (in brackets) have been multiplied by 100*

Table 8. *MNL estimation for individual-, firm-, and regional- level controls on high tech manufacturing and knowledge intensive services (SNI 29-33 and 72-74). Marginal effects.*

Variable	**Spin-off (I)**	**Spin-off (II)**	**Spin-off (III)**	**Spin-off (IV)**
Tenure	-0.039*** [0.001]	-	-	-0.034*** [0.001]
Age	0.053*** [0.003]	-	-	0.049*** [0.003]
Age2	-0.000*** [0.000]	-	-	-0.000*** [0.000]
Male†	0.289*** [0.009]	-	-	0.270*** [0.009]
Log of wage	-0.263*** [0.007]	-	-	-0.246*** [0.006]
Education lvl 2†	0.201*** [0.042]	-	-	0.152*** [0.037]
Education lvl 3†	0.268*** [0.037]	-	-	0.209*** [0.033]
Education lvl 4†	0.423*** [0.042]	-	-	0.323*** [0.038]
Education lvl 5†	0.589*** [0.052]	-	-	0.463*** [0.045]
Education lvl 6†	0.631*** [0.051]	-	-	0.444*** [0.045]
Education lvl 7†	0.766*** [0.144]	-	-	0.587*** [0.100]
Age of firm	-	-0.008*** [0.001]	-	-0.000 [0.001]
Declining Employment†	-	0.052*** [0.011]	-	0.065*** [0.010]
Declining Sales†	-	0.069*** [0.011]	-	0.071*** [0.010]
Log of Productivity	-	0.000 [0.003]	-	0.000 [0.003]
Knowledge intensity	-	0.184*** [0.013]	-	0.112*** [0.021]
Size 11-50†	-	-0.092*** [0.012]	-	-0.039*** [0.012]
Size 51-100†	-	-0.179*** [0.013]	-	-0.114*** [0.013]
Size 101-250†	-	-0.278*** [0.011]	-	-0.204*** [0.012]
Size 251-500†	-	-0.354*** [0.011]	-	-0.276*** [0.011]
Size 501 +†	-	-0.466*** [0.012]	-	-0.359*** [0.012]
Log of regional size	-	-	0.023*** [0.007]	0.014** [0.006]
PS index	-	-	0.023 [0.026]	0.089*** [0.023]
UV index	-	-	-0.535*** [0.064]	-0.421*** [0.006]
RV index	-	-	0.281*** [0.049]	0.210*** [0.004]
ASIZE index	-	-	0.399*** [0.032]	0.238*** [0.027]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*

*Notes: ***significant at 0.1%, **significant at 1%, *significant at 5%, †dummy variable, marginal effects and standard errors (in brackets) have been multiplied by 100.*

Table 9. *Alternative specification (robustness check) MNL Estimation on high tech manufacturing and knowledge intensive services (SNI 29-33 and 72-74) – marginal effects*

Variable	**Stay**	**Switch**	**Exit**	**Spin-off**
Tenure	1.081***	-0.866***	-0.178***	-0.037***
	[0.007]	[0.006]	[0.003]	[0.001]
Age	1.233***	-0.380***	-0.903***	0.049***
	[0.016]	[0.014]	[0.007]	[0.003]
Age2	-0.013***	0.002***	0.012***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Male†	-1.075***	0.550***	0.247***	0.278***
	[0.053]	[0.045]	[0.028]	[0.009]
Log of wage	5.478***	-1.259***	-3.992***	-0.226***
	[0.046]	[0.039]	[0.020]	[0.008]
Educational Group 2†	-1.129***	1.256***	-0.264***	0.137***
	[0.065]	[0.054]	[0.036]	[0.012]
Age of firm	0.328***	-0.254***	-0.072***	-0.002
	[0.005]	[0.004]	[0.003]	[0.001]
Declining Employment†	-2.580***	1.835***	0.683***	0.062***
	[0.059]	[0.050]	[0.003]	[0.010]
Declining Sales†	-2.686***	2.115***	0.493***	0.077***
	[0.061]	[0.052]	[0.032]	[0.011]
Log of Productivity	0.545***	-0.416***	-0.126***	-0.003
	[0.014]	[0.011]	[0.008]	[0.003]
Log of size of firm	-0.146***	0.104***	0.112***	-0.070**
	[0.001]	[0.009]	[0.005]	[0.002]
Log of regional size	-0.825***	0.644***	0.159***	0.022***
	[0.034]	[0.029]	[0.018]	[0.006]
PS index	0.756***	-0.637***	-0.176**	0.057*
	[0.115]	[0.098]	[0.060]	[0.023]
UV index	4.154***	-3.016***	-0.709***	-0.429***
	[0.299]	[0.258]	[0.152]	[0.057]
RV index	0.526*	-0.816***	0.074	0.217***
	[0.231]	[0.198]	[0.120]	[0.043]
ASIZE index	2.459***	-1.312***	-1.331***	0.184***
	[0.145]	[0.121]	[0.080]	[0.028]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*
Y = Pr(Choice = 1)	*0.85313*	*0.10135*	*0.04067*	*0.00484*

Notes: ***significant at 0.1%, **significant at 1%, *significant at 5%, †dummy variable, number of obs: *2019257, marginal effects and standard errors (in brackets) have been multiplied by 100.*

Table 10. *The Hausman-McFadden IIA tests on the full MNL specification.*

Omitted Alternative	**MFH statistic**	**Degrees of freedom**	**Threshold value α=0.01**	**Evidence**
Switch	1200.00	68	97,2866	Reject IIA
Exit	-640.00	68	97,2866	Accept IIA
Spin	219.477	68	97,2866	Reject IIA

Table 11. *The suest-based Hausman IIA tests on the full MNL specification.*

Omitted Alternative	SBH statistic	Degrees of freedom	Threshold value α=0.01	Evidence
Switch	1.8e+04	70	99,0858	Reject IIA
Exit	5.0e+04	70	99,0858	Reject IIA
Spin	3590.872	70	99,0858	Reject IIA

Table 12. *The Small-Hsiao IIA tests on the full MNL specification.*

Omitted Alternative	$L_R(\widehat{\boldsymbol{\beta}}_{12U})$	$L_R(\widehat{\boldsymbol{\beta}}_{2R})$	**SH statistic**	**Degrees of freedom**	**Threshold value α=0.01**	**Evidence**
Switch	-9.00e+05	-8.99e+05	313.505	70	99,0858	Reject IIA
Exit	-1.41e+06	-1.41e+06	650.287	70	99,0858	Reject IIA
Spin	-2.09e+06	-2.09e+06	87.488	70	99,0858	Accept IIA

Table 13. *NL Estimation results*

Variable	**Switch**	**Exit**	**Spin-off**
Tenure	-0.038***	-0.020***	-0.065***
	[0.008]	[0.004]	[0.004]
Age	-0.018***	-0.075***	0.123***
	[0.004]	[0.017]	[0.009]
Age2	0.000***	0.001***	-0.001***
	[0.000]	[0.000]	[0.000]
Male†	0.036	0.031***	0.720***
	[0.009]	[0.008]	[0.037]
Log of wage	-0.124***	-0.417 ***	-0.595***
	[0.027]	[0.092]	[0.033]
Education lvl 2†	0.104***	-0.076***	0.319***
	[0.024]	[0.018]	[0.080]
Education lvl 3†	0.111***	-0.036***	0.479***
	[0.026]	[0.010]	[0.073]
Education lvl 4†	0.124***	-0.007	0.573***
	[0.028]	[0.007]	[0.076]
Education lvl 5†	0.170***	0.045***	0.790***
	[0.038]	[0.013]	[0.080]
Education lvl 6†	0.213***	0.010	0.759***
	[0.048]	[0.010]	[0.089]
Education lvl 7†	0.219***	0.097*	0.714***
	[0.052]	[0.038]	[0.222]
Age of firm	-0.005***	-0.005***	-0.002
	[0.001]	[0.001]	[0.003]
Declining Employment†	0.042***	0.041***	0.125***
	[0.010]	[0.010]	[0.034]
Declining Sales†	0.092***	0.070***	0.066
	[0.021]	[0.016]	[0.034]
Log of Productivity	-0.024***	-0.023***	-0.022
	[0.005]	[0.005]	[0.013]
Knowledge intensity	0.012	-0.004	0.367**
	[0.011]	[0.016]	[0.109]
Size 11-50†	0.054***	0.050***	-0.270***
	[0.013]	[0.013]	[0.041]
Size 51-100†	0.068***	0.074***	-0.403***
	[0.016]	[0.018]	[0.056]
Size 101-250†	0.063***	0.072***	-0.646***
	[0.015]	[0.017]	[0.058]
Size 251-500†	0.069***	0.079***	-0.634***
	[0.016]	[0.019]	[0.066]
Size 501 +†	0.043***	0.074***	-0.853***
	[0.010]	[0.017]	[0.046]
Log of regional size	0.016***	0.009**	0.002
	[0.004]	[0.003]	[0.019]
PS index	-0.009***	-0.006	0.0418
	[0.006]	[0.008]	[0.070]
UV index	-0.124***	-0.035	-0.696***
	[0.032]	[0.022]	[0.183]
RV index	0.009	0.040*	0.569***
	[0.012]	[0.018]	[0.136]
ASIZE index	1.642***	-0.171***	0.234***
	[0.044]	[0.030]	[0.011]
Additional controls	*Year and industry category dummies*	*Year and industry category dummies*	*Year and industry category dummies*
Nest parameter λ_A	0.356***		
	[0.079]		
LR test for IIA (λ_A = 1):	*Chi2(1) =* 55.03	*Prob >chi2* =0.000	

*Notes: ***significant at 0.1%,**significant at 1%,*significant at 5%, †dummy variable, number of obs: 852100*

Table 14. *Marginal effects, MNL versus NL at the mean observation vector*

Variable	Stay (MNL)	Stay (NL)	Switch (MNL)	Switch (NL)	Exit (MNL)	Exit (NL)	Spin-off (MNL)	Spin-off(NL)
Tenure	1.009	1.062	-0.796	-0.855	-0.183	-0.175	-0.030	-0.032
Age	1.074	1.055	-0.310	-0.351	-0.820	-0.771	0.056	0.067
Age2	-0.012	-0.012	0.002	0.002	0.011	0.010	0.000	0.000
Male†	-1.425	-1.434	0.866	0.779	0.286	0.279	0.273	0.376
Log of wage	7.038	7.006	-2.293	-2.441	-4.444	-4.267	-0.301	-0.300
Education lvl 2†	-1.551	-1.714	2.361	2.449	-0.914	-0.899	0.105	0.164
Education lvl 3†	-2.084	-2.084	2.472	2.570	-0.556	-0.488	0.169	0.248
Education lvl 4†	-2.725	-2.938	2.709	2.843	-0.215	-0.200	0.231	0.296
Education lvl 5†	-4.581	-4.562	3.939	3.853	-0.280	0.302	0.363	0.407
Education lvl 6†	-5.734	-5.160	5.540	4.873	-0.237	-0.103	0.431	0.389
Education lvl 7†	-6.904	-6.110	5.473	4.943	-0.887	0.804	0.544	0.363
Age of firm	0.146	0.147	-0.106	-0.102	-0.039	-0.044	-0.000	0.000
Declining Employment†	-1.349	-1.374	0.840	0.920	0.464	0.391	0.044	0.063
Declining Sales†	-2.705	-2.741	2.020	2.066	0.633	0.646	0.052	0.029
Log of Productivity	0.754	0.759	-0.521	-0.534	-0.224	-0.215	-0.009	-0.010
Knowledge intensity	-0.870	-0.392	0.433	0.257	0.274	-0.058	0.164	0.193
Size 11-50†	-1.645	-1.541	1.290	1.202	0.444	0.484	-0.088	-0.146
Size 51-100†	-2.275	-2.017	1.635	1.510	0.784	0.724	-0.144	-0.217
Size 101-250†	-2.183	-1.775	1.625	1.410	0.741	0.710	-0.184	-0.344
Size 251-500†	-2.176	-1.988	1.558	1.547	0.819	0.780	-0.200	-0.338
Size 501 +†	-1.385	-1.265	0.951	0.957	0.724	0.760	-0.290	-0.452
Log of regional size	-0.414	-0.435	0.308	0.355	0.081	0.079	0.024	0.025
PS index	0.553	0.242	-0.371	-0.211	-0.196	-0.054	0.014	0.023
UV index	3.480	3.393	-2.810	-2.792	-0.380	-0.241	-0.290	-0.359
RV index	-0.822	-0.846	-0.344	0.146	0.338	0.402	0.140	0.298
ASIZE index	..	..	..	..	..	..	..	..
Y = Pr(Choice = 1)	0.869	0.873	0.086	0.082	0.041	0.037	0.004	0.005