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Acqui-hiring and deep-tech ventures: Evidence from Sweden

Jing Xiao* & Åsa Lindholm Dahlstrand**

Abstract:
Recently, acqui-hiring, which refers to the acquisitions driven by gaining access to target human capital, has emerged as a proliferating phenomenon in acquisitions of small technology firms. However, we still know little about this phenomenon, particularly outside the community of Silicon Valley. This study sheds new light on the nature of acqui-hiring by focusing on what drives acqui-hiring. Using a sample of 213 technological acquisitions of Swedish technology firms, our results show that firms tend to be acqui-hired when they are younger and when they are based on the development of deep tech, a group of emerging disruptive technologies, of which the technological base involves high levels of technological newness and complexity. The results show a support to our initial idea that acqui-hiring could be driven by the acquiring firm's need to acquire complex knowledge and/or new capabilities that are embodied in target key employees or engineering teams. In addition, we develop a typology and identify four types of acqui-hiring. We use case illustrations of deep-tech acqui-hiring to demonstrate four differentiated acquisition strategies, including technology strengthening, product expansion, product experimentation and technology experimentation.

Key words: Acqui-hiring, deep tech, technological acquisitions, technological newness and complexity, combined methods, Sweden

JEL Classification: G34 L26 O33 O32

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1. Introduction

Acquisitions have long been highlighted as an important mechanism for business and capability reconfiguration (Capron & Mitchell, 1998a; 1998b; Karim & Mitchell, 2000). Over recent decades, technological change has been accelerating at an unprecedented speed. In response to the emergence of a new wave of disruptive technologies (e.g., artificial intelligence), leading tech giants, such as Google and Meta, are increasingly using acquisitions of small technology ventures to insource new technologies and capabilities (WIPO, 2019). More recently, gaining access to target human capital has emerged as a prominent feature of acquisitions of small technology firms. This phenomenon is termed "acqui-hiring" and has attracted extensive attention from practitioners and the press (Coyle & Polsky 2013; Chatterji & Patro 2014). However, our current knowledge regarding this new form of acquisitions remains very limited. In this study, we focus on two aims. The first aim is to investigate the antecedents of acqui-hiring. The second aim is to develop a typology to demonstrate the differentiated strategies of how acquirers use acquired personnel and technology for business and capability reconfiguration.

Why does acqui-hiring occur? Among the two pioneering studies based on anecdotal evidence in Silicon Valley, Coyle & Polsky (2013) focus on the relationship between entrepreneurs and investors. They argue that entrepreneurs may fear potential social sanctions if they are just hired away through a normal recruitment channel without considering the consequences to their investors. Chatterji and Patro (2014), as the other pioneering study, emphasize acqui-hiring as a tool of (human) asset orchestration by top management team of acquirers to sustain competitive advantage. However, it is still not fully understood why incumbent firms need to engage in acqui-hiring instead of other channels to gain access to human capital. In this study, we seek to understand this question combining the perspectives of the knowledge-based view and the labor market approach.

The knowledge-based view suggests that individuals are the main carriers of knowledge (Grant, 1996; Kogut & Zander, 1992). According to this view, employee mobility naturally becomes a critical conduit of knowledge flow and diffusion (Almeida & Kogut, 1999). The labor market approach is relevant to the recruitment nature of acqui-hiring. The search and matching frictions in conventional labor markets imply that firms may use acquisitions as a strategic tool to search for scarce human capital. As technology advances, the new generation of frontier technology has become more complex and cumulative in nature (Broekel, 2018; Luo & Wood, 2017; Nelson & Winter, 1982). Newness and complexity have been two intertwined features of technological development. In this sense, we argue that the newness and complexity of target technology should be a critical factor that drives acquirers to engage in acqui-hiring. First, acqui-hiring could be a choice of acquirers given the interdependence between knowledge transfer and individuals, especially when the involved technology is complex. Second, acqui-hiring could also be a strategy of acquirers who are not able to find the appropriate employees through conventional labor markets, especially when they are searching for individuals or a team of individuals with the skills and capabilities related to the cutting-edge technology that is outside their existing knowledge base.

Over the recent decades, a group of disruptive technologies, such as artificial intelligence (AI), blockchain, cyber security, robotics, advanced materials and high-performance computing, has been emerging as a driver of future innovations. These technologies are referred to as "deep technology" (or "deep tech") to highlight its strong research base and significant potential of societal and environmental impact (Boston Consulting Group & Hello Tomorrow, 2019). Venture capitalists (see e.g., Chaturvedi, 2015) use the concept of deep tech to distinguish the startups which are developed based on concrete scientific discovery or engineering innovation (e.g., DeepMind and Boston Dynamics) from those based on business model innovation (e.g., Uber and Airbnb). In this study, we use deep tech to capture the target firms of which the technological base involves high levels of technological newness and complexity, and test whether deep-tech ventures are more likely to be acqui-hired relative to other tech ventures.

We use Sweden as our empirical base. We collect the data from a wide range of sources and develop a method to identify acqui-hiring systematically by tracing the post-acquisition career path of target founding teams and key employees. The final sample consists of 213 recent acquisitions of Swedish technology firms, of which 47 are identified as acqui-hiring. Based on the descriptive and regression analyses, we show what characterizes acqui-hired ventures relative to other acquired firms. More specifically, we find that firms tend to be acqui-hired when they are younger, when they are based on the development of deep tech, when they are in the ICT sector, especially when the acquirers are from the US.

In addition, we divide acqui-hiring into four categories based on two dimensions: component technology and market relatedness. The former is a critical dimension to capture for what purpose the acquired technology is used, and the latter is a critical dimension to capture the potential of strategic interdependence between the acquirer and target firm in product markets. We apply this typology into the observations of deep-tech acqui-hiring identified from our sample. We further select four representative cases, one from each category, and use case illustrations to briefly demonstrate the differentiated strategies of acquirers.

This paper continues as follows. Sect. 2 discusses the theoretical framework. Sect. 3 describes the data and variables. Sect. 4 displays the regression analysis and results. Sect. 5 presents the typology analysis and case illustrations. Sect. 6 discusses and concludes the paper.

2. Theoretical framework

2.1 Acqui-hiring and deep-tech ventures

Why do firms hire new talents through acquisitions? First, acqui-hiring could be a choice of acquirers given the interdependence between knowledge transfer and individuals. The knowledge-based view suggests that knowledge is the most valuable resource to sustain a firm's competitive advantage, and knowledge is argued to be embodied in individuals, in either individual or collective form (Grant, 1996; Kogut & Zander, 1992). In this sense, employee mobility naturally becomes a critical conduit of knowledge flow and diffusion (Almeida & Kogut, 1999). To leverage the acquired technologies and capabilities, acquirers need to depend on target employees to facilitate knowledge transfer and absorption. A large group of research on corporate acquisitions has revealed that the retention of target executives is positively related to post-acquisition integration and performance (see e.g., Bilgili et al., 2017; Krug et al., 2014, for a review). Recent studies on high-tech acquisitions have turned to focus on the critical role of knowledge workers, such as R&D personnel or scientists, in facilitating acquirers to absorb target technological capabilities or develop highly impactful knowledge (Park et al., 2018; Ranft & Lord, 2000).

Second, acqui-hiring could also be a strategy for acquirers who are not able to find the appropriate employees through conventional labor markets. Like other markets, labor markets also suffer from the search and matching frictions, referring to the market inefficiency due to the difficulties of locating an appropriate employer/employee or the misallocation between employers and employees (Martellini & Menzio, 2021; Pissarides, 2011). Firms may not easily find the individuals with matched skills or capabilities through conventional labor markets, especially when they are searching for a team of talents with a certain type of collective human capital. Firms coordinate and integrate the specialized knowledge embedded in individuals and create their own unique organizational capabilities and routines which are difficult for others to imitate (Grant, 1996; Kogut & Zander, 1992). These organizational imprints and competences tend to reside in the organizational networks and social relationships among individuals (Kogut & Zander, 1992; Nelson & Winter, 1982). The social component of knowledge exists collectively within a team of key employees in the form of shared routines, behaviors, social norms, attitudes, and culture (Barney, 1991; Nelson & Winter, 1982; Ranft & Lord, 2000), and thus depends on the mobility of a team to facilitate knowledge transfer. According to this view, one explanation for why acquiring firms use acquisitions rather than other recruitment channels could be the market failure or inefficiency of conventional labor markets.

The technological base of deep-tech ventures involves high levels of technological newness and complexity, which distinguishes them from other technology ventures. First, many of the deep-tech ventures are still in their early stage of development and their market applications have not yet been clearly identified (Boston Consulting Group & Hello Tomorrow, 2019). Deep tech thus may consist of a significant portion of tacit knowledge as the knowledge related to deep tech has not yet been extracted and codified from practice (Inkpen & Dinur, 1998; Spender, 1996). Second, deep-tech ventures are based on a group of cutting-edge technologies, many of which emerge from basic research and could be the incubators of next generation of platform technologies. These advanced technologies usually exhibit a cumulative nature and tend to draw on multidisciplinary knowledge. The more complex the knowledge, the more difficult it is to articulate and transfer and the more likely it is to embed in individuals and their social relationships (Kogut & Zander, 1992). These two features imply that, on the one hand, acquirers may depend more on target employees to leverage the acquired knowledge when the targets are deep-tech ventures. On the other hand, incumbents may face more difficulties in locating or finding human capital with matched skills or capabilities related to deep tech that is outside their existing knowledge base. In this sense, acqui-hiring becomes a viable choice. We argue that deep-tech ventures are more likely to be targets for acqui-hiring compared to other tech ventures.

2.2 Types of acqui-hiring

To categorize acqui-hiring and the underlying strategies of acquirers, we develop a typology based on two important dimensions related to technological acquisitions. The first is component technology. This is a critical dimension to capture for what purpose the acquired technology is used. Acquisitions may be driven by different motivations (Graebner, 2010). The major motivation behind justifies why the acquirer initiates the transaction and thus should indicate in what way acquisitions will influence the acquiring company. We follow Puranam et al. (2009) to distinguish between two purposes for acquiring technology. In the first scenario, the acquirers use the acquired technology to fill knowledge gaps in their existing innovation/product development processes. In the second scenario, the acquirers use the acquired technology to develop standalone innovations/products.

The second is relatedness. This is a critical dimension to capture the potential of strategic interdependence between the acquiring and the target firm. In the mergers and acquisitions (M&As) literature, relatedness in resources and knowledge bases between the acquiring and target firm before acquisition is an important factor to predict the post-acquisition levels of integration and performance (Aghasi et al., 2017; Ahuja & Katila, 2001; Cassiman et al., 2005; Cloodt et al., 2006; Hagedoorn & Duysters, 2002; Puranam et al., 2009). On the one hand, relatedness may imply a high potential of synergistic gains of acquisitions that could derive from economies of scale or scope (Hagedoorn and Duysters 2002). On the other hand, relatedness could promote knowledge transfer and recombination as the cognitive proximity in knowledge bases between the acquiring and target firm eases communication and interactive learning (Cohen & Levinthal, 1989; Lane & Lubatkin, 1998).

The organizational learning literature suggests that firms need to possess two distinctive learning processes, exploitative learning and explorative learning, to sustain long-term competitiveness and survival (March, 1991). Exploitative learning aims for leveraging a firm's existing knowledge or capabilities, while explorative learning aims for augmenting a firm's knowledge base or building new capabilities (March, 1991). Thus, an exploitative acquisition strategy (often reflected by a high level of relatedness between the acquiring and target firm) is more common among acquirers focusing on creating and realizing synergies based on their existing activities, while an explorative acquisition strategy (often reflected by a low level of relatedness) instead is more common among acquirers focusing on experimenting with new growth opportunities.

In this study, we argue that firms engage in acqui-hiring to access human resources not available internally. If the knowledge base between the acquiring and target firm is too similar, the acquiring firm could easily obtain the needed human capital internally or build the human capital through on-the-job training. Or the acquiring firm possesses the knowledge which allows it to efficiently search for qualified candidates from external labor markets. Hence, technological relatedness, which reflects the overlap between the acquiring and target firm in knowledge base, may not be an important factor to distinguish different types of acqui-hiring. Instead, we use market relatedness to capture the overlap between the acquiring and target firm in product market (Cassiman et al., 2011; Hagedoorn & Duysters, 2002), which distinguishes between the strategies aiming for exploitative learning and explorative learning in product markets.

By combining the two dimensions, we define four types of acqui-hiring, as shown in Figure 1. Quadrant I and II captures the situations when the market relatedness between the acquiring and target firm is high, which reflects a more exploitative strategy of the acquirer to rationalize and strengthen its competitive advantage in one of its existing product markets. We term Quadrant I "technology strengthening", and the acquirer in this category is expected to use the acquired personnel's knowledge to strengthen the technological leadership in one of its existing product markets. We term Quadrant II "product expansion", and the acquirer in this category is expected to leverage the acquired personnel's capability to develop new products or business lines in one of its existing product markets. Quadrant III and IV captures the situations when the market relatedness between the acquiring and target firm is low, which reflects a more explorative strategy of the acquirer to experiment with new technological or business opportunities in an unfamiliar business environment. We term Quadrant III "product experimentation", and the acquirer in this category is expected to leverage the acquired personnel's capability to experiment with new products or business lines which are not directly related to its existing business areas. We term Quadrant IV "technology experimentation", and the acquirer in this category is expected to use the acquired personnel's knowledge to experiment with new technologies which are not directly related to its existing business areas.

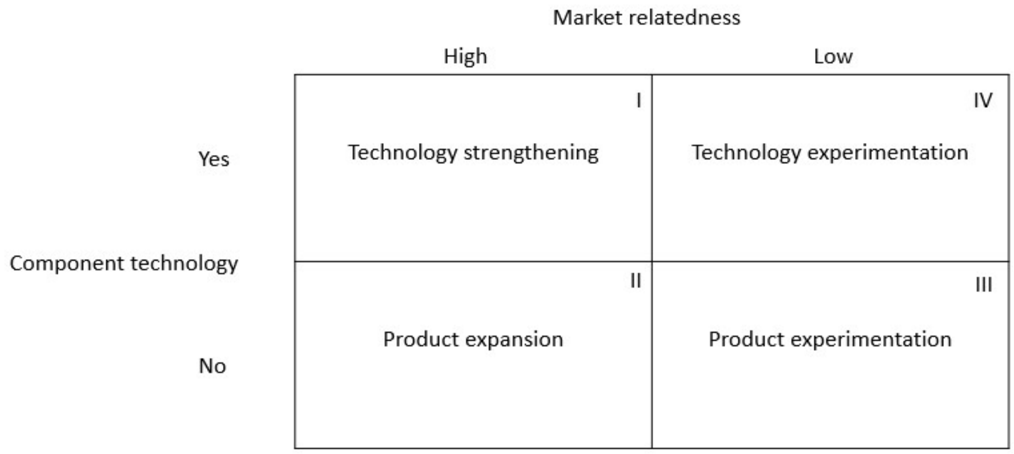

Figure 1 Typology of acqui-hiring.

3 Data and variables

3.1 Base data and sample

The data for our analyses are collected from various sources. The base data of acquisitions are from CrunchBase. CrunchBase is a leading data platform founded by TechCrunch in 2007. It traces up-to-date information of technology ventures worldwide. CrunchBase also collects data related to a wide range of activities/actors in entrepreneurial ecosystems, such as funding, investment, investors, entrepreneurs, M&As. Based on CrunchBase, we have access to several variables related to acquisitions, such as acquisition dates, names of acquiring and target firms, locations, technological category, firm description. Particularly, the variable of technological category provides a unique source of information on technological background of target firms. Because conventional industrial classification scheme such as the NACE system may neglect technology firms which operate in traditional sectors, we use the variable of technological category plus the description of target firms as the source to define technology firms and deep tech. We define technology firms as those which are based on the development of technology products or services. Following Boston Consulting Group & Hello Tomorrow (2019), we define deep tech as the following cutting-edge technologies: AI, blockchain, cyber security, cloud technologies, Internet of Things (IoT), biotechnology, advanced materials, robotics, photonics, electronics, and high-performance computing.

In Crunchbase, we searched Swedish firms which were founded after 1999 and acquired between 2009 and 2017, which ends up with 404 acquisitions[1]. In the data cleansing stage, we drop one error case where the target founding year is later than the acquisition year and the cases where the target firms are suspected to be acquired for the purpose of share restructuring (e.g., when the target and acquirer has the same owner). Furthermore, we exclude the non-technology firms. The final sample contains 213 acquisitions of Swedish technology firms.

Identifying acqui-hiring

To distinguish acqui-hiring from other acquisitions, we link the employee profiles of each target firm in LinkedIn and trace the career path of the entrepreneurs or key employees up to four years after acquisitions. By going through the employee profiles, we focus on individuals

[1] The search was conducted on March 13, 2019.

in the founding teams (with the titles such as founder or co-founder), the management teams (with the titles such as CEO, CTO, CFO, COO, managing director, or VP) and key employees (with the titles such as chief design engineer, senior knowledge architect or lead project engineer). If at least one of the entrepreneurs or key employees of the acquired firm who either stayed in the acquired firms or switched their employer to the acquiring firm or the business unit which are affiliated to the acquiring firm, we group the acquisition into the category of "acqui-hiring". This process ends up with 47 acqui-hired firms.[2]

3.2 Financial and other business data

Lack of tangible assets and a good measure of valuation makes it difficult for small young firms, especially those depending on tacit knowledge and high technologies, to gain capital from external financial markets (Meoli et al., 2013). In this context, being acquired by incumbents has been an alternative commercialization strategy for many entrepreneurs, especially those who are facing financial difficulties (Andersson & Xiao, 2016; Gans & Stern, 2003). The two pioneering studies on acqui-hiring also point out that acqui-hiring may be a bailout for entrepreneurs in financially struggling ventures (Coyle & Polsky 2013; Chatterji & Patro, 2014). Entrepreneurs with financial difficulties may be more likely to be acquired in the form of acqui-hiring than other types of acquisitions because acqui-hiring not only solves the difficult situation of the start-ups but also finds a career solution for themselves. To control for the potential impacts of financial situations, we construct four financial indicators which have been used in previous studies to measure financial performance of small young firms (Meoli et al. 2013, Andersson and Xiao 2016), including *Productivity*, *Profitability*, *Internal financial resources* and *Leverage*, and include them as controls for our analysis.

To add financial data and other relevant business data for target firms, we link our base sample to the Serrano database. The Serrano database is a comprehensive firm-level database that compiles historical financial data for Swedish firms from 1998. The database builds on the financial data from the Swedish Companies Registration Office (Bolagsverket). The Serrano database is also supplemented with other sources of business data, including the data from Statistics Sweden (SCB) and Bisnode's group register. To improve the matching rate of the data, we add the organizational number of each target firm before matching. We obtain the organizational number by matching the names of target firm with Zephyr database and Retriever Business database. The Zephyr database is a comprehensive database on M&As worldwide[3] and the Retriever business database contains data for Swedish firms.[4] At the end, there are 185 firms matched with the Serrano Database[5].

We use the variable of deep tech to indicate the technological newness and complexity of the technological base of target firms. In addition, the Serrano Database provides a variable of sectoral branch to categorize the sector of the firms into 11 overall areas, see Table A1 in the appendix. Based on this variable, we construct a variable of ICT (Information and Communications Technology) as a control for sectoral activities and as an alternative indicator of the technological newness and complexity. ICT includes the sectoral areas of IT, electronics, telecommunications and media. The other control variables are mainly from

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[2] One limitation of this method is that it is subject to the data availability of individual career profiles in LinkedIn.

[3] The Zephyr database is compiled and developed by Bureau van Dijk.

[4] The Retriever business database is compiled and developed by Mediebevakning och analys.

[5] Among the 28 non-matched, 22 is because of the failure of identifying their organizational numbers, and 6 is because their organizational numbers were not found in the Serrano database.

Crunchbase, with missing values supplemented form the Retriever Business database[6]. Table 1 displays the description of the variables and their respective data sources.

3.3 Descriptive analysis

The final sample contains 213 acquisitions of Swedish technology firms that were founded between 1999 and 2016 and acquired between 2009 to 2017. Among others, there are 47 acqui-hired firms, which account for 22% of the acquisitions in the sample. Most of the firms in the sample are small young firms. The median size of the target firms is 14 employees, and the median age is 8 years old. There are 36 firms (17%) classified in the category of deep tech and 117 firms (63%) classified in the category of ICT.[7] Over 70% of the firms are located in the three metropolitan areas in Sweden, with 55% in Stockholm, 10% in Gothenburg and 8% in Malmö. The value added per employee is about 460,000 Swedish kronor in average (base year=2009). However, over 50% of the firms show an operating loss. The high values of standard deviation for *Internal financial resources* and *Leverage* reveal there is a high variability among firms in terms of their financial situations. Over 40% of the acquirers are from Sweden, 24% from the US, and 35% from other countries.

[6] In case of any discrepancy of business data between Crunchbase and Retriever, Retriever prevails.
[7] It is noteworthy that 28 observations have missing values for the variable of ICT and 21 firms that are classified in both deep tech and ICT.

Table 1 Variable description, descriptive statistics and data sources

Variables	Description	Obs.	Mean	Median	Std. Dev.	Min.	Max.	Data source
Ac_year	Acquisition year	213	2015	2016	2.2973	2009	2017	Crunchbase, Retriever
Acquihiring	Dummy variable for acqui-hiring	213	0.2207	0	0.4157	0	1	Crunchbase, LinkedIn
Target_size	Size of target firm	185	22.9243	14	27.2539	0	167	Serrano
Target_year	Founding year of target firm	213	2006	2006	4.5338	1999	2016	Crunchbase, Retriever
Target_age	Age of target firm at year of acquisition	213	8.6479	8	4.4194	1	18	Crunchbase, Retriever
Deep_tech	Dummy variable for technological filed of deep tech	213	0.1690	0	0.3756	0	1	Crunchbase
ICT	Dummy variable for technological filed of ICT	185	0.6324	1	0.4835	0	1	Serrano
Stockholm	Dummy variable for target firm located in Stockholm	213	0.5540	1	0.4982	0	1	Crunchbase, Retriever
Gothenburg	Dummy variable for target firm located in Gothenburg	213	0.1033	0	0.3050	0	1	Crunchbase, Retriever
Malmo	Dummy variable for target firm located in Malmo	213	0.0845	0	0.2788	0	1	Crunchbase, Retriever
Rest	Dummy variable for target firm located in the rest regions (reference group)	213	0.2582	0	0.4387	0	1	Crunchbase, Retriever
Productivity	Value added per employee (in thousands of Swedish Kronor; deflated by CPI, base year=2009)	172	460.4696	615.1609	833.7873	-3637.1080	3360.7920	Serrano
Profitability	Ratio of operating profit to total asset	183	-0.2180	-0.0099271	1.0031	-10.6596	0.8468	Serrano
Internal financial resources	Ratio of cash flow to sales	169	1.8944	0.1021583	10.6999	0.0000	119.4815	Serrano
Leverage	Ratio of debt to equity	175	12.3561	1.4542	63.5998	0.0003	708.8800	Serrano
Swedish acquirer	Dummy variable if the acquirer from Sweden	213	0.4038	0	0.4918	0	1	Crunchbase
US acquirer	Dummy variable if the acquirer from the U.S.	213	0.2441	0	0.4306	0	1	Crunchbase
Other	Dummy variable if the acquirer from the other countries (reference group)	213	0.3521	0	0.4788	0	1	Crunchbase

Note: The variables of productivity, profitability, internal financial resources, leverage, and target size are measured at one-year before acquisition. There are some missing values in some variables.

3.4 A closer look at acqui-hiring

Figure 2 shows the numbers of acqui-hiring and all acquisitions of Swedish tech firms between 2009 and 2017 in our sample. There is only one acqui-hiring in 2009. Between 2010 and 2014, the number stabilizes at about 4 acqui-hirings on average annually. Chatterji and Patro (2014) mention that acqui-hiring has been popular in Silicon Valley since 2011. Compared to the total number of acquisitions of Swedish tech firms, the share of acqui-hiring in Sweden shows a high variability over time.

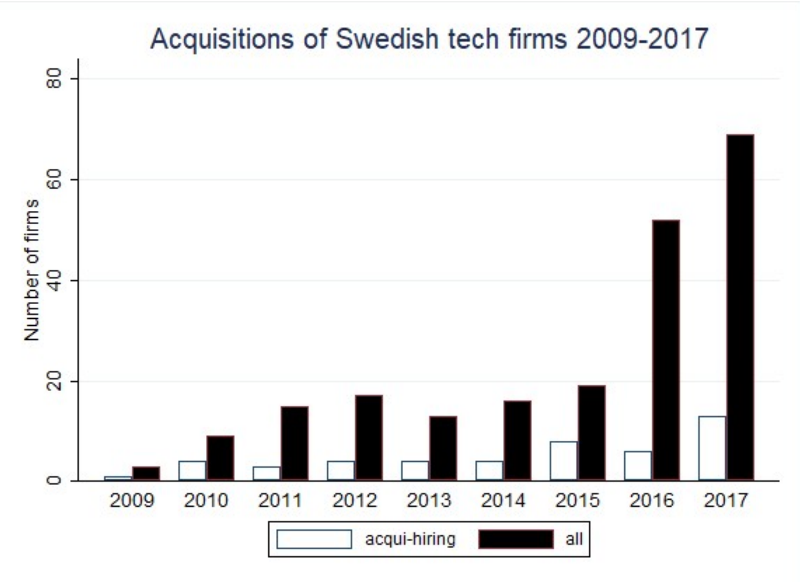

Figure 2 Acquisitions of Swedish tech firms 2009-2017

Among the 47 acqui-hirings, 30% of the firms (14 firms) are based on the development of deep tech, which is much higher than the share of deep-tech acquisitions in the whole sample (17%). Table 2 further breaks down the acqui-hired firms by some main variables. In terms of the sectoral area, over 78% of the acqui-hired firms are in the sector of ICT (IT & Electronics and Telecom & Media), again a figure which is much higher than that of the whole sample. It seems that deep-tech and ICT firms are more likely to be acqui-hired. Furthermore, it is noteworthy that over 80% of the firms were established within 10 years when they were acqui-hired and over 90% of the firms had fewer than 15 employees before acqui-hiring. It seems that smaller and younger firms are more likely to be acqui-hired compared to other acquired firms. In terms of the location, about 53% of the acqui-hired firms are located in Stockholm, which is a bit lower than the share in the whole sample.

Table 2 Frequency of acqui-hired firms by some main variables

Variable	Frequency	Percent	Cum.
Target age (at year of acquisition)			
1-10	40	85.11	85.11
11-15	7	14.89	100.00
Total	47		
Size			
≤10	23	56.10	56.10
11-15	17	41.46	97.56
101-250	1	2.44	100.00
Total	41		
Location			
Stockholm	25	53.19	53.19
Gothenburg	6	12.77	65.96
Malmo	6	12.77	78.72
Rest	10	21.28	100.00
Total	47		
Sectoral area			
IT & Electronics	28	68.29	68.29
Telecom & Media	4	9.76	78.05
Corporate services	4	9.76	87.80
Shopping goods	2	4.88	92.68
Finance & Real estate	2	4.88	97.56
Industrial goods	1	2.44	100.00
Total	41		

4. Regression analysis and results

We use the logit model to quantitatively measure the impact of technological and financial factors on the probability of target firms being acquired in the form of acqui-hiring relative to other types of acquisitions. The correlation matrix of the variables is presented in Table A2 in the appendix and the regression results are shown in Table 3 below. To facilitate interpretation of the impact of the variables, we report odds ratio (exponentiated coefficients) in Table 3. An odds ratio greater than 1 means a positive effect of the variable on the occurrence of being acqui-hired, and vice versa. In Specification (1) of Table 3, we only include the variable of deep tech, which shows a strong significantly positive effect on being acqui-hired. Deep-tech firms have a 178% [(2.777-1)*100%] higher odds ratio of being acqui-hired. In Specification (2), we add the variable of ICT, which also shows a significantly positive effect on being acqui-hired. In Specification (3), we add the variables of firm age and size. Both are found to have negative effects on being acqui-hired, but the effect of firm size is not statistically significant. It is noted that the positive effect of ICT gets stronger after adding firm age and firm size. In Specification (4), we add location variables. Being located in Stockholm has a negative effect and being located in either Gothenburg or Malmo has a positive effect. However, the effects of all the three location variables are not statistically significant. In Specification (5), we add the country/region of origin of acquirers. We find that acquirers from the US are significantly more likely to engage in acqui-hiring. This positive effect is particularly strong. Since the variable of Swedish acquirers is not significant, we drop it in Specification (6), i.e., we test the effect of the US acquirers relative to the acquirers from all the other countries (including Sweden). Similarly, we group the variables of Gothenburg and Malmö into one variable in Specification (6) because both show a positive but non-significant effect. We find that the positive effect of the US acquirers is relatively lower in Specification (6) than in Specification (5). In Specification (7), after adding the financial variables, being in Stockholm now shows a positive but still non-significant effect. However, the positive effect of the US acquirers gets even stronger. It is noted that both deep tech and ICT show a lower positive effect. Particularly, the effect of deep tech is only significant at 10% level and the variable of ICT becomes non-significant. One possible explanation could be that there are less observations in the regression because the financial variables have more missing values. In terms of the financial variables, none of them show a significant effect. That is, compared to other technological acquisitions, entrepreneurs involved in acqui-hiring seem not to be driven by financial motivations.

To summarize, we find the following characteristics that distinguish acqui-hiring from other technological acquisitions. Firms tend to be acqui-hired when they are younger, when they are based on the development of deep tech, when they are in the ICT sector, especially when the acquirers are from the US. However, the financial variables are not found to have significant impact on being acqui-hired. The results show a support to our initial idea that acqui-hiring could be driven by the acquiring firm's need to acquire complex knowledge and/or new capabilities that are embodied in target key employees or engineering teams.

Table 3 The impact of technological and financial variables on being acqui-hired

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Deep_tech	2.777***	3.420***	3.513***	3.547***	2.696**	2.633**	2.443*
	(1.090)	(1.434)	(1.532)	(1.595)	(1.275)	(1.234)	(1.265)
ICT		2.633**	3.415***	3.072**	2.441*	2.490*	1.385
		(1.120)	(1.542)	(1.414)	(1.171)	(1.192)	(0.732)
Target_age			0.880**	0.865***	0.860***	0.861***	0.829***
			(0.0451)	(0.0473)	(0.0487)	(0.0488)	(0.0569)
Target_size			0.891	0.938	0.988	0.981	0.834
			(0.167)	(0.180)	(0.198)	(0.195)	(0.225)
Stockholm				0.871	0.848	0.504	1.130
				(0.428)	(0.426)	(0.251)	(0.630)
Gothenburg				1.490	1.567		
				(0.986)	(1.054)		
Malmo				2.085	1.777		
				(1.431)	(1.235)		
Gothenburg+Malmo						1.646	2.517
						(0.929)	(1.625)
Swedish					1.292		
					(0.631)		
US					3.431**	3.010**	4.294***
					(1.763)	(1.302)	(2.285)
Productivity							1.000
							(0.000419)
Profitability							1.094
							(0.561)
Internal financial							0.987
							(0.0227)
Leverage							0.939
							(0.0498)
Constant	0.229***	0.110***	0.346*	0.350	0.264*	0.308*	0.959
	(0.0442)	(0.0432)	(0.188)	(0.229)	(0.193)	(0.206)	(0.832)
Obs	213	185	185	185	185	185	156
Log-likelihood	-109.19758	-91.068958	-85.949112	-84.812822	-81.570397	-81.729591	-67.076175
Prob > chi2	0.0113	0.0011	0.0001	0.0005	0.0002	0.0000	0.0003

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Results are reported in the form of odds ratio. Target_size is measured in the logarithmic form of (employee number+1) as some firms have zero employees.

5. Typology of deep-tech acqui-hiring

5.1 How to operationalize the two dimensions

In Sect. 2.2, we group acqui-hiring into four categories based on two dimensions: component technology and market relatedness. Following the previous studies (Aghasi et al., 2017; Puranam et al., 2009), we use information from press releases to measure component technology. Component technology was coded as 1 if the acquirer aimed to use the acquired technology to fill knowledge gap in their existing product development. For example, when the press release mentioned that the acquired firm "will all be winding down their existing projects to focus on VR full-time at Oculus as part of both product engineering and Oculus Research" (Meta, 2014). On the contrary, component technology was coded as 0 if the acquirer aimed to use the acquired technology to develop standalone products. For example, when the acquired firm mentioned that "This acquisition provides strong synergies for both companies as it enables us to increase the pace of introducing new leading wireless products through MediaTek's global network" (MediaTek, 2012).

Following the previous studies (Aghasi et al., 2017; Puranam et al., 2006), we measure market relatedness as the overlap in SIC (Standard Industrial Classification) codes between the acquiring and target firm. The relatedness was assessed mainly based on all SIC codes (4-digit) each firm has and calculated as the number of overlapped codes divided by the number of all codes of the acquired firm. For the share ranging between 0 and 1, we depended on whether there is overlap in the primary codes (4-digit) between the acquiring and target firm as the final value for relatedness. We derive the data of SIC codes from Zephyr Database.

We apply this typology to the 14 deep-tech acqui-hirings identified from our sample. Table 4 displays a summary of basic information of the 14 acqui-hirings, including target name, target location, target technological base, year of acquisition, acquirer name, country/region of origin of the acquirer, component technology and market relatedness. As noted in Table 4, the 14 deep-tech ventures cover several important technological fields which represent Sweden's technological strength, such as ICTs, semiconductor and autonomous driving related technologies. The typology of the 14 acqui-hirings is shown in Figure 3.

Table 4 The 14 deep-tech acqui-hirings

Target	Location	Tech_base	Ac_year	Acquirer	Acquirer_country/region	Component technology	Market relatedness
Donya Labs	Linkoping	3D-optimization, Virtual reality (VR)	2017	Microsoft	US	1	0
13th Lab	Stockholm	3D model, VR	2014	Oculus/Facebook (Meta)	US	1	0
Tail-f Systems	Stockholm	Network automation	2014	Cisco	US	1	1
Saplo	Malmo	Text analysis, Machine learning	2015	Strossle	SE	0	1
AnaCatum	Linkoping	Analog to Digital Converter (ADC), Application-specific integrated circuit (ASIC), Semiconductor	2014	Fingerprint Cards	SE	1	0
Coresonic	Linkoping	Digital Signal Processor (DSP), Semiconductor	2012	MediaTek	TW	0	1
Expertmaker	Malmo	AI, Machine learning, Big data analytics	2016	eBay	US	1	0
Fotonic	Skelleftea	Light detection and ranging (LiDAR), Time of Flight cameras	2017	Autoliv	SE	1	0
Pelagicore	Gothenburg	Autonomous driving, Connectivity/IoT, Telematics, Navigation technologies	2016	Luxoft	CH	0	1
Mistbase	Lund	IoT, Telecommunications	2017	ARM	UK	0	0
OCULUSai	Stockholm	Image and object recognition technology, AI	2013	Meltwater	US	1	0
Acumem	Uppsala	High-performance computing (HPC) tool	2010	Rogue Wave Software	US	0	0
Panopticon	Stockholm	Big data analytics (visual data discovery)	2013	Datawatch	US	0	1
Syntune	Stockholm	Tunable laser, Photonics	2009	Ignis/Finisar	US	0	0

Note: Oculus was later acquired by Facebook (Meta) and Ignis was later acquired by Finisar.

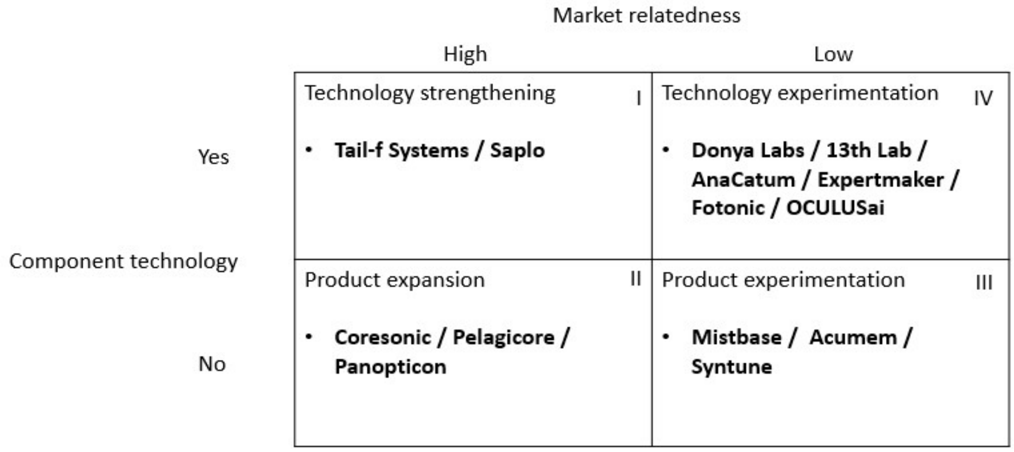

Figure 3 Typology of the 14 deep-tech acqui-hirings

5.2. Case illustrations

In this section, we select 4 representative cases, one from each category as shown in Figure 3, and use case illustrations to briefly demonstrate the differentiated acquisition strategies. The four case illustrations are based on publicly available information from e.g., press releases and media articles.

Technology strengthening: Tail-f Systems acquired by Cisco

Tail-f Systems is a Stockholm-based firm, founded in 2005. It is a leading developer of multi-vendor network service orchestration solutions. Tail-f's technology reduces operating costs and delivery time, which allows IT companies and network equipment vendors to provide more competitive solutions and services.

Cisco acquired all shares of Tail-f in July 2014. In Cisco's press release, Hilton Romanski, senior vice president of Cisco Corporate Development, made two important statements related to the transaction.

> *"With a rapidly increasing number of people, devices, and sensors connecting across the Internet of Everything (IoE), service providers require new capabilities to deliver value-added, cloud-based services and applications."* (Cisco, 2014)

> *"Our goal is to help to eliminate the bottleneck caused by operational complexity within the network. The acquisition of Tail-f's network services configuration and orchestration technology will extend Cisco's innovation in network function virtualization, helping service providers reduce operating costs and the time it takes to deploy new services, making agile service provisioning a reality."* (Cisco, 2014)

In the press release, Cisco also highlighted that the target employees would join Cisco's Cloud and Virtualization Group after acquisition and Cisco would use retention incentives to retain the target employees. Among others, Jan Lindblad, who was Principal Solutions Architect of Tail-f, joined Cisco after acquisition and still stayed until now as Engineering Architect.

In this case, Cisco was motivated to acquire Tail-f's technology to advance its own innovation in cloud virtualization. In contrast to Tail-f, which focuses on a niche market in network service orchestration solutions, Cisco is a technology conglomerate, develops and manufactures networking and telecommunications products or services. As to market relatedness, the two companies have an overlap in the market of networking software and solutions. From this case, we observe a strategy of "technology strengthening" where Cisco aimed to use the acquired technology and personnel to strengthen its technological leadership in one of its existing business areas.

Product expansion: Coresonic acquired by MediaTek
Coresonic is a spin-off from Linköping University. It was founded in December 2004, as a result of ten years of research at the University. All four founders are researchers from the Department of Systems Engineering, Linköping University.

Coresonic is a market leader in Digital Signal Processor (DSP) architecture for wireless basebands. The new type of processor architecture can save both silicon surface and power consumption, which reduces costs and increases flexibility for the production of integrated circuit (IC).

In 2011, Coresonic was one of the companies on Ny Teknik's 33 list, a national list of the country's most promising innovative start-ups. Earlier that year, Coresonic had received a breakthrough order from MediaTek, a semiconductor giant based in Taiwan, which is a world leader as a brandless designer, developing and providing IC products and services, such as multimedia IC chips, ICs for advanced consumer electronics. MediaTek bought all shares of Coresonic in April 2012.

In its press release, MediaTek revealed some information related to the motivations behind the deal.

> *"MediaTek will use Coresonic's DSP technology to further improve the efficiency and flexibility of its expanding product lines, strengthening MediaTek's position as a leading provider of wireless communication and digital multimedia IC solutions."* (MediaTek, 2012)

Johan Lodenius, CEO of Coresonic until the deal, commented that:

> *"This acquisition provides strong synergies for both companies as it enables us to increase the pace of introducing new leading wireless products through MediaTek's global network."* (MediaTek, 2012)

The press release also mentioned that Coresonic would become a wholly owned subsidiary of MediaTek after acquisition. Coresonic continues to develop its DSP processor platform in Linköping. The 20 employees of the former Coresonic would be retained. In 2020, Coresonic/MediaTek Sweden presents its first 5G processor, Dimensity. Central in the development are two of Coresonic's co-founders, still working with the development in Linköping (Elektroniktidningen, 2020).

The main aim of the acquisition was to expand existing product lines. As to market relatedness, the two companies both operated in the semiconductor industry. But compared to MediaTeck which engages in a wide range of IC related products, Coresonic specializes in the new DSP technology. This case represents a strategy of "product expansion", where the acquirer aimed to use the acquired personnel's capability to develop new products and strengthen its leadership in its existing product markets.

Product experimentation: Mistbase acquired by ARM
Mistbase is a spin-off from Lund University. It was founded in 2015 by Michal Stala and Magnus Midholt together with LU Holding AB – Lund University's holding company. Mistbase develops wireless communication hardware and software in the field of IoT. In 2016, Mistbase demonstrated the first hardware prototype of IoT modem at the Mobile World Congress in Barcelona. In 2017, Mistbase was acquired by ARM, which is a world leading semiconductor and software design company based in UK.

Di Digital (Norrlid, 2017) reports that ARM has the ambition to build a "wireless design center" in Lund and thus expects to see a growing number of employees of Mistbase in the coming years.

> *"The acquisition makes it clear that Skåne has a vision to become a world leader on the internet of things. In many deals, you buy technology and expertise and move the team to, for example, California, but here you build on the team on spot," said Linus Wiebe, Innovation director at LU Holding AB, which is one of the major owners of Mistbase until the deal.* (Norrlid, 2017)

Clearly, ARM targets the technology and the team, but not for their existing innovation or products. ARM was not a major player in the field of IoT before the deal. As to market relatedness, the two companies have no overlap in the existing product markets. IoT is an emerging disruptive technology which challenges the status of quo of the semiconductor industry. To mitigate the influences of disruption, many semiconductor companies are actively devising new strategies, e.g., to identify new products or business areas through experimenting with their ecosystem partners (Ciacchella et al., 2018). As shown in the case of Mistbase, it represents a "product experimentation" strategy where the acquirer aimed to use the acquired personnel's capability to experiment with new products or business lines related to the emerging IoT technology.

Technology experimentation: Expertmaker acquired by eBay
Expertmaker was founded by Lars Hård in 2006. The Malmö-based company specializes in data mining solutions powered by AI, machine learning and Big Data analytics. Since 2010, Expertmaker has been working with e-commerce giant eBay, helping the company structure data to improve eBay's insights into supply and demand. In 2015, Expertmaker was awarded the prize "Rapidus Company of the Year". In 2016, ExpertMaker was acquired by eBay.

As a global trading platform, eBay is in urgent need of a full understanding of market and customer data. This made acquisition of a team of engineers with a tailored expertise a viable and fast solution. According to the press release of eBay, human capital was clearly emphasized as the main target of the transaction. Lars Hård, founder and CEO of Expertmaker, joined eBay as Director of Data Science.

> *"As a part of eBay, Expertmaker's technology, expertise and talented engineers will play an important role in helping advance eBay's structured data initiative," said Amit Menipaz, Vice President and General Manager of Structured Data at eBay.* (eBay, 2016)

According to the statement, the major motivation behind the deal was to advance eBay's own structured data initiative. As to market relatedness, the two companies have no overlap in product markets. This case represents a strategy of "technology experimentation", where the acquirer aimed to use the acquired personnel's expertise and capability to experiment with new technologies and identify new growth opportunities.

6. Discussion and conclusion

In this paper, we aimed to shed new light on the nature of acqui-hiring. Using a sample of 213 technological acquisitions of relatively young Swedish firms (founded after 1999), we investigated what characterized acqui-hired ventures relative to other acquired ventures. Our quantitative analysis shows that acqui-hired ventures tend to be younger than other acquired ventures. They are also more often based on the development of deep tech, and in the ICT sector, especially when the acquirers are from the US. The results show a support to our initial idea that acqui-hiring could be driven by the acquiring firm's need to acquire complex knowledge and/or new capabilities that are embodied in target key employees or engineering teams.

The nature of acqui-hiring was further investigated through a typology of acqui-hiring. We categorized acqui-hiring into four types and apply the typology to deep-tech acqui-hirings. We further select one case from each category and use the four case illustrations to demonstrate four differentiated acquisition strategies, including technology strengthening, product expansion, product experimentation and technology experimentation. Our case illustrations show that an acquirer with a strong explorative orientation tends to emphasize more directly the role of target personnel and expertise when justifying the acquisition. This may suggest that acquirers with a strong explorative orientation may be more likely to take acqui-hiring as an active tool to search for scarce human capital.

The contribution of the paper is three-fold. First, our research provides new insights into the acqui-hiring literature. As an emerging phenomenon, acqui-hiring is still understudied. Among the two pioneering studies based on anecdotal evidence in Silicon Valley, Coyle and Polsky (2013) focus on the explanation from the perspective of entrepreneurs. However, this study could not explain why firms need to recruit talents through acqui-hiring rather than other channels, such as poaching employees from other firms directly? The study by Chatterji and Patro (2014) presents acqui-hiring as an example of asset orchestration by top management team but does not unveil the deep reason of why acqui-hiring occurs. Our research, combing the knowledge-based view and the labor market approach, highlights the role of technological change in driving acqui-hiring. More specifically, we show evidence that the technological newness and complexity of target technology could be an important driver for acquirers to engage in acqui-hiring. Moreover, as far as we know, there are no systematic studies on acqui-hiring outside the community of Silicon Valley. This paper contributes to the literature by providing a systematic analysis of acqui-hiring in Sweden which is a frequent target country for technological acquisitions.

Second, there is lack of a systematic procedure to identify acqui-hiring in the existing studies. For example, Chatterji and Patro (2014) identify acqui-hiring based on internet search of key words plus the other sources, e.g., press releases and media articles. In this study, we develop a method to identify acqui-hiring systematically by tracing the post-acquisition career path of target founding teams and key employees. This systematic approach helps reduce the biases from internet search of key words related to acquisition deals. For example, some acquirers, such as Apple, are less willing to disclose the information related to the acquisition deals because the rationales behind the acquisitions may reflect corporate-level strategies which tend to be kept confidential. The advantage of the method of this study is that it is more objective and systematic, which may facilitate the accumulation of knowledge in this subject. But one limitation of this method is that it is subject to the data availability of individual career profiles on the internet. We assume that this bias is small because most of professionals are willing to share their career history in professional networking platform for career development. In addition, in comparative case studies, the choices of comparison groups are usually criticized to be arbitrary (Abadie et al., 2010). In this study, we use data-driven procedures to identify the comparison cases and show the merits of combining quantitative and qualitative methods in studying a new phenomenon.

Third, this paper also contributes to the technological acquisition literature. In terms of technological acquisitions, the existing research focuses on how this type of acquisitions promotes innovation performance or organizational learning of technological capabilities (Ahuja & Katila, 2001; Phene et al., 2012; Puranam & Srikanth, 2007; Schildt et al., 2005). However, we know little about the specific strategies of how acquirers leverage the acquired technologies or capabilities for the purpose of business renewal. In this study, we focus on two important dimensions related to technological acquisitions: component technology and market relatedness, to differentiate four types of acqui-hiring and use four case illustrations of deep-tech acqui-hiring to demonstrate the differentiated strategies of acquirers.

Sweden is a leading country in Europe in breeding technology start-ups. Stockholm is claimed to be “the capital of start-ups” with the world's most supportive environments for technology ventures, just behind Silicon Valley (Davidson, 2015). This frequently make Swedish technology ventures acquisition targets by foreign multinationals, such as the acquisition of Mojang by Microsoft in 2014 and the acquisition of King by Activision Blizzard in 2015. However, this has raised a political concern about whether foreign acquisitions may lead to the related knowledge-intensive activities flowing away from Sweden after acquisitions. The knowledge of acqui-hiring provides a new lens for us to rethink the concern as we argue that the focus of post-acquisition retention should be on high-quality human capital not just on the acquired entities or projects. In this study, we found evidence of US firms being very active in acquisitions in Sweden, not only of deep-tech ventures but also of technology ventures more generally. US acquirers seem to follow a more aggressive approach in the post-acquisition integration, where it is quite common that they redeploy the acqui-hired personnel back to US and integrate the talents into the acquiring firm. This would mean a brain drain from Sweden. If this is so it would bear important policy implications. But it might also be that other effects are more important than this, presumably limited, brain drain. For example, the acquisition price paid in an acquisition, is likely to be used in future activities of the bought-out investors, for example earlier founders engaged as business angels, or (public or private) investors receiving capital to use in new activities. Clearly, this study cannot address these questions, but, hopefully, opens for future research along these lines.

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Appendix

Table A1 Sectoral area

Grouping of branches into eleven overall sectors.
Energy & Environment
Materials
Industrial goods
Construction industry
Shopping goods
Convenience goods
Health & Education
Finance & Real estate
IT & Electronics
Telecom & Media
Corporate services

Source: Serrano. The categorization is based on Swedish Standard Industrial Classification 2007.

Table A2 Correlation matrix of the variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Acquihiring (1)	1.0000															
Deep_tech (2)	0.2346	1.0000														
ICT (3)	0.1107	0.0131	1.0000													
Target_age (4)	-0.2274	-0.0671	0.1649	1.0000												
Target_size (5)	-0.1762	-0.17	0.2292	0.4271	1.0000											
Stockholm (6)	-0.0494	-0.142	0.0114	-0.1997	0.0541	1.0000										
Gothenburg (7)	0.0656	0.0495	0.1127	0.1089	-0.0538	-0.3699	1.0000									
Malmo (8)	0.1101	-0.0294	0.1706	0.076	0.0711	-0.3299	-0.1019	1.0000								
Rest (9)	-0.058	0.1439	-0.1963	0.1023	-0.0682	-0.6641	-0.2052	-0.183	1.0000							
Swedish (10)	-0.0787	-0.1033	-0.0602	0.0708	-0.0583	-0.0873	-0.0199	0.0827	0.06	1.0000						
US (11)	0.2869	0.2355	0.2695	0.0314	-0.0467	-0.0777	0.0376	0.0766	0.0138	-0.4181	1.0000					
Other (12)	-0.1583	-0.091	-0.1625	-0.0972	0.0973	0.152	-0.0111	-0.1465	-0.0718	-0.6595	-0.4071	1.0000				
Productivity (13)	-0.0109	-0.0757	0.2544	0.3198	0.2863	-0.0916	-0.0205	0.105	0.0514	0.0966	0.0263	-0.1189	1.0000			
Profitability (14)	-0.0548	-0.0882	0.186	0.2675	0.1901	-0.0486	0.0763	0.0314	-0.0171	0.072	-0.0649	-0.0187	0.5413	1.0000		
Internal financial (15)	0.0083	0.1727	-0.1257	-0.0756	-0.2359	0.0596	-0.0512	-0.041	-0.0064	-0.0645	0.1329	-0.0451	-0.4435	-0.0965	1.0000	
Leverage (16)	-0.0912	-0.0818	-0.0354	-0.0249	0.0002	0.0828	-0.0575	0.0301	-0.0724	-0.0513	-0.0621	0.1029	-0.3262	-0.0902	-0.0247	1.0000

Note: Target_size is measured in the logarithmic form of (employee number+1) as some firms have zero employee.