Post-acquisition dynamics of technology start-ups:

drawing the temporal boundaries of post-acquisition restructuring process

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Abstract

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1. Introduction

Over recent decades, technology acquisitions have been an important corporate instrument for firms to source external technologies and capabilities (Lindholm, 1996; Chaudhuri and Tabrizi, 1999; Desyllas and Hughes, 2008). The strategic management literature emphasizes the critical role of post-acquisition implementation and integration strategies in deciding acquisition outcomes (Jemison and Sitkin, 1986; Pablo, 1994; Paruchuri et al., 2006; Puranam et al., 2006; Graebner et al., 2017). However, no consensus has yet been reached when it comes to the outcomes of technology acquisitions (see e.g. Ahuja and Katila, 2001; Hagedoorn and Duysters, 2002; Zhao, 2009; Desyllas and Hughes, 2010). One reason for the existence of the mixed results could be attributed to a lack of a temporal dimension in the evaluation of acquisition outcomes. The timing of the evaluation of acquisition outcomes has been somewhat random in most of the previous studies (see e.g. Ahuja and Katila, 2001; Hagedoorn and Duysters, 2002; Zhao, 2009; Desyllas and Hughes, 2010). Recent research reveals that post-acquisition processes involve multiple distinct phases and post-acquisition performance may differ between different specific phases in the processes (Kapoor and Lim, 2007; Bresman et al., 2010; Allatta and Singh, 2011; Drori et al., 2013; Monin et al., 2013). However, empirical examination of the temporality of post-acquisition processes has been limited to qualitative research, small-scale data and a short observation period after acquisition, mainly because it is difficult to trace the dynamics of target firms after acquisition.

The main aim of this paper is to draw the temporal boundaries of the post-acquisition restructuring process by tracing post-acquisition dynamics of organizational forms of target start-ups. Post-acquisition restructuring is the initial phrase of post-acquisition implementation and integration, which arguably plays a major role in reconfiguring resources and creating values from acquisitions (Karim and Mitchell, 2000; Puranam et al., 2006; Barkema and Schijven, 2008). One major debate in this line of research is on the integration-autonomy dilemma: whether the target is to be integrated into the acquiring firm to foster the benefits from coordination and exploitation of the acquired knowledge base or to be preserved as an autonomous business unit to favor the target's exploration capacity to innovation (Puranam et al., 2006; Ranft, 2006; Puranam and Srikanth, 2007). However, the studies on this topic focus on the static and linear relationship between structural designs and acquisition outcomes but ignore the dynamic and interactive natures of post-acquisition restructuring. Owing to asymmetric information and bounded rationality, the initial restructuring strategies

are argued to be suboptimal (Barkema and Schijven, 2008). In this sense, the restructuring strategies are in no way static, but rather evolve as they unfold after acquisition.

The evolutionary perspective suggests that post-acquisition restructuring is a process of internal selection and experimentation. Drawing on the prior literature on dynamic capabilities, strategic integration and organizational learning, we argue that internal selection and experimentation are supposed to be concentrated into a short period after acquisition given the adjustment costs (Lockett et al., 2011) associated with the post-acquisition restructuring. In the short-run, post-acquisition restructuring will lead to a high turbulence of change in organizational forms of acquired start-ups. In the long-run, however, when internal selection and experimentation are complete, the organizational forms of the acquired start-ups should be stable. To test the hypotheses, we study the survival performance of target start-ups as autonomous business units compared to their independent counterparts. It is expected that the post-acquisition survival rate of target firms as autonomous business units should differ substantially between the short-run and the long-run. By observing the turning point of the survival performance, the temporal boundaries of post-acquisition restructuring are identified.

The data used in this paper are observations of a large sample of firms from the whole population of start-ups in Sweden entering from 1997 to 2002 in high-technology manufacturing and knowledge-intensive business services (KIBS) sectors. Each firm is followed from entry, either until exit (from the status of being autonomous business units) or until 2009, the last year of observation in the data. The longitudinal nature of the data not only allows us to identify acquisition events but also to follow target firms up to 11 years after acquisition. This paper applies discrete-time duration models to consider the duration dependence after both entry and acquisition. Based on this method, this study could not only examine the acquisition effects on the survival of target start-ups as autonomous business units in a dynamic manner, but also identify the temporal boundaries of post-acquisition restructuring. When examining the acquisition effects on the survival performance of target start-ups, a possible endogeneity problem may be encountered: firms with specific survival prospects are more likely to experience acquisition. Thus, standard duration models may give a biased estimate of acquisition effects without considering the potential endogeneity problem. In this context, this paper uses the estimator of inverse-probability-of-treatment weights (IPTW) (Robins et al., 2000; Azoulay et al., 2009; Buenstorf, 2009) to account for endogeneity, especially that arising from time-varying confounders.

The findings show that acquisition indeed impacts the survival of acquired start-ups as autonomous business units in a dynamic manner. Within the first 4 years after acquisition, acquired start-ups exhibit a lower survival probability than non-acquired start-ups. However, from the 5th year after acquisition, acquired start-ups tend to have a higher likelihood of survival. However, the long-run survival premium of acquired start-ups is insignificant after possible endogeneity of acquisition is controlled for. The findings are robust with sensitivity checks.

This study contributes to the literature on technology acquisitions and post-acquisition integration (Jemison and Sitkin, 1986; Pablo, 1994; Chaudhuri and Tabrizi, 1999; Ahuja and Katila, 2001; Paruchuri et al., 2006; Puranam et al., 2006; Ranft, 2006; Desyllas and Hughes, 2008; Graebner et al. 2017). Technology start-ups, as an important source of innovations and technologies, are popular targets in technology acquisitions (Andersson and Xiao, 2016). However, the knowledge concerning what happens to the target start-ups after acquisition is currently limited. This study fills this gap with a systematic empirical analysis of post-acquisition survival rates of the target start-ups over time. In addition, there is an increasing recognition for incorporating temporality into post-acquisition integration research (Graebner et al., 2017). This study contributes in this regard with a systematic study to draw the temporal boundaries of post-acquisition restructuring. The availability of a large scale of longitudinal data that span up to 11 years after acquisition enables us to tell the exact length of post-acquisition restructuring. The findings of this paper also suggest that it is important to distinguish the short-run and long-run effects on outcomes of technology acquisitions in future research.

The rest of this paper is organized as follows: section 2 presents the theoretical framework and hypotheses; section 3 introduces the data, sample, and descriptive statistics; empirical strategies and results are displayed in sections 4 and 5 respectively; and section 6 discusses and concludes the paper.

2. Theoretical framework

Firms need to constantly renew their knowledge and capabilities to keep innovating and adapting to fast-changing environments. Particularly in high-tech industries, acquisitions are found to be an important alternative to the internal development of innovation to achieve

long-term business renewal (Karim and Mitchell, 2000; 2004). The literature on dynamic capabilities emphasizes the firm's self-driven ability to sense the need of change, seize the opportunity of change and reconfigure the resources for generating new values (Teece et al., 1997; Eisenhardt and Martin, 2000; Teece, 2007). In this sense, to realize the values of acquisitions, post-acquisition restructuring would be a critical stage as it embodies the main processes of reconfiguring resources and recombining knowledge (Karim and Mitchell, 2000; Puranam et al., 2006; Barkema and Schijven, 2008). In this body of literature, "routines" are given broader attributes, including not only regular and predictable organizational processes but also experiential and dynamic processes to experiment with new possibilities (Eisenhardt and Martin, 2000). Thus, in the post-acquisition restructuring, when the main task is to reconfigure the acquired resources for experimenting with new possibilities, those routines that are used to guide the process tend to more iterative and unpredictable.

The prior research suggests that post-acquisition restructuring is an evolutionary process which involves both selection and adaptation *within* the organization (Haspeslagh and Jemison, 1991; Meyer and Lieb‑Dóczy, 2003). After an acquisition, the initial and fundamental decision that the acquirer faces is how to restructure organizational forms to fit the strategic motives behind the acquisition (Puranam et al., 2006; Maksimovic et al., 2011). One important debate in the strategic integration literature is the integration-autonomy dilemma: whether the target is to be integrated into the acquiring firm to foster the benefits from coordination and exploitation of the acquired knowledge base or to be preserved as an autonomous business unit to favor the target's exploration capacity to innovation (Puranam et al., 2006; Ranft, 2006; Puranam and Srikanth, 2007). However, due to aystemtric information and bounded rationality, the initial restructuring strategies are argued to be suboptimal (Barkema and Schijven, 2008). Information asymmetries between buyers and sellers before acquisition usually hinder the existence of an effective acquisition market. This will lead to a high probability of a "bad" match between acquisition partners (Lichtenberg et al., 1987). The initial restructuring strategies are designed based on the ex-ante information of the target. The full information about whether the acquisition is a "good" or "bad" match will only unfold after the acquisition. In the post-acquisition restructuring, the acquirer may alter their initial restructuring strategies when the full information of the target unfolds after the acquisition. In addition, when the acquirer designs the restructuring strategies, bounded rationality will restrict the acquirer in a way that the firm tends to search for new routines locally (Cyert and March, 1992). However, the routines which are close to the existing organizational knowledge

of the acquirer may not be sufficient to handle the acquired resources, especially when the acquirer uses acquisitions to obtain new capabilities outside their existing knowledge base. The acquirer may not have the absorptive capacity to process, assimilate and apply the new knowledge (Cohen and Levintha,l 1990), which may drive the acquirer to engage in a "distant search" (Cyert and March, 1992) to build new routines to handle the acquired resources. In this sense, the post-acquisition restructuring embodies a large scale of "trial and error" in structural forms of the involving organizations.

Recent research proposes that acquisitions by established firms may serve as an alternative commercialization strategy for technology start-ups to scale-up their innovations and products (the nurturing effects of acquisitions), relative to competition with established firms directly in the product market (Gans and Stern, 2003; Xiao, 2014; Andersson and Xiao, 2016). Established firms are also motivated to engage in nurturing the start-ups to trace and experiment with new technological opportunities for explorative learning (Huber, 1991; Puranam et al., 2006). If the main motive behind the acquisition is for explorative learning, the acquirer will tend to keep the target start-up as an autonomous business unit as the initial structural design. However, as discussed above, the initial restructuring decision is likely to be sub-optimal. The acquirer experiments with and evaluates whether the target start-up matches the structural design in terms of both strategic fit and organizational fit when implementing the restructuring strategies. If the target is found to be a "bad" match or fails to justify its existence as an autonomous business unit, it will be selected out by the acquirer through divesting, downsizing, or closing down. It is also possible that the target firm will be integrated to other business units within the acquiring firm for knowledge recombination (Karim, 2006).

Owing to selection and experimentation by the acquirers, the acquisition effects on the dynamics of acquired start-ups are extensively shaped by the post-acquisition restructuring. In this sense, compared to independent counterparts, acquired start-ups face a high turbulence in change of organizational forms after acquisition, reflected by a considerably lower survival probability of being autonomous business units in the post-acquisition restructuring process. This is because, in addition to external selection by the environments that applies to both acquired start-ups and their independent counterparts (Hannan and Freeman, 1977; Jovanovic, 1982), the former have to face internal selection and experimentation by the acquirers in the process. However, given the adjustment costs (Lockett et al., 2011) associated with internal

selection and experimentation, the post-acquisition restructuring should be concentrated in a short period after acquisition. By contrast, in the long-run, when the target start-ups that have been preserved as the autonomous business units are successfully incorporated into the main strategy domains of the acquiring firms (Burgelman, 1991), they may benefit from the synergies realized from the acquisitions, such as ownership advantages possessed by the parent firms. For example, by being affiliated to a corporation, start-ups could obtain financial resources from internal capital markets (Stein, 1997; Hubbard and Palia, 1998; Matsusaka and Nanda, 2002) and receive support in complementary assets and capabilities (Teece, 1986). Moreover, the affiliation – as a signal of legitimacy through endorsements of parent firms – could also help start-ups to attract financial resources from imperfect external capital markets (Mata & Portugal, 2002; Meoli et al., 2013). These ownership advantages will increase the survival performance of the acquired start-ups as autonomous business units compared to their non-acquired counterparts. Thus, the first and second hypotheses are proposed as follows:

H1: In the short-run after acquisition, acquired start-ups have a lower survival probability of being autonomous business units than non-acquired start-ups.

H2: In the long-run after acquisition, acquired start-ups have a higher survival probability of being autonomous business units than non-acquired start-ups.

3. Data, sample, and descriptive statistics

3.1. Data

The data used in this paper are originally derived from a dataset that identifies the entire population of Swedish entrepreneurial firms[1] entering from 1991 to 2002 (see Ejermo & Xiao, 2014, for a description of the construction of the dataset and the orginal sources of different databases used). A variety of demographic information for firms and their employees is included in the original dataset, such as firms' age, size, sector and location, employees' education length and major. The data used in this paper, however, have undergone two updates. First, information on business statistics from SCB has been added. CPI index[2] obtained from SCB is used to deflate the data of business statistics. Second, the follow-up year has been extended from 2007 to 2009.

3.2. Construction of sample

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[1] Ejermo and Xiao (2014) define entrepreneurial firms as new, small, and independent businesses.
[2] Base year = 1980.

The sample used in this study is constructed as follows. First, this paper focuses on technology start-ups. Technology start-ups are identified when entrepreneurial firms are in high-technology manufacturing or knowledge-intensive business services (KIBS) sectors. In this study, "high-technology" includes high-tech manufacturing and medium-high-tech manufacturing sectors. This study classifies industries according to the industry classification of OECD (Hatzichronoglou, 1997; Eurostat, 2011). According to the definition of Miles (2005),[3] KIBS includes "Post and telecommunications" (NACE code 64), "Computer and related activities" (NACE code 72), "Research and development" (NACE code 73), and "Other business activities" (NACE code 74[4]). Second, the sample contains firms entering from 1997 to 2002. The reason is that business statistics have only been available for the whole population of firms since 1997. Third, about 26% of technology start-ups are dropped as they have missing or unreliable values in some variables[5] according to the observation history.

An acquisition is identified when a start-up joins a business group. This means that the business group possesses over 50% of the voting rights of the acquired start-up. Survival is identified when a firm operates as a separate autonomous business unit. This study does not have information about acquirers' motives and thus we could not distinguish the selection from the experimentation. In this case, it is not meaningful to distinguish whether the acquired start-up exited due to closing down or integrating into other business units within acquiring firms as this study cannot tell whether the latter case is due to purposeful selection or failure in experimentation. In this situation, exits are identified if an acquired firm either closes down[6] or loses the observation as an autonomous business unit (such as merger or split). Each firm is followed from the first year after entry until 2009 (if it has not yet exited).

The final sample is an unbalanced panel consisting of 43,688 unique firms and 158,977 firm-year observations. Table 1 shows the composition of the sample. Firms acquired in 2009 do not contribute any duration spells after acquisition as the observation ends in 2009. In total,

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[3] In the study of Miles (2005), he mentioned that KIBS may also exist in other sectors such as telecommunications but did not explicitly include "Post and telecommunications" (NACE code 64) in his definition of major KIBS sectors. This paper, however, includes "Post and telecommunications" in KIBS sectors.
[4] Some subsectors under NACE division 74 are excluded according to the definition of Miles (2005).
[5] The firms are dropped if the value of the ratio of cash to sales is below the 1st percentile or above the 99th percentile or if the variable of labor productivity is missing.
[6] Divestiture is not identified as the event of exit, as it does not apply to non-acquired firms. If acquired firms are observed to be divested from their acquiring firms, the corresponding observations are coded as censored in the duration analysis.

1,472 firms have been acquired from 1998 to 2008. Among them, 711 firms exited, and 423 firms divested by 2009. Only 23% of firms acquired from 1998 to 2008 have survived as autonomous business units within acquiring business groups by the end of observation.

Table 1 Composition of the sample

Year	Entrants	Observations	Acquisition	Exit / Exit of acquired firms	Divestiture of acquired firms
1997	7185	-	-	-	-
1998	6787	7185	57	2664 / -	-
1999	6462	11308	210	3621 / 19	14
2000	7661	14135	70	4296 / 80	9
2001	7519	17491	182	5105 / 61	24
2002	8074	19881	234	5289 / 72	37
2003	-	22629	179	6011 / 98	39
2004	-	16579	116	3352 / 75	56
2005	-	13171	178	1999 / 68	69
2006	-	11103	138	1502 / 94	43
2007	-	9558	53	1090 / 52	57
2008	-	8411	55	842 / 58	43
2009	-	7526	37	734 / 34	32
Total	43688	158977	1509	36505 / 711	423

Note: Firms are followed from the first year after entry. In total, 1,472 firms have been acquired from 1998 to 2008.

3.3. Control variables

In addition to acquisition, a number of other variables are included as control variables in the analysis.

Age

This study controls for firm age, which has been discussed as one of the most important factors that shape the survival of new firms. The literature on industrial organization recognizes that new firms experience a high exit rate (Geroski, 1995; Caves, 1998) because associated high risks and uncertainties put them at a competitive disadvantage compared to established firms in the search for resources in external environments (Mata & Portugal, 2004). Organizational ecology describes this phenomenon as a "liability of newness" and argues that new firms need time to obtain "legitimacy" through building their reliability and accountability with the external environment, resulting in a strong age dependence of exit rate (Freeman et al., 1983; Hannan & Freeman, 1984).

Size

Besides a "liability of newness", new firms also suffer from a "liability of smallness". The two phenomena are often intertwined (Freeman et al., 1983) as new firms are usually small. The size of new firms reflects their level of resources and thus positively relates to their chances of survival (Evans, 1987; Hall, 1987; Mata et al., 1995; Audretsch et al., 2000) and is controlled for in this study.

Human capital and technical capital

This study also controls for human capital (the share of employees with tertiary education or above) and technical capital (the share of scientists and engineers, the presence of inventor[s]), which both reflect the quality of technology start-ups and are assumed to positively influence their subsequent survival (Bates, 1990; Colombo & Grilli, 2005b; Ejermo & Xiao, 2014).

Entrepreneurs' working experience

Previous studies have shown that the working experience of entrepreneurs is associated with their motives for founding new firms. Some individuals leave their current position and start a new firm to explore an entrepreneurial opportunity. However, others start a new firm to escape unemployment. The quality of the two types of start-ups is assumed to be very different given the opportunity costs between the two types of entrepreneurs. There is empirical evidence that employee start-ups have better survival rates than new firms initiated by unemployed individuals (Carrasco, 1999; Pfeiffer & Reize, 2000; Klepper, 2001; Andersson & Wadensjö, 2007; Santarelli & Vivarelli, 2007). Moreover, spin-offs are found to demonstrate better survival performance than other types of new firms as spin-offs can inherit knowledge and routines from their parent companies (Nelson & Winter, 1982; Klepper & Sleeper, 2005; Eriksson & Kuhn, 2006; Klepper, 2007; Andersson & Klepper, 2013).

Following Andersson and Klepper (2013), this study controls for the work experience of initial employees by dividing new firms into five types: pulled spin-offs, pushed spin-offs, other new firms, unemployment firms, and self-employment firms. A spin-off is identified if over 50% of employees in a new firm come from the same parent firm. A pulled spin-off is one type of spin-off whose parent firm continues in the year the spin-off enters. A pushed spin-off is one type of spin-off whose parent firm exits in the same year the spin-off enters. Other new firms are new firms whose employees come from different previous firms, but no

firm dominates the source of employees. Unemployment firms are firms founded by unemployed individuals. Self-employment firms are founded by only one individual initially.

Internal financial resources

Extensive literature has shown that difficulties in gaining access to external financing impedes the survival of new firms due to the imperfection of external financial markets, in particular when associated with high-tech projects (Carpenter & Petersen, 2002a; 2002b; Colombo & Grilli, 2005a; 2007). Thus, internal financing may be the main resource that new firms depend upon for survival in their early stages after entry. Following Andersson and Lööf (2012), the ratio of cash flow to sales is used to indicate internal financial resources and is controlled for in this study.

Labor productivity

Previous studies have revealed that firm productivity deteriorates a couple of years before exit, a phenomenon termed the "shadow of death" effect (Baily et al., 1992; Griliches & Regev, 1995; Olley & Pakes, 1996). This study controls for the variable of labor productivity measured by the logarithm of ratio of value added to the number of employees.

Industry controls

This study controls for industry dummies (defined as 2-digit NACE[7] code) to account for industry-specific effects, such as technological regime (Audretsch, 1991; Malerba & Orsenigo, 1999); R&D intensity (Audretsch, 1995; Licht & Nerlinger, 1998); concentration, entry barriers, and economies of scales (Dunne et al., 1988; Mitchell, 1994; Audretsch, 1995; Geroski, 1995); and industry lifecycles (Utterback & Suárez, 1993; Jovanovic & MacDonald, 1994).

Location controls

Previous research has indicated that location matters for the survival of new firms (Fotopoulos & Louri, 2000; Sorenson & Audia, 2000; Acs et al., 2007). One argument is that firms located in metropolitan regions may have a higher chance of survival as they could benefit from the effects of agglomeration economies (Fotopoulos & Louri, 2000). The other argument, however, is that being located in metropolitan regions is detrimental to firm survival as the

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[7] NACE Version 1.1.

geographical concentration could intensify the competition (Sorenson & Audia, 2000). This study controls for regional effects by including four location dummy variables: Stockholm, Gothenburg, Malmo and other regions in Sweden.

3.4. Descriptive statistics

Table 2 provides a description of main variables and their mean values for the whole sample. Table 2 also reports mean values for acquired and non-acquired firms[8] respectively and *t* tests on the equality of means by comparing acquired and non-acquired firms. All the variables are given as values at entry year. In the whole sample, about 3.5% of technology start-ups have experienced acquisition by business groups by 2009. While acquired firms account for only a small share of firms in the whole sample, they are significantly larger and more productive and have a significantly higher level of human capital and technical capital but fewer internal financial resources on average than non-acquired firms at entry year. Acquired firms are significantly more likely to be spin-offs and other new firms than non-acquired firms. In terms of industry distribution, a significantly higher proportion of acquired firms are in high-tech and medium-high-tech manufacturing sectors than non-acquired firms. Furthermore, acquired firms are significantly more likely to be located in Stockholm than non-acquired firms.

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[8] Firms are defined as acquired firms if they are acquired within the observation period, otherwise as non-acquired firms.

Table 2 Main variables' description and descriptive statistics

Variable	Description	Mean			*t* test	
		Total sample	Acquired firms	Non-Acquired acquired firms	Statistics	*p* value
Acquisition	Dummy variable for acquisition	0.035	-	-		
Size	Number of employees in logarithm	0.185	0.568	0.171	34.965	0.0000
Share of tertiary education or above	Share of employees with tertiary or above education	0.287	0.326	0.285	3.545	0.0004
Share of S&E	Share of employees with tertiary or above education in the field of science and engineering	0.082	0.123	0.080	6.259	0.0000
Inventor	Dummy variable for firms with inventors	0.006	0.011	0.006	2.549	0.0108
Pulled spin-offs	Dummy variable for pulled spin-offs	0.010	0.058	0.008	19.433	0.0000
Pushed spin-offs	Dummy variable for pushed spin-offs	0.012	0.074	0.010	22.202	0.0000
Other new firms	Dummy variable for other new firms	0.133	0.332	0.126	23.377	0.0000
Unemployment firms	Dummy variable for firms started by unemployed individuals	0.021	0.028	0.021	1.728	0.0839
Self-employment firms	Dummy variable for firms started by only one individual (reference group)	0.824	0.508	0.835	−33.173	0.0000
Ratio of cash flow to sales	Ratio of cash flows to sales	0.379	0.166	0.387	−27.398	0.0000
Labor productivity	Ratio of value added to number of employees (in logarithm)	11.788	12.391	11.767	19.745	0.0000
High-tech	Dummy variable for firms in high-tech manufacturing sectors	0.014	0.022	0.014	2.499	0.0125
Medium-high-tech	Dummy variable for firms in medium-high-tech manufacturing sectors	0.035	0.047	0.035	2.542	0.0110
KIBS	Dummy variable for firms in knowledge-intensive business service sectors	0.950	0.931	0.951	-3.528	0.0004
Stockholm	Dummy variable for firms located in Stockholm region	0.449	0.475	0.449	2.044	0.0410
Gothenburg	Dummy variable for firms located in Gothenburg region	0.122	0.133	0.122	1.341	0.1798
Malmo	Dummy variable for firms located in Malmo region	0.108	0.083	0.109	−3.210	0.0013
Other regions	Dummy variable for firms located in other regions (reference group)	0.320	0.309	0.321	−0.984	0.3250

Note: Descriptive statistics are based on the values at entry year (the baseline values). Sector dummies (based on 2-digit NACE code) are reported grouped into high-tech manufacturing, medium-high-tech manufacturing, and KIBS. The dummy variable of acquisition in this table is time invariant, indicating whether firms have experienced acquisition by 2009.

4. Empirical strategy

This study applies discrete-time duration models to explore how acquisition affects the survival performance of technology start-ups given the following considerations. First, the dataset of this study is constructed by observing firms on a yearly basis. Discrete-time duration models are more appropriate and convenient to analyze data that are recorded in discrete units than continuous-time model (Allison, 1982). Second, duration models account for the presence of right-censoring subjects (Singer & Willett, 1993). Subjects that have not experienced the event (e.g. exit in this study) in the given observation period are defined as right-censoring in the duration analysis. The study takes into account two types of right censoring: (1) firms that have not completed their duration spells because they have not exited by the end of observation; (2) acquired firms that they have divested from acquiring firms because this event does not apply to non-acquired firms. Third, duration models consider duration dependence in that the amount of elapsed time potentially affects the probability of staying in a particular state. It is particularly important to account for the duration dependence when exploring the survival performance of new firms given the "liability of newness" or the "passive learning" process involved where new firms only know their true efficiency as they grow old (Jovanovic, 1982). Fourth, duration models are convenient to accommodate time-varying covariates (Allison, 1982) as time-varying covariates can capture firms' dynamic capabilities that are obtained through the "active learning", such as investments in R&D, over time (Ericson & Pakes, 1995).

Equation (1) and Equation (2) define the discrete-time hazard and survivor function respectively (Singer & Willett, 2003).

$$h(t_{ij}) = Pr[T_i = j | T_i \geq j] \tag{1}$$

$$S(t_{ij}) = Pr(T_i > j) \tag{2}$$

The hazard for subject i at time interval j is the probability that the subject will experience the event of exit in the time interval j given that it has not experienced the exit before time j; while the survival for subject i at time j is the probability that the subject will survive time j (Singer & Willett, 2003). Following Singer and Willett (2003), this study adopts the logit hazard (proportional hazard odds) model to represent the discrete-time hazard by assuming a logistic distribution for the hazard odds; see Equation (3a).

$$logit\ h(t_{ij}) = \sum_{j=1}^{l} \alpha_j D_{ij} + \gamma A_{ij} + \sum_{m=1}^{p} \beta_m X_{(ij)m} \tag{3a}$$

where $h(t_{ij})$ refers to the discrete hazard for firm i at duration interval j; D_{ij} is the duration dummy (age)[9] at duration interval j;[10] α_j is the estimated parameter of the duration dummy at duration interval j; $X_{(ij)m}$ is the m th covariate; β_m is the estimated parameter of the m th covariate; A_{ij} is a dummy variable to indicate the treatment of acquisition; γ is the estimated parameter of the treatment of acquisition. The logit model is estimated by the maximum likelihood method.

This study employs three empirical models to estimate the effects of acquisition on survival. In the first model, this paper examines acquisition effects without considering the time dimension after acquisition; see Equation (3a). The dummy variable of acquisition is time varying and switched from 0 to 1 after firms have been acquired by a business group. In the second model, this paper decomposes acquisition effects over time to capture possible non-linear effects of acquisition over time after acquisition. This is done by separating the acquisition dummy into multiple ones, each for one duration interval after acquisition; see Equation (3b). Each dummy is switched from 0 to 1 when firms are acquired and when their observations fall into the corresponding duration interval after acquisition.

$$logit\ h(t_{ij}) = \sum_{j=1}^{l} \alpha_j D_{ij} + \sum_{n=1}^{q} \gamma_n A_{(ij)n} + \sum_{m=1}^{p} \beta_m X_{(ij)m} \tag{3b}$$

In the third model, this paper distinguishes acquisition effects in the short-run from those in the long-run based on the results from the model of (3b). This is done by introducing the short-run and long-run dummies of acquisition; see Equation (3c).

$$logit\ h(t_{ij}) = \sum_{j=1}^{l} \alpha_j D_{ij} + \gamma_{short} A_{(ij)short} + \gamma_{long} A_{(ij)long} + \sum_{m=1}^{p} \beta_m X_{(ij)m} \tag{3c}$$

Recall that acquired and non-acquired firms have already exhibited a significant difference in most covariates at the year of entry. This may indicate a possible endogeneity problem: firms with specific survival prospects are more likely to experience the treatment of acquisition. Furthermore, past acquisition may also have an impact on the current level of covariates, which in turn affects survival chances in the future. Thus, standard duration models may give a biased estimate of acquisition effects without considering the endogeneity problem.

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[9] The duration is identical to age here as the data in this paper follow firms since their entry.
[10] Duration dummies let the baseline hazard (the hazard depending only on time when all covariates equal zero) be constant at each duration interval but vary across duration intervals without imposing any a priori assumption about the shape of the baseline hazard.

A new estimator, inverse-probability-of-treatment weights (IPTW), originally developed in biostatistics (Robins et al., 2000), has been recently introduced by economists to account for time-varying confounders (Azoulay et al., 2009; Buenstorf, 2009). The rationale of using the IPTW estimator is to make a treatment as random as possible by controlling for time-varying confounders. Following the procedures of Fewell, Hernán, Wolfe, Tilling, Choi, and Sterne (2004), IPTW are constructed, as shown in Equation (4).

$$w_{ij} = \prod_{t=1}^{j} \frac{1}{Prob(A_{it}|\bar{A}_{i,t-1},\bar{X}_{it})} \tag{4}$$

The denominator of Equation (4) calculates the probability of receiving the observed treatment of acquisition for each firm-year observation conditional on its previous history of acquisition and covariates. By inversing the estimated probability, firms with higher probabilities of acquisition receive lower weights, while firms with lower probabilities of acquisition receive higher weights. However, Fewell et al. (2004) points out that w_{ij} is very likely to follow a skewed distribution with higher variance and thus proposes a stabilized version; see Equation (5).

$$sw_{ij} = \prod_{t=1}^{j} \frac{Prob(A_{it}|\bar{A}_{i,t-1},\bar{X}_{i0})}{Prob(A_{it}|\bar{A}_{i,t-1},\bar{X}_{it})} \tag{5}$$

The numerator calculates the probability of the firm receiving the observed treatment of acquisition for each firm-year observation conditional on its previous history of acquisition and the baseline values of covariates (the values at entry year). The weights are introduced into the logit hazard model to account for the potential endogeneity.

5. Results

For illustrative purposes, Figure 1 displays the estimated hazard of exit and survival probabilities over time after entry (age) for both acquired firms and non-acquired firms before introducing any covariates. The exits for acquired firms are observed from age 2 as acquisitions need at least one year to be observed. It is obvious that generally acquired firms experience a lower exit (higher survival) probability than non-acquired firms over time after entry, which may indicate the existence of an endogeneity problem of acquisition.
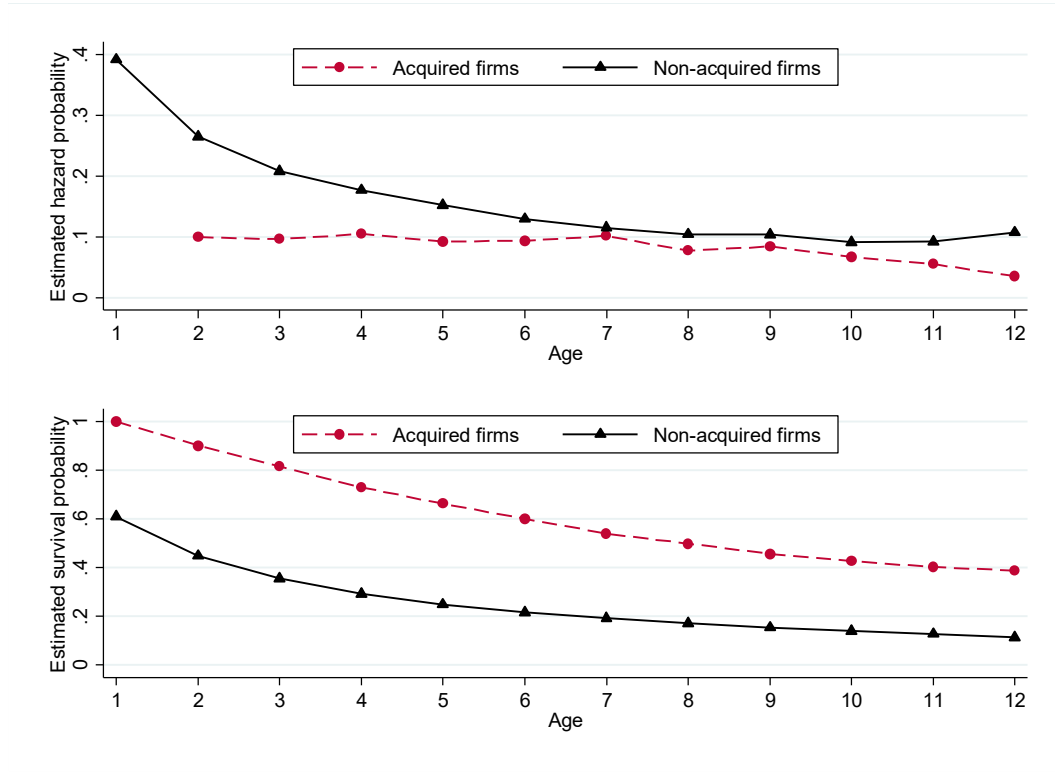
Figure 1 Estimation of hazard and survival probabilities: acquired vs. non-acquired

5.1. Multivariate regression results

Table 3 reports regression results for acquisition effects based on the three logit hazard models. For each model, the results for the standard specification and the specification weighed by IPTW are displayed. Except for dummy variables of inventor and firm type, all the other control variables are time varying. Only the values at entry year of control variables are included in the regression in order to avoid a possible simultaneity problem.[11] However, the time-varying values of the control variables are used to construct the IPTW estimators.

Estimated hazard odds ratios $(exp(\widehat{\beta}))$ instead of coefficients are reported. Hazard odds ratios are a more intuitive way to quantify the effects of independent variables. If an odds ratio is larger than 1, it implies a positive effect on the hazard odds by the amount of $[|exp(\widehat{\beta}) - 1| * 100\%]$ upon a one-unit increase in the value of the independent variable after controlling for other covariates, and likewise, an odds ratio smaller than 1 implies a negative effect upon a one-unit increase.

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[11] A simultaneity problem occurs when two events take place at the same time. For example, a firm is usually found to have a dramatic drop in size at the same time as it exits. One can hardly distinguish the causal relationship between the two events.

The first three specifications (columns) of Table 3 display the estimation results of Model A (see Equation (3a)). The first specification only includes the dummy variables of acquisition and the baseline hazard. The odds ratio of acquisition shows that acquired firms after acquisition have a significantly higher hazard probability of exit than non-acquired firms. Given the same age, the hazard odds of acquired firms after acquisition are around 37.5% higher than that of non-acquired firms. The second specification includes the control variables. The effect of acquisition on the hazard probability for start-ups is still significantly positive but with a larger magnitude than in the first specification. The third specification accounts for the endogeneity of acquisition by being weighted by IPTW. Acquisition has an even larger and significantly positive effect on the hazard probability for start-ups. The findings based on Model A reveal that acquisition decreases the survival probability of start-ups in general. The positive effects of acquisition on the hazard probability will be underestimated without controlling for the endogeneity problem.

Table 3 Multivariate estimation (hazard odds ratios) for the acquisition effects: the logit hazard models

Variables	Model A			Model B		Model C	
	Standard without controls	Standard	IPTW	Standard	IPTW	Standard	IPTW
Acquisition effects							
Acquisition	1.375***	1.492***	1.982***				
	(0.0595)	(0.0663)	(0.187)				
A1				1.660***	2.613***		
				(0.110)	(0.403)		
A2				1.606***	1.586***		
				(0.141)	(0.192)		
A3				1.553***	1.884***		
				(0.174)	(0.298)		
A4				1.396**	1.747**		
				(0.206)	(0.472)		
A5				0.616*	0.638		
				(0.166)	(0.195)		
A6				1.024	1.614		
				(0.273)	(0.589)		
A7				0.900	1.381		
				(0.336)	(0.542)		
A8				0.415	0.269*		
				(0.300)	(0.205)		
A9				1.342	0.141***		
				(0.829)	(0.0902)		
A-short						1.601***	2.127***
						(0.0741)	(0.210)
A-long						0.765*	0.925
						(0.122)	(0.187)
Control variables							
Size		1.997***	1.972***	2.000***	1.974***	2.000***	1.975***
		(0.0773)	(0.0995)	(0.0775)	(0.0983)	(0.0775)	(0.0992)
Share of tertiary education or above		0.983	0.981	0.983	0.981	0.983	0.982
		(0.0155)	(0.0157)	(0.0155)	(0.0157)	(0.0155)	(0.0157)
Share of S&E		0.916***	0.915***	0.917***	0.916***	0.916***	0.915***
		(0.0240)	(0.0247)	(0.0240)	(0.0246)	(0.0240)	(0.0247)
Inventor		1.009	0.914	1.013	0.917	1.012	0.911
		(0.0802)	(0.110)	(0.0806)	(0.110)	(0.0805)	(0.113)
Pulled spin-offs		0.208***	0.915***	0.208***	0.916***	0.208***	0.916***
		(0.0182)	(0.0204)	(0.0182)	(0.0206)	(0.0182)	(0.0205)
Pushed spin-offs		0.242***	0.800***	0.241***	0.800***	0.241***	0.800***
		(0.0200)	(0.00508)	(0.0200)	(0.00507)	(0.0200)	(0.00508)

Other new firms		0.472***	0.238***	0.471***	0.237***	0.471***	0.238***
		(0.0200)	(0.0295)	(0.0200)	(0.0281)	(0.0200)	(0.0292)
Unemployment firms		0.620***	0.238***	0.620***	0.238***	0.620***	0.238***
		(0.0322)	(0.0240)	(0.0323)	(0.0237)	(0.0323)	(0.0238)
Ratio of cash flow to sales		0.905***	0.465***	0.905***	0.465***	0.905***	0.464***
		(0.0196)	(0.0238)	(0.0196)	(0.0234)	(0.0196)	(0.0237)
Labor productivity		0.802***	0.624***	0.802***	0.625***	0.802***	0.624***
		(0.00445)	(0.0355)	(0.00445)	(0.0352)	(0.00445)	(0.0353)
Stockholm		1.051***	1.051***	1.051***	1.051***	1.051***	1.051***
		(0.0153)	(0.0158)	(0.0153)	(0.0158)	(0.0153)	(0.0158)
Gothenburg		0.981	0.990	0.981	0.990	0.981	0.991
		(0.0206)	(0.0224)	(0.0206)	(0.0222)	(0.0206)	(0.0224)
Malmo		0.976	0.976	0.976	0.976	0.976	0.976
		(0.0214)	(0.0221)	(0.0214)	(0.0221)	(0.0214)	(0.0221)
Baseline hazard	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	158554	158554	156931	158535	156912	158554	156931
Log likelihood/pseudo-likelihood	−80762.561	−79533.064	−79182.647	−79517.548	−79145.071	−79521.223	−79166.817
Wald χ^2	41598.880	42196.510	40960.880	42182.400	41005.820	42190.780	40938.590
Prob > χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Estimated coefficients of the baseline hazard, sector, and year dummies are not reported due to space limitation.

Model B (see Equation (3b)) decomposes acquisition effects over time after acquisition by introducing multiple dummies. In both the standard and weighted specifications (the fourth and fifth columns), acquired firms show a significantly higher hazard probability of exit than non-acquired firms within 4 years after acquisition. However, in the 5th year after acquisition, the effect of acquisition on the hazard probability tends to become negative (significant at a 10% significance level for the standard specification but statistically insignificant for the weighted specification). The acquisition effects on the hazard probability (the standard specification) are insignificant from the 6th year after acquisition. The findings based on Model B show that acquisition impacts the survival probability of start-ups non-linearly over time after acquisition. It seems that a structural break in the effects of acquisition occurs during 4-5 years after acquisition.

According to the results of Model B, Model C delimitates the short-run and the long-run effects of acquisition by introducing two dummies. The short-run effects aggregate the acquisition effects within 4 years after acquisition. The long-run effects aggregate the acquisition effects from the 5th year after acquisition. In both the standard and weighted specifications (the sixth and seventh columns), acquired firms have a significantly higher hazard probability of exit than non-acquired firms in the short-run after acquisition. In the long run, acquisition exhibits a negative impact on the hazard probability of start-ups, but this is significant only in the standard specification at a 10% significance level. By comparing the magnitude of hazard odds ratios between the standard and weighted specifications, it should be noted that the standard one tends to underestimate the positive effects of acquisition but overestimate the negative effects of acquisition on the hazard probability of exit than the weighted one.

The findings show that the post-acquisition survival rate of the acquired technology start-ups as autonomous business units indeed differs substantially between the short-run and the long-run. Within the first 4 years after acquisition, acquired start-ups exhibit a lower survival probability than non-acquired start-ups, which supports Hypothesis 1. From the 5th year after acquisition, the survival likelihood of acquired start-ups tends to become positive. However, the long-run survival premium of acquired start-ups is insignificant after possible endogeneity of acquisition is controlled for. Thus, Hypothesis 2 is only partially supported.

In terms of control variables, the results are very robust across different specifications. The effects of most of the control variables are consistent with the findings in the previous studies. The survival probability of start-ups increased with age in general (not reported in Table 3), particularly during the first 8 years after entry. Firms with a higher share of scientists and engineers have a higher probability of survival. However, human capital (the share of employees with tertiary education or above) and the presence of inventor(s) has no significant effects on the survival of start-ups. One explanation could be that the sample of firms in this study is restricted to high-tech sectors. The variance of the share of employees with tertiary education or above may not be that high for a sample including only technology start-ups. This variable thus may not be a significant factor that can distinguish the survival performance between technology start-ups. In addition, spin-offs, particularly pulled spin-offs, exhibit a higher survival chance than self-employment firms. A higher level of internal financial resources and labor productivity also predicts higher survival probabilities for start-ups. Moreover, firms located in the Stockholm regions are found to have a lower probability of survival than those located in other regions, which may indicate that the effects of concentrated competition, other than agglomeration economies, dominate the survival of technology start-ups in Stockholm. The exception is the variable of entry size, which is found to have a strong negative effect on the survival of start-ups. Previous studies have shown that entry size predicts a higher chance of survival for new firms. An earlier study of Ejermo and Xiao (2014) that is based on the similar data[12] but without controlling for firm type shows a higher probability of survival for firms with larger entry size. In this context, one explanation could be that firm type is controlled for in the analysis. Particularly, the dummy variable of self-employment firms identifies start-ups initiated with only one individual initially, which account for over 80% of the start-ups in the sample. After controlling for variables of firm type, there may not be much variation that can be captured by entry size.

5.2. Robustness checks

Recall that the sample of this paper dropped about 26% of firms from the whole population of technology start-ups due to missing or unreliable values in the variables of ratio of cash to sales and labor productivity. To check whether the results of the short-run and the long-run effects of acquisition are sensitive to dropping those firms, we estimate Model C for the whole population of start-ups by dropping the variables of ratio of cash to sales and labor

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[12] The data used in Ejermo and Xiao (2014) include entrepreneurial firms in both high-tech and low-tech manufacturing and knowledge-intensive and less knowledge-intensive service sectors.

productivity. The estimation results are reported in Specification (1) in Table 4, showing that the main findings hold.

One assumption of the logit hazard model is no unobserved heterogeneity (Singer & Willett, 1993). This assumption postulates that the heterogeneity is all observed and thus does not introduce any error terms. Although this study uses IPTW estimators to control for time-varying confounders, this study cannot totally rule out that there is no unobserved heterogeneity. To test whether the findings are sensitive to accommodating unobserved individual heterogeneity, an error term μ_i is introduced into Model C and assumed to be normally distributed with zero mean and finite variance σ^2. The results are reported in Specification (2) in Table 4. The likelihood-ratio test shows that unobserved heterogeneity exists in the data. The results show that the main findings still hold.

Table 4 Multivariate estimation (hazard odds ratios) for the acquisition effects: robustness checks

Variables	(1) The logit model for the whole population of technology start-ups	(2) The logit model with unobserved heterogeneity
Acquisition effects		
A-short	1.460***	1.966***
	(0.0530)	(0.145)
A-long	0.780**	0.992
	(0.0923)	(0.199)
Control variables	Yes	Yes
Baseline hazard	Yes	Yes
Obs	222781	158554
Log likelihood	-111618.530	-79362.071
Wald Chi square	61845.410	3986.390
Prob > Chi2	0.0000	0.0000

Notes: Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Estimated coefficients of the baseline hazard and control variables are not reported due to space limitation. Specification (1) excludes the variables of ratio of cash to sales and labor productivity. Specification (2): LR test of rho=0: chibar2(01) = 318.30 Prob >= chibar2 = 0.000.

6. Discussion and conclusions

This study contributes to an important debate in strategic management literature on the trade-off of organizational forms of target firms in the post-acquisition restructuring process (Paruchuri et al., 2006; Puranam et al., 2006; Puranam and Srikanth, 2007; Puranam et al., 2009; Zaheer et al., 2013). This study draws on the previous literature on dynamic capabilities, strategic integration and organizational learning to show that the restructuring strategy is not a one-off decision but instead follows an dynamic process. Consistent with the theoretical prediction, this study finds that acquisition affects the survival of target start-ups being autonomous business units differently in the short-run and the long-run. During the first 4 years after acquisition, the survival probability of acquired start-ups is significantly lower than that of their non-acquired counterparts. In the long run (from the 5th year after acquisition), however, the acquisition effect on the survival of acquired start-ups becomes positive. Nonetheless, the long-term positive effect is not statistically significant once the potential endogeneity is controlled for. The findings of this paper suggest that acquired firms may experience selection and experimentation within the acquiring organization in the first 4 years after acquisition, when the restructuring shapes the organizational forms of target firms extensively.

This study also provides new empirical evidence on the temporality of post-acquisition processes (Kapoor and Lim, 2007; Bresman et al., 2010; Allatta and Singh, 2011; Drori et al., 2013; Monin et al., 2013). To the best of the author's knowledge, this study is the first

systematic empirical analysis of the temporality of post-acquisition restructuring. By employing a discrete-time duration analysis, this study identifies the exact length of post-acquisition restructuring.

This study sheds light on the research on post-acquisition integration processes and outcomes (Graebner et al., 2017). The findings in this study suggest that a dynamic view is necessary when scholars evaluate the post-acquisition performance of involved firms. The results of acquisition outcomes will be biased if scholars fail to recognize that there exist multiple stages in the post-acquisition processes and that the different stages impact acquisition outcomes differently. In particular, for technology acquisitions, the main motive behind them is usually for the long-term strategic considerations instead of short-term financial returns (Chaudhuri and Tabrizi, 1999; Karim and Mitchell, 2000; 2004). In this regard, this calls for a new and consistent framework to define, measure and evaluate outcomes of technology acquisitions, which differ from other types of acquisitions in both motives and post-acquisition integration processes. However, most of previous studies only focus on the performance of 3-4 years after acquisition (see e.g. Ahuja and Katila, 2001; Hagedoorn and Duysters, 2002; Zhao, 2009; Desyllas and Hughes, 2010). The author would argue that it may need a longer time to allow for the full effects to take place if the motives behind the technology acquisitions are for long-term strategic considerations.

The findings of this study show that only a small portion of acquired start-ups are retained as autonomous business units within acquiring firms after acquisition. This implies that technology start-ups may not have to survive as autonomous business units to exert their technological and economic influence after acquisition. Acquirers may prefer to integrate acquired start-ups into other business units within acquiring firms to realize the technology transfer. However, another explanation could be a failure in the post-acquisition experimentation process or that acquirers have offensive motives, such as grabbing technology or pre-empting potential competitors in the technology markets (Reinganum, 1983; Grimpe & Hussinger, 2008). Nonetheless, one limitation of the current study is that it cannot distinguish the selection process from the experimentation process due to a lack of information on acquirers' motives. Thus, in future studies, the information on acquirers' motives and the development of indicators to reflect the strategic and organizational fit between acquirers and target firms may help to distinguish the selection from the experimentation process.

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References

Acs, Z. J., Armington, C., & Zhang, T. (2007). The determinants of new-firm survival across regional economies: The role of human capital stock and knowledge spillover. *Papers in Regional Science*, *86*(3), 367-391.

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal*, *22*(3), 197-220.

Allatta, J. T., & Singh, H. (2011). Evolving communication patterns in response to an acquisition event. *Strategic Management Journal, 32*(10), 1099-1118.

Allison, P. D. (1982). Discrete-time methods for the analysis of event histories. *Sociological Methodology*, *13*(1982), 61-98.

Andersson, M., & Klepper, S. (2013). Characteristics and performance of new firms and spinoffs in Sweden. *Industrial and Corporate Change*, *22*(1), 245-280.

Andersson, M., & Lööf, H. (2012). Small business innovation: Firm level evidence from Sweden. *The Journal of Technology Transfer, 37*(5), 732-754.

Andersson, P., & Wadensjö, E. (2007). Do the unemployed become successful entrepreneurs? *International Journal of Manpower*, *28*(7), 604-626.

Andersson, M., & Xiao, J. (2016). Acquisitions of start-ups by incumbent businesses: A market selection process of "high-quality" entrants? *Research Policy*, *45*(1), 272-290.

Audretsch, D. B. (1991). New-firm survival and the technological regime. *The Review of Economics and Statistics*, *73*(3), 441-450.

Audretsch, D. B. (1995). Innovation, growth and survival. *International Journal of Industrial Organization*, *13*(4), 441-457.

Audretsch, D. B., Houweling, P., & Thurik, A. R. (2000). Firm survival in the Netherlands. *Review of Industrial Organization*, *16*(1), 1-11.

Azoulay, P., Ding, W., & Stuart, T. (2009). The impact of academic patenting on the rate, quality and direction of (public) research output. *The Journal of Industrial Economics*, *57*(4), 637-676.

Baily, M. N., Hulten, C. R., & Campbell, D. (1992). Productivity dynamics in manufacturing plants. *Brookings Papers on Economic Activity*, *Microeconomics* (1992), 187-249.

Barkema, H. G., & Schijven, M. (2008). Toward Unlocking the Full Potential of Acquisitions: The Role of Organizational Restructuring. *The Academy of Management Journal, 51*(4), 696-722.

Bates, T. (1990). Entrepreneur human capital inputs and small business longevity. *The Review of Economics and Statistics*, *72*(4), 551-559.

Bresman, H., Birkinshaw, J., & Nobel, R. (2010). Knowledge Transfer in International Acquisitions. *Journal of International Business Studies, 41*(1), 5-20.

Buenstorf, G. (2009). Is commercialization good or bad for science? Individual-level evidence from the Max Planck Society. *Research Policy*, *38*(2), 281-292.

Burgelman, R. A. (1991). Intraorganizational ecology of strategy making and organizational adaptation: Theory and field research. *Organization Science*, *2*(3), 239-262.

Carpenter, R. E., & Petersen, B. C. (2002a). Capital market imperfections, high-tech investment, and new equity financing. *The Economic Journal*, *112*(477), F54-F72.

Carpenter, R. E., & Petersen, B. C. (2002b). Is the growth of small firms constrained by internal finance? *Review of Economics and Statistics*, *84*(2), 298-309.

Carrasco, R. (1999). Transitions to and from self-employment in Spain: An empirical analysis. *Oxford Bulletin of Economics and Statistics*, *61*(3), 315-341.

Caves, R. E. (1998). Industrial organization and new findings on the turnover and mobility of firms. *Journal of Economic Literature*, *36*(4), 1947-1982.

Chaudhuri, S., & Tabrizi, B. (1999). Capturing the real value in high-tech acquisitions. *Harvard Business Review*. 77(5), 123-130.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly, 35*(1), 128-152.

Colombo, M. G., & Grilli, L. (2005a). Start-up size: The role of external financing. *Economics Letters*, *88*(2), 243-250.

Colombo, M. G., & Grilli, L. (2005b). Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy*, *34*(6), 795-816.

Colombo, M. G., & Grilli, L. (2007). Funding gaps? Access to bank loans by high-tech start-ups. *Small Business Economics*, *29*(1-2), 25-46.

Cyert, R. M., & March, J. G. (1992). *Behavioral Theory of the Firm* (2nd ed.). Hoboken, NJ: Wiley-Blackwell.

Desyllas, P., & Hughes, A. (2008). Sourcing technological knowledge through corporate acquisition: Evidence from an international sample of high technology firms. *The Journal of High Technology Management Research, 18*(2), 157-172.

Desyllas, P., & Hughes, A. (2010). Do high technology acquirers become more innovative? *Research Policy, 39*(8), 1105-1121.

Drori, I., Wrzesniewski, A., & Ellis, S. (2013). One Out of Many? Boundary Negotiation and Identity Formation in Postmerger Integration. *Organization Science, 24*(6), 1717-1741.

Dunne, T., Roberts, M. J., & Samuelson, L. (1988). Patterns of firm entry and exit in U.S. manufacturing industries. *The Rand Journal of Economics*, *19*(4), 495-515.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic Capabilities: What Are They? *Strategic Management Journal*. 21(10/11), 1105-1121.

Ejermo, O., & Xiao, J. (2014). Entrepreneurship and survival over the business cycle: How do new technology-based firms differ? *Small Business Economics*, *43*(2), 411-426.

Ericson, R., & Pakes, A. (1995). Markov-perfect industry dynamics: A framework for empirical work. *The Review of Economic Studies*, *62*(1), 53-82.

Eriksson, T., & Kuhn, J. M. (2006). Firm spin-offs in Denmark 1981–2000: Patterns of entry and exit. *International Journal of Industrial Organization*, *24*(5), 1021-1040.

Eurostat (2011). *High technology and knowledge-intensive sectors* [PDF document]. European Commission. Retrieved from: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/hrst_st_esms_an9.pdf

Evans, D. S. (1987). The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries. *The Journal of Industrial Economics*, *35*(4), 567-581.

Fewell, Z., Hernán, M. A., Wolfe, F., Tilling, K., Choi, H., & Sterne, J. A. C. (2004). Controlling for time-dependent confounding using marginal structural models. *Stata Journal*, *4*(4), 402-420.

Fotopoulos, G., & Louri, H. (2000). Location and survival of new entry. *Small Business Economics*, *14*(4), 311-321.

Freeman, J., Carroll, G. R., & Hannan, M. T. (1983). The liability of newness: Age dependence in organizational death rates. *American Sociological Review*, *48*(5), 692-710.

Gans, J. S., & Stern, S. (2003). The product market and the market for "ideas": Commercialization strategies for technology entrepreneurs. *Research Policy*, *32*(2), 333-350.

Geroski, P. (1995). What do we know about entry? *International Journal of Industrial Organization*, *13*(4), 421-440.

Griliches, Z., & Regev, H. (1995). Firm productivity in Israeli industry 1979–1988. *Journal of Econometrics*, *65*(1), 175-203.

Graebner, M. E., Heimeriks, K. H., Huy, Q. N. & Vaara, E. (2017). The Process of Postmerger Integration: A Review and Agenda for Future Research. *Academy of Management Annals, 11*(1), 1-32.

Grimpe, C., & Hussinger, K. (2008). Pre-empting technology competition through firm acquisitions. *Economics Letters*, *100*(2), 189-191.

Hagedoorn, J., & Duysters, G. (2002). The effect of mergers and acquisitions on the technological performance of companies in a high-tech environment. *Technology Analysis & Strategic Management*, *14*(1), 67-85.

Hall, B. H. (1987). The relationship between firm size and firm growth in the US manufacturing sector. *The Journal of Industrial Economics*, *35*(4), 583-606.

Hannan, M. T., & Freeman, J. (1977). The Population Ecology of Organizations. *American Journal of Sociology*, 82(5), 929-964.

Hannan, M. T., & Freeman, J. (1984). Structural inertia and organizational change. *American Sociological Review*, *49*(2), 149-164.

Haspeslagh, P. C., & Jemison, D. B. (1991). *Managing Acquisitions: Creating Value Through Corporate Renewal*. New York: Free Press.

Hatzichronoglou, T. (1997). *Revision of the high-technology sector and product classification* (OECD Science, Technology and Industry Working Papers, 1997/02). Paris, France: OECD Publishing. http://dx.doi.org/10.1787/134337307632.

Hubbard, R. G., & Palia, D. (1998). A re-examination of the conglomerate merger wave in the 1960s: An internal capital markets view (Working Paper No. 6539). Cambridge, MA: National Bureau of Economic Research (NBER). Retrieved from: http://www.nber.org/papers/w6539

Huber, G. P. (1991). Organizational Learning: The Contributing Processes and the Literatures. *Organization Science, 2*(1), 88-115.

Jemison, D. B., & Sitkin, S. B. (1986). Corporate acquisitions: A process perspective. *Academy of Management Review*, *11*(1), 145-163.

Jovanovic, B. (1982). Selection and the evolution of industry. *Econometrica*, *50*(3), 649-670.

Jovanovic, B., & MacDonald, G. M. (1994). The life cycle of a competitive industry. *Journal of Political Economy*, *102*(2), 322-347.

Kapoor, R., & Lim, K. (2007). The Impact of Acquisitions on the Productivity of Inventors at Semiconductor Firms: A Synthesis of Knowledge-Based and Incentive-Based Perspectives. *Academy of Management Journal, 50*(5), 1133-1155.

Karim, S. (2006). Modularity in organizational structure: the reconfiguration of internally developed and acquired business units. *Strategic Management Journal, 27*(9), 799-823.

Karim, S., & Mitchell, W. (2000). Path-dependent and path-breaking change: reconfiguring business resources following acquisitions in the U.S. medical sector, 1978–1995. *Strategic Management Journal, 21*(10-11), 1061-1081.

Karim, S., & Mitchell, W. (2004). Innovating through acquisition and internal development: A quarter-century of boundary evolution at Johnson & Johnson. *Long Range Planning, 37*(6), 525-547.

Klepper, S. (2001). Employee startups in high-tech industries. *Industrial and Corporate Change*, *10*(3), 639-674.

Klepper, S. (2007). Disagreements, spinoffs, and the evolution of Detroit as the capital of the U.S. automobile industry. *Management Science*, *53*(4), 616-631.

Klepper, S., & Sleeper, S. (2005). Entry by spinoffs. *Management Science*, *51*(8), 1291-1306.

Licht, G., & Nerlinger, E. (1998). New technology-based firms in Germany: A survey of the recent evidence. *Research Policy*, *26*(9), 1005-1022.

Lichtenberg, F. R., Siegel, D., Jorgenson, D., & Mansfield, E. (1987). Productivity and changes in ownership of manufacturing plants. *Brookings Papers on Economic Activity*, *1987*(3), 643-683.

Lindholm, Å. (1996). Acquisition and Growth of Technology-Based Firms (Working paper No.47). Cambridge, UK: University of Cambridge, ESRC Centre for Business Research.

Lockett, A., Wiklund, J., Davidsson, P., & Girma, S. (2011). Organic and Acquisitive Growth: Re-examining, Testing and Extending Penrose's Growth Theory. *Journal of Management Studies*, *48*(1), 48-74.

Maksimovic, V., Phillips, G., & Prabhala, N. R. (2011). Post-merger restructuring and the boundaries of the firm. *Journal of Financial Economics*, *102*(2), 317-343.

Malerba, F., & Orsenigo, L. (1999). Technological entry, exit and survival: An empirical analysis of patent data. *Research Policy*, *28*(6), 643-660.

Mata, J., & Portugal, P. (2002). The survival of new domestic and foreign-owned firms. *Strategic Management Journal*, *23*(4), 323-343.

Mata, J., & Portugal, P. (2004). Patterns of entry, post-entry growth and survival: A comparison between domestic and foreign owned firms. *Small Business Economics*, *22*(3-4), 283-298.

Mata, J., Portugal, P., & Guimarães, P. (1995). The survival of new plants: Start-up conditions and post-entry evolution. *International Journal of Industrial Organization*, *13*(4), 459-481.

Matsusaka, J. G., & Nanda, V. (2002). Internal capital markets and corporate refocusing. Journal of Financial Intermediation*, 11*(2), 176-211.

Meoli, M., Paleari, S., & Vismara, S. (2013). Completing the technology transfer process: M&As of science-based IPOs. *Small Business Economics*, *40*(2), 227-248.

Meyer, K. E., & Lieb‐Dóczy, E. (2003). Post-Acquisition Restructuring as Evolutionary Process*. *Journal of Management Studies, 40*(2), 459-482.

Miles, I. (2005). Knowledge intensive business services: Prospects and policies. *Foresight*, *7*(6), 39-63.

Mitchell, W. (1994). The dynamics of evolving markets: The effects of business sales and age on dissolutions and divestitures. *Administrative Science Quarterly*, *39*(4), 575-602.

Monin, P., Noorderhaven, N., Vaara, E., & Kroon, D. (2013). Giving Sense to and Making Sense of Justice in Postmerger Integration. *Academy of Management Journal, 56*(1), 256-284.

Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change*. Cambridge, MA: The Belknap Press of Harvard University Press.

Olley, G. O., & Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*, *64*(6), 1263-1297.

Pablo, A. L. (1994). Determinants of Acquisition Integration Level: A Decision-Making Perspective. *The Academy of Management Journal, 37*(4), 803-836.

Paruchuri, S., Nerkar, A., & Hambrick, D. C. (2006). Acquisition Integration and Productivity Losses in the Technical Core: Disruption of Inventors in Acquired Companies. *Organization Science, 17*(5), 545-562.

Pfeiffer, F., & Reize, F. (2000). Business start-ups by the unemployed: An econometric analysis based on firm data. *Labour Economics, 7*(5), 629-663.

Puranam, P., Singh, H., & Chaudhuri, S. (2009). Integrating Acquired Capabilities: When Structural Integration Is (Un)necessary. *Organization Science, 20*(2), 313-328.

Puranam, P., Singh, H., & Zollo, M. (2006). Organizing for Innovation: Managing the Coordination-Autonomy Dilemma in Technology Acquisitions. *The Academy of Management Journal, 49*(2), 263-280.

Puranam, P., & Srikanth, K. (2007). What they know vs. what they do: how acquirers leverage technology acquisitions. *Strategic Management Journal, 28*(8), 805-825.

Ranft, A. L., & Lord, M. D. (2000). Acquiring new knowledge: The role of retaining human capital in acquisitions of high-tech firms. *The Journal of High Technology Management Research*, *11*(2), 295-319.

Ranft, A. L., & Lord, M. D. (2002). Acquiring new technologies and capabilities: A grounded model of acquisition implementation. *Organization Science*, *13*(4), 420-441.

Ranft, A. L. (2006). Knowledge preservation and transfer during post-acquisition integration. *Advances in Mergers and Acquisitions, 5*, 51-67.

Reinganum, J. F. (1983). Uncertain innovation and the persistence of monopoly. *The American Economic Review*, *73*(4), 741-748.

Robins, J. M., Hernán, M. A., & Brumback, B. (2000). Marginal structural models and causal inference in epidemiology. *Epidemiology*, *11*(5), 550-560.

Santarelli, E., & Vivarelli, M. (2007). Entrepreneurship and the process of firms' entry, survival and growth. *Industrial and Corporate Change*, *16*(3), 455-488.

Singer, J. D., & Willett, J. B. (1993). It's about time: Using discrete-time survival analysis to study duration and the timing of events. *Journal of Educational and Behavioral Statistics*, *18*(2), 155-195.

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis:Modeling change and event occurrence*. New York, NY: Oxford University Press.

Sorenson, O., & Audia, Pino G. (2000). The social structure of entrepreneurial activity: Geographic concentration of footwear production in the United States, 1940–1989. *American Journal of Sociology*, *106*(2), 424-462.

Stein, J. C. (1997). Internal capital markets and the competition for corporate resources. *Journal of Finance, 52*(1), 111-133.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *15*(6), 285-305.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319-1350.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533.

Utterback, J. M., & Suárez, F. F. (1993). Innovation, competition, and industry structure. *Research Policy*, *22*(1), 1-21.

Xiao, J. (2014). Entrepreneurial Dynamics and Acquisitions of New Technology-Based Firms. (Doctoral dissertation). Department of Economic History. Lund, Sweden: Lund University.

Zaheer, A., Castañer, X., & Souder, D. (2013). Synergy Sources, Target Autonomy, and Integration in Acquisitions. *Journal of Management, 39*(3), 604-632.

Zhao, X. (2009). Technological Innovation and Acquisitions. *Management Science, 55*(7), 1170-1183.