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# Does acquisition lead to the growth of high-tech scale-ups? Evidence from Europe☆

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ABSTRACT

The post-acquisition growth of high-tech scaleups has received relatively little research attention. This is surprising since buyers are known to target these firms for growth opportunities whilst sellers increasingly seek strategic partners to access resources to scale their ventures. We examine the post-acquisition revenue and employment growth of high-tech scaleups in a multi-country setting, comprising five European economies. Using a propensity-score matching approach and difference-in-differences regression, for a sample of 2187 high-tech scaleups, we demonstrate that acquisition has a positive effect on target firms equivalent to cumulative growth of revenue (employment) of 9–13 (6–10) percent after five (four) years, relative to control firms. We find that nationality matters such that the targets of foreign-owned acquirers exhibit significantly higher cumulative revenue and employment growth than their domestic counterparts. Taking a longer-term perspective, we show that growth dips in the first year, then stabilizes and accelerates in the years following acquisition, indicating a period of adjustment.

## 1. Introduction

High-tech, high-potential startups, more recently referred to as "scaleups" are targeted by corporate investors as a significant proportion of their value is related to intangible assets in the form of research and development, intellectual property rights and growth opportunities (Myers, 1977). Over the period 2010–2018, 21,800 unlisted, high-tech scaleups were acquired, and the value of the small proportion of deals reported was 1.2 trillion dollars (Mind the Bridge, 2018).[1] High value deals such as the sale of WhatsApp (US) to Meta (US), Skype (Luxemburg) to Microsoft (US) and Flipkart (India) to Walmart (US) are the subject of international headlines, pointing to a growing interest in 'the seller's side of the story'. Accordingly, finance researchers have become increasingly interested in the post-acquisition performance of privately held targets, counterbalancing the focus on publicly listed acquirers. Event analysis of share price changes on the day of the takeover announcement shows that acquisitions of private targets are value-increasing in the US

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[1] This figure understates the total value as it includes only 15.2 % of M&A transactions with disclosed amounts. Typically, amounts for large acquisitions are announced.

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(S. Chang, 1998; Fuller et al., 2002; Harford et al., 2012; Officer et al., 2008) and Europe (Faccio et al., 2006; Martynova and Renneboog, 2011). Martynova and Renneboog (2011) report significantly positive abnormal returns of 0.77 % to bidders on the announcement of a bid for a private European firm, compared to insignificantly negative returns of − 0.12 % for a publicly listed firm. We also report significantly positive cumulative abnormal returns to the acquirer of high-tech scaleups in our study, in the range of 1.53–3.13 %, in the short term. However, it is only in the longer term that the growth potential of the target is realised. We focus on the effect of acquisition on both revenue and employment growth in targets, up to 5 years post acquisition, which has received scant research attention compared with its effect on value (Amess et al., 2014). This is an important empirical question given the reported growth focused ambitions of managers of public companies, often at the expense of profitability and value (Wruck, 2008).

The post-acquisition growth of scaleups is also an important issue for entrepreneurial/innovation finance (European Commission, 1995, European Investment Bank, 2019; European Commission, 2013; Kauffman Foundation, 2013; OECD, 1996), with many countries seeking to replicate the success of Silicon Valley (Armour and Cumming, 2006). Our paper is positioned within the entrepreneurial finance literature which focuses on younger, privately-owned startups and scaleups and their investors over the financial lifecycle (Cumming et al., 2019; Cumming and Groh, 2018). Much of the research in this emerging field has examined the role of equity in the early stage funding of prototype development, however recently researchers have highlighted the need for empirical evidence on 'second stage funding' for ventures that need significant funds to realize their growth potential (Cumming et al., 2019; Wilson et al., 2018). This shortage of risk capital beyond the start-up stage is a key contributory factor in Europe's failure to match the Unites States in scaling high-tech startups (AFME, 2017; EIF, 2019; Wilson et al., 2018). Wilson et al. (2018) estimated that there was a second stage equity gap of £ 1.2 billion in the UK market for high-tech ventures. Viewed from the lifecycle perspective, acquisition represents a harvesting event that provides an exit for investors however entrepreneurs have long sought partners in order to access financial resources (Cosh and Hughes, 1994; Ravenscraft and Scherer, 1987). A strong performing acquisitions market increases the probability scaleups will be acquired by deep-pocketed companies thus reassuring investors of successful exits (Duruflé et al., 2017; EIF, 2019). If found to boost growth, the acquisition by large established firms could complement or provide an alternative to late stage venture capital in funding innovation and entrepreneurship in Europe. Our paper answers calls for evidence on whether or not acquisition enables European scaleups to realise their growth plans (Duruflé et al., 2017; EIF, 2019).

Our study seeks to isolate the growth effects of acquisition on targets. Empirically, private targets can be difficult to study due to the lack of publicly available data post acquisition, particularly in the US. However, this is not the case in Europe where targets are required to report financial information, provided they remain independent subsidiaries following acquisition (Erel et al., 2015). We construct a novel cross-country dataset by merging information from the Zephyr and Amadeus databases, both compiled by Bureau van Dijk. The Zephyr database provides better coverage of smaller deals than alternative databases (Bollaert and Delanghe, 2015; Huyghebaert and Luypaert, 2010). We identify a sample of 4714 European private high-tech targets covering the period 2003–2015, each of which is a surviving wholly owned subsidiary after acquisition and a separate reporting entry. The mean (median) value of the deals in our sample, for which the data is available, ranges from 23.2 (6.2) million EUR in 2010 up to 196.5 (10.9) million EUR in 2014. We then isolate the growth effects of acquisition by comparing the revenue and employment growth of 2187 high-tech targets, for which we have sufficient data, with a matched sample of independent firms for 5 years post-acquisition. Our sample contains both domestic (66.8 %) and cross-border (33.8 %) deals which also allows us to examine the impact of the acquirer's nationality on post-acquisition revenue and employment growth in high-tech scaleups in Europe.

Our contribution is threefold. First, we address a gap in the M&A and entrepreneurial finance research by measuring the effect of acquisition on revenue and employment in high-tech scaleups in Europe (Duruflé et al., 2017). Research on entrepreneurial finance in Europe has tended to focus on venture capital and high-tech stock markets (Revest and Sapio, 2012) with little empirical evidence on the role of acquisition in the funding lifecycle (Duruflé et al., 2017). Whilst, in the M&A literature, the empirical research continues to focus on large-scale acquisitions, where both acquirers and targets are listed companies (Gemson, 2021). Except for single country studies for Sweden (Xiao, 2015) and Belgium (Feys and Manigart, 2010), there is little empirical evidence on the growth of high-tech scaleups after acquisition. Our paper extends extant knowledge to estimate the effect of acquisition on the cumulative growth of revenue and employment of acquired firms, in 5 European countries including Germany, France and Italy, Sweden and the UK. These five countries represent 18 % of M&A activity worldwide which is dominated by the US accounting for 50 % of total acquisitions (IMAA, 2018). We find that acquisition has a positive effect on both revenue and employment growth in high-tech scaleups in Europe. After 5 years, acquired firms exhibit stronger cumulative growth in revenue of 9 %− 13 % when compared with matched firms. These results are robust for strict matching of treated and control firms within the same country, 2-digit industry and year. There is no significant effect on employment growth in the year of acquisition and the subsequent employment growth effect takes longer to materialize. It is only after 4 years that acquired firms register a significant employment growth dividend of 6–10 % in comparison with non-acquired matched firms. In terms of innovation financing, our findings suggest that matching high-tech targets to acquirers with complementary assets and deep pockets can enable the scaling process and in turn long term revenue and employment growth in the local economy.

Second, we shed light on the contentious issue of nationality in post-acquisition growth by separating results for domestic versus foreign acquirers. Cross-border or foreign acquisitions tend to be negatively perceived (Bena et al., 2017) and researchers report that governments in Europe are more likely to support acquisition proposals led by domestic buyers and oppose those from foreign buyers (Dinc and Erel, 2013). Duruflé et al. (2017) call for systematic evidence on how difference in the nationality of the acquirer impacts the growth of the acquired company. With the exception of Sweden (Xiao, 2015), there is little evidence on this phenomenon in Europe. We apply difference-in-differences regression on a matched sample to test for the moderating effects of the acquirer's nationality and target firm size and age on subsequent growth. We find that the nationality of the acquirer matters. After two years, foreign-owned targets exhibit significantly higher cumulative revenue growth than their domestic counterparts. The difference in post-acquisition

employment effects is even greater between domestic and foreign acquirers. The targets of domestic acquirers experience no significant increases in employment post acquisition, whilst the targets of foreign acquirers achieve higher employment growth in each subsequent year after the acquisition. This results in a 7 % increase in employment in the year after the acquisition, rising to 14 % in year 5, such that any significant growth in acquisition-driven employment is attributable to foreign rather than domestic acquirers. This is an important finding that informs debates on the impact of post-acquisition restructuring activities on employment (Amess et al., 2014; Shleifer and Summers, 1988) particularly when the acquirer is from overseas (Bena et al., 2017).

Third, we identify the short and long-term effects of acquisition by examining growth over 5 years. Prior research has not given sufficient consideration to the impact of time when measuring the growth effects of acquisition (Meglio and Risberg, 2011). To reflect the added complexity involved in the post-acquisition integration of high-tech firms, we examine growth effects up to 5 years after acquisition whilst prior research examines results up to 2 years (Xiao, 2015). We find there is a 2.4 %− 2.9 % decrease in revenue growth in the year of acquisition, followed by a steady acceleration in growth in the following years.

We also take specific measures to address the problem of survivorship post-acquisition. To disentangle the causal effect of acquisitions from plain correlation, we control for selection bias and unobserved firm heterogeneity by using methods of propensity score matching combined with double difference approach that consider pre-acquisition differences in firm performance. As an additional check for survivorship bias, we also estimate an extended linear regression model that allows us to control for sample selection in addition to the endogenous treatment assignment.

The remainder of the paper is structured as follows. Section 2 draws on several strands of literature to identify our two main hypotheses. Section 3 describes our data and discusses our empirical strategy, while Section 4 presents the findings. Section 5 concludes.

## 2. Background literature

### *2.1. Acquisitions and high-tech firm growth*

Gans and Stern (2003) coined the expression “the market for ideas” to explain high-tech M&A markets where buyers seek innovative products and services and sellers seek investment to fund the expensive and risky commercialisation process. In a globally competitive economy, even the largest firms supplement internal capabilities by ‘in-sourcing’ product or process innovations through both acquisition and collaboration (Blonigen and Taylor, 2000; Chesbrough, 2003). We draw on literature from finance and management to posit that high-tech targets have a higher probability of achieving post-acquisition growth because of the alignment of buyers’ and sellers’ motivations.

On the buyer’s side, the acquisition of a high-tech scaleup presents the opportunity to grow via a low-risk alternative to R&D expenditure (Ahuja and Katila, 2001; Blonigen and Taylor, 2000; Brown and Mason, 2014; Chakrabarti et al., 1994; Desyllas and Hughes, 2008; Graebner et al., 2010; Hussinger, 2010). This is achieved through the appropriation of the target’s intellectual property (Graebner et al., 2010) or the diversification of technological capabilities (Szücs, 2014). Research demonstrates that the acquisition of small (private) and not large (publicly traded) high technology firms is a viable source of external technology for established firms (Desyllas and Hughes, 2008; Phillips and Zhdanov, 2013) particularly if they have relatively low levels of internal R&D and R&D productivity (Desyllas and Hughes, 2008). Based on the population of startups in Massachusetts, over the period 1988–2005, Guzman and Stern (2015) show that having a patent increases the likelihood of acquisition 40-fold.

On the sellers’ side, it is well established that access to finance for growth is an important motive in the decision by private firms to seek an acquisition partner (Cosh and Hughes, 1994; Ravenscraft and Scherer, 1987), particularly for owners in high-tech sectors (Andersson and Xiao, 2016; Garnsey and Heffernan, 2005; Graebner and Eisenhardt, 2004; Graebner et al., 2010). However, there has been little empirical evidence on the financing efficiencies of acquisition as few studies have examined target firms’ financial management policies both as separate firms and as part of their acquirers, due to data restrictions. A novel study by Erel et al. (2015) demonstrates, for a European sample dominated by private targets, that acquisition significantly reduces the financial constraints and increases the average firm’s investment by 23–31%. Appropriately, the reduction in financial constraints was greatest for targets that were independent prior to acquisition and smaller targets. The study provides the strongest evidence that financial synergies resulting from reductions in financial constraints could motivate acquisitions. High-tech start-ups have higher R&D expenditures and commercialisation expenses and as a result are more likely to require external sources of finance in the form of private equity and venture capital (Brewer and Genay, 1994; Coleman and Robb, 2012; Moore, 1994). Post start-up, high-tech firms continue to experience difficulties in accessing finance due to information asymmetries, underdeveloped revenue streams and asset intangibility (Wilson et al., 2018). Research indicates that external equity is more difficult to obtain at later stages (Aernoudt, 2017) and IPOs play a relatively minor role in financing the growth of European firms (Duruflé et al., 2017). Given the equity-focused funding structure, high-tech start-ups are subsequently more likely to exit via acquisition so that investors can realise the returns on their investment (Gompers and Lerner, 1999; Ragozzino and Blevins, 2016). Consequently, for the owners of high-tech scaleups, finding a suitable acquisition partner is a viable and sometimes the only option to secure the financing needed to continue developing the technology (Andersson and Xiao, 2016; Miozzo and DiVito, 2016).

Access to finance is not the only benefit of acquisition. Acquirers can also add considerable value to the target, particularly if they have the necessary complementary resources and acquisition experience (Lindholm Dahlstrand, 2000; Mason and Harrison, 2006; Xiao, 2015). Several studies have found a positive impact of M&As on the productivity of the target firm (USA: Maksimovic and Phillips, 2001; France: Bertrand and Zitouna, 2008; UK: Girma, 2005; Japan: Fukao et al., 2008) suggesting that the acquiring management team can add value to the target in terms of increased efficiency.

However, the evidence for a positive impact of M&As on the growth of the target firm is inconclusive. The prevailing evidence on performance effects of mergers and acquisitions relates to acquisition of large publicly listed firms of other large publicly listed firms (Gemson, 2021; Haleblian et al., 2009; King et al., 2004) that are very different to the population of high-tech scaleups. The best evidence comes from a series of studies of Swedish acquisitions (Andersson and Xiao, 2016; Granstrand and Sjölander, 1990; Xiao, 2015). Xiao (2015) finds that acquisition has a positive impact on the growth of scaleups in high-tech manufacturing and knowledge-intensive business services sectors, when measured in terms of employment but not revenue.

Consistent with the conclusions of Andersson and Xiao (2016) we hypothesize that the high-tech M&A market is more likely to feature entrepreneurial sellers seeking access to complementary resources particularly finance, and buyers seeking to grow via a low-risk alternative to R&D expenditure that gives rise to a higher probability of post-acquisition growth.

**H1**. Acquired high-tech scaleups experience higher growth post-acquisition when compared with matched non-acquired scaleups in the same sector.

### *2.2. Type of acquisition and firm growth: foreign versus domestic acquirers*

Cross-border M&As are motivated by the same reasons as domestic ones, but with added elements to the analysis of benefits as well as costs (Erel et al., 2012). In the case of high-tech firms, the primary motive revolves around "the acquisition of existing innovatory assets" or "strategic asset seeking" (Dunning and Narula, 1995). Accordingly, Frey and Hussinger (2011) report that acquisition of technological competencies was one of the main motives for cross-border acquisitions within the EU in the 1990 s. Researchers also report that scaleups in life sciences (Mohr and Garnsey, 2009) and medicine (Bertram et al., 2012) are attractive targets for international acquirers. These targets are acquired to complement the acquirer's innovative capacity and boost future growth.

We identify several other potential motives for the foreign acquirer that may result in performance consequences for the target firm. According to internalization theory of international expansion, acquisitions can be seen as a way to deploy intangible resources of the firm on foreign assets (Buckley and Casson, 1998; Frésard et al., 2017). Management practices, shown to differ across countries (Bloom et al., 2012a), are an example of such an intangible asset that the acquirer transfers to the target via foreign acquisition (Bloom et al., 2012b). Localized intangibles can also stem from the industry specialization of the acquirer. Acquirers from more specialized industries in a country gain industry-specific advantages they can transfer to targets in countries that are less specialized in the same industries, thus creating a motive for as well as the value of the cross-border acquisition (Frésard et al., 2017). Another channel for value creation is corporate governance improvements to target firms that happen when the acquirer is subjected to better country-level corporate governance standards than the target (Albuquerque et al., 2018; Erel et al., 2012; Martynova and Renneboog, 2008).

Entering new geographic markets, to increase sales or diversify, is another motive for cross-border acquisitions. Acquirers are especially motivated to do so when growth in the domestic market is limited or when there are trade barriers in place that limit exports (Seth et al., 2000, 2002). In some cases, it is the existing trade flows that lead to the decision for cross-border acquisition, as shown by Ahmad et al. (2020). Companies that start to export to a foreign market get more informed about the export destination and learn about it, which can then motivate M&As in this market (Ahmad et al., 2020). Some of the costs of entering a foreign market, for example that of acquiring knowledge of the local market, will be smaller in the case of acquisition (Görg, 2000; Ahmad et al., 2020). Reaching a new geographic client base will benefit the foreign acquirer, but similar could be expected for the target firm which will get better access to acquirers' international markets. Cross-border acquisition can also create value by reducing competition in the target firm's market (Buckley and Casson, 1998) and through valuation differences, due to fluctuations in exchange rates for example (Erel et al., 2012).

However, cross-border acquisitions can also have a negative effect on the growth of high-tech scaleups. International business literature suggests that borders imply risks, due to cultural distance and the resulting costs of post-acquisition integration (Dikova and Rao Sahib, 2013; Steigenberger, 2017) as well as the differences in institutional context (Brouthers, 2002), leading to the so-called "liability of foreignness" (Nachum, 2010). However, as shown by McCarthy and Aalbers (2016), foreignness is actually an asset in the high-tech sector, not a liability, so that cross-border acquisitions outperform domestic ones in terms of increased innovation. One of the explanations they offer is that the risks from expanding across borders are lower for technological acquisitions compared to an average foreign acquisition; for example, cultural differences that usually imply a hurdle might encourage innovation through approaching the same problem in a different way.

Whether the motives for foreign acquisitions are actually realized in the form of synergies that also extend to the performance of target firms and whether these outweigh the "liability of foreignness", is a question that can be answered by empirical studies. Empirical evidence comparing the effect of foreign and domestic investors on the growth of the target high-tech firms is scarce. Xiao (2015) finds that acquisition by domestic MNEs and not foreign MNEs result in growth. In contrast, Feys and Manigart (2010) report that entrepreneurial targets underperform in domestic acquisitions relative to independent firms, both pre- and post-sale. In cross-border acquisitions, targets match independent firms in terms of growth and profitability but have better margins and higher returns post acquisition, which the authors attribute to operational synergies. Studies of the employment effects of cross-border acquisitions also provide ambiguous results. Some researchers report an increase in the rate of employment growth post-acquisition (Sweden: Bandick and Görg, 2010; Europe: Oberhofer, 2013; China: Gong et al., 2007), whereas others report job losses, downsizing and reduced rate of employment growth (UK: Conyon et al., 2002; Finland: Huttunen, 2007; Canada: Oldford and Otchere, 2016).

Clearly, there is a need for further evidence on this important issue (Duruflé et al., 2017). We predict that the benefits of access to international markets, better management practices and corporate government standards of the acquirer, and localized industry-specific knowhow will exceed the risks connected to cross-border acquisitions of high-tech firms.

**H2**. High-tech scaleups acquired by foreign acquirers will exhibit higher growth than high-tech scaleups acquired by domestic acquirers.

## 3. Data and empirical strategy

### 3.1. Data

The sample is derived using merged firm-level data sourced from two commercial databases. The data on acquisitions is from the Zephyr database compiled by Bureau van Dijk (BvD). Zephyr provides information on over 1.6 million M&A, VC and PE deals and rumours, as well as IPOs and other stock issuances. It provides comprehensive coverage of smaller deals and is increasingly used in finance studies (see, for example, Tykvová, 2018; Tykvová and Borell, 2012; Wilson et al., 2018). This makes it particularly useful in the study of acquisitions of privately held scaleups.

The focus of our research is not all startups per se, but scaleups, that is high-tech startups with the potential to scale and attract acquirers. We use three criteria; age, technology intensity and independence to define scaleups following prior research on the classifications of high-tech firms (Colombo and Grilli, 2007; Storey and Tether, 1998). First, we restrict our analysis to firms less than 20 years old at the time of the acquisition (Colombo and Grilli, 2010). Second, we only include firms from high-tech knowledge intensive (HTKI) sectors as defined by Eurostat (2016). High-tech manufacturing industries include NACE Rev. 2 codes 21 and 26, and knowledge-intensive services comprise codes 50–51; 58–63; 64–66; 69–75; 78; 80; 84–93. Finally, in order to focus on acquisitions involving independent firms, we exclude firms listed at the time of the acquisition and deals that involve secondary buyouts between investors.

We code a firm as acquired when the target firm loses its independence, i.e. when an acquisition is control-changing and the acquiring firm holds more than 50 % of shareholding rights, similar to Andersson and Xiao (2016). If there were multiple deals of the same category related to one target firm in a specific year, only the last one was retained, as we wanted to capture the last acquirer with the control-changing deal. Information on the nationality of the acquiring firm allows us to categorize deals as either domestic or foreign.

The second data source used was the Amadeus database, by the same data provider. Amadeus is a comprehensive database of European companies containing annual account items on approximately 21 million companies across Europe. We used different historical waves of Amadeus to include non-surviving firms.[2] A database of financial and other relevant data (such as the year of incorporation and whether the firm is listed) was thus built for firms from the five European countries. Consolidated and unconsolidated accounting data are available in Amadeus and we use unconsolidated accounts, both for acquired and non-acquired firms. We restrict the analysis to the period 2003–2015. We matched Amadeus data with the transaction data from Zephyr, using the common identification number.

The sample includes target firms from five European countries including France, the UK, Italy, Germany and Sweden. In terms of the global acquisitions market, these five countries are in the top 10 list of acquisitive nations and together account for 18 % of M&A activity worldwide which is dominated by the US, accounting for 50 % of deals (IMAA, 2018). In total 15,688 acquisition deals for high-tech scaleups were recorded in Zephyr over the period 2003–2015 for these five countries (UK 7914; Germany 3118; France 2368; Sweden 1584 and Italy 704). For our analysis, we need data on the post-acquisition growth of the target firm and this is available only if the firm continues to exist after the acquisition and remains a separately reporting entity. The Zephyr *Target Status* variable reveals that 33 % of targets are dissolved. This share is similar for domestic acquirers (34 %) and foreign acquirers (29 %). The poor coverage of smaller firms in Amadeus reduces the sample size to 4714 acquisition targets (Table 1) before proceeding to the next step involving matching procedures. Thus of the 3118 acquisitions of German high-tech scaleups recorded in Zephyr, we only have full information for 435 targets (13 %). Coverage for Germany is particularly poor which reflects the fact that small firms were not required to file detailed accounts (Kalemli-Ozcan et al., 2015). Table 1 (Panel A) reports the total number of acquisitions across the five countries (UK 1899; Germany 435; France 999; Sweden 1092 and Italy 289), as well as the share of foreign and domestic acquisitions.

Panel B of Table 1 reports the yearly distribution of acquisitions, together with the average deal value and the number and share of foreign and domestic acquisitions. The data on the value of the deal is available for 1655 acquisition deals out of 4714 and thus missing for almost 65% of transactions. This is not surprising, given that we focus on the sample of high-tech private firms and the deals of smaller value are rarely disclosed.[3] The mean deal value in our sample for which the data is available ranges from 23.2 million EUR in 2010 up to 196.5 million EUR in 2014. The median deal value is much lower and ranges from 4.7 million EUR in 2009–14.9 million EUR in 2007.

Although many of our targets are small, we investigate the market reaction to these acquisitions first to check if these deals create value for acquirers (Appendix A). We observe, depending on the window period, that the cumulative abnormal return from the acquisition deal to the acquirer is in the range of 1.53 % (3 days) to 3.13 % (31 days) for the 1619 announcements for which we have data (Table A.1). The returns to both domestic and foreign acquirers are positive (Table A.2). However, for the short run (three and five-day window periods) domestic acquirers generate significantly higher returns than foreign acquirers (1.46 % and 1.55 %). Longer windows show no significant difference.

[2] We used the following Amadeus data vintages: 2017, 2015, 2012, 2009 and 2006.

[3] The Mind the Bridge (2018) study based on Cruchbase data reports deal value for 15 % for privately-held hightech M&A worldwide.

**Table 1**
Sample composition by countries of target firms and by year, pre-matching.

Panel A: By foreign and domestic acquirers

| | Foreign acquisitions | | Domestic acquisitions | | All acquisitions | |
|---|---|---|---|---|---|---|
| Country of the target firm | N. firms | % | N. firms | % | N. firms | % |
| Germany | 196 | 12.5 % | 239 | 7.6 % | 435 | 9.2 % |
| France | 308 | 19.7 % | 691 | 21.9 % | 999 | 21.2 % |
| Italy | 111 | 7.1 % | 178 | 5.7 % | 289 | 6.1 % |
| Sweden | 346 | 22.1 % | 746 | 23.7 % | 1092 | 23.2 % |
| United Kingdom | 603 | 38.6 % | 1296 | 41.1 % | 1899 | 40.3 % |
| TOTAL | 1564 | 100.0 % | 3150 | 100.0 % | 4714 | 100 % |

Panel B: Deal characteristics by year

| | Acquisitions | | Deal value | | | | Foreign acquisitions | | Domestic acquisitions | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Number | % | Deal value (in th. EUR), mean | Deal value (in th. EUR), median | Deal value - frequency | % of missing values | Number | % | Number | % |
| 2003 | 117 | 2.5 | 49,631 | 10,206 | 56 | 52.1 | 36 | 2.3 | 81 | 2.6 |
| 2004 | 174 | 3.7 | 29,061 | 7494 | 80 | 54.0 | 57 | 3.6 | 117 | 3.7 |
| 2005 | 348 | 7.4 | 117,044 | 8670 | 175 | 49.7 | 124 | 7.9 | 224 | 7.1 |
| 2006 | 453 | 9.6 | 172,449 | 10,000 | 211 | 53.4 | 143 | 9.1 | 310 | 9.8 |
| 2007 | 415 | 8.8 | 43,044 | 14,903 | 179 | 56.9 | 128 | 8.2 | 287 | 9.1 |
| 2008 | 469 | 9.9 | 92,521 | 8668 | 182 | 61.2 | 173 | 11.1 | 296 | 9.4 |
| 2009 | 375 | 8.0 | 63,418 | 4764 | 118 | 68.5 | 112 | 7.2 | 263 | 8.3 |
| 2010 | 411 | 8.7 | 23,246 | 6204 | 131 | 68.1 | 133 | 8.5 | 278 | 8.8 |
| 2011 | 338 | 7.2 | 112,142 | 5645 | 124 | 63.3 | 112 | 7.2 | 226 | 7.2 |
| 2012 | 427 | 9.1 | 31,428 | 8933 | 107 | 74.9 | 139 | 8.9 | 288 | 9.1 |
| 2013 | 402 | 8.5 | 48,425 | 11,983 | 106 | 73.6 | 142 | 9.1 | 260 | 8.3 |
| 2014 | 400 | 8.5 | 196,510 | 10,850 | 97 | 75.8 | 146 | 9.3 | 254 | 8.1 |
| 2015 | 385 | 8.2 | 54,324 | 8500 | 89 | 76.9 | 119 | 7.6 | 266 | 8.4 |
| TOTAL | 4714 | 100 | | | 1655 | 64.9 | 1564 | 100 | 3150 | 100 |

Note: The sample includes acquired target firms (when a control-changing acquisition happens, with the acquiring firm now possessing more than 50% of shareholding rights) that enter the Zephyr dataset between 2003 and 2015. Columns 2, 4 and 6 of Panel A show the percentage of the corresponding type of acquisitions calculated with respect to the total number of acquisitions in that category. This sample reports the total number of acquisitions across the five countries based on merging Amadeus and Zephyr data; it was further reduced when applying propensity score matching.

### 3.2. Matching

The paper aims to evaluate the average impact of acquisition on high-tech scaleups' growth $\tau$ years after the acquisition: $E(\Delta_{i,\tau}) = E(y^1_{i,\tau} - y^0_{i,\tau})$. Identification of the treatment effect faces the fundamental problem of the missing counterfactual in that researchers only observe the change in the size of firm $i$ being acquired ($y^1_{i,\tau}$), but not the outcome in absence of acquisition ($y^0_{i,\tau}$). Matching methods try to overcome the missing observation problem by constructing appropriate counterfactual observations from the non-treated group (non-acquired firms). However, the decision to acquire and be acquired is not randomly determined but decided by the management and owners of the firms, and their decisions may also be related to the benefits of the acquisition ($\Delta_i$). This is called the self-selection effect: the decision to become acquired depends on observable and unobservable characteristics that in turn could also influence the effect of the acquisition. For example, if acquired firms are on average larger and more profitable already prior to acquisition, not taking these two facts into account might lead us to understate the causal effect of acquisition as a consequence of larger firms growing more slowly and overstate the treatment effect of acquisition as a result of more profitable firms growing faster in general.

Rosenbaum and Rubin (1983) show that under the strong ignorability of treatment assumption conditional on observable confounders,[4] one can consistently estimate average treatment effect - by matching treated and non-treated units based on the propensity score. The propensity score in our case is the conditional probability of being acquired, given the confounding variables $X$. Propensity scores provide a way to balance measured covariates across acquired and non-acquired firms and better approximate the counterfactual for target firms. Matching methods are well established in the acquisition and VC literature (Croce et al., 2013; Grilli and Murtinu, 2014; Szücs, 2014).

Propensity scores were estimated with a probit model on a set of explanatory variables employed in similar settings (Amess et al., 2016; Bertrand, 2009; Croce et al., 2013; Grilli and Murtinu, 2014; Scellato and Ughetto, 2013) including: log of operating revenue, log of number of employees, log of capital-employment ratio, log of average wage per employee, EBITDA per employee, profit margin,

[4] The first assumption, balancing of confounding variables, given the propensity-score, states that conditionally on $p(x)$, the treatment $D$ and the observables $X$ are independent. The second assumption, unconfoundedness, given the propensity-score, states that assignment to treatment is random given the propensity-score, which follows from the conditional independence assumption. The third assumption is common support assumption: $0 < p(x) < 1$ (Cerulli, 2015; Wooldridge, 2010).

debt leverage, cash flow per operating revenue, age of a firm, country dummies, 2-digit NACE industry dummies and year dummies. A full list of variables is provided in Appendix B. All regressors except dummy variables entered the probit in the quadratic polynomial form to allow for a more flexible functional form and achieve a better fit. Furthermore, we use the lagged values of these regressors to achieve the balance between acquired and non-acquired firms in the year prior to the acquisition and to avoid simultaneity bias. The dependent variable is an indicator of acquisition equal to 1 if a firm is acquired in the current year, 0 if there is no acquisition and missing for observations after the acquisition.

After the propensity score is estimated, we test whether the balancing property is satisfied (the covariates' distribution in the treated and control group has to be equal) by first identifying the optimal number of blocks and then performing the balancing test within each block. The final optimal number of propensity-score blocks is equal to 24. When the propensity score is balanced within blocks across the acquired and control firms, we perform a check for balance of individual covariates across both groups within each block of the propensity score. This ensures that the propensity score's distribution is similar across groups within each block and that the propensity score is properly specified (Imbens, 2004). There are only seven instances where one of the variables is not balanced within a block. This is deemed satisfactory given the number of variables included in the probit model and the number of propensity score blocks. In addition to an ex-ante balancing test, we evaluate how well the acquired and control firms are balanced in the matched samples (Appendix C). If the treatment and comparison groups are poorly balanced, the propensity score needs to be respecified (Austin, 2009; Ho et al., 2007).

We estimate the average treatment effect on the treated (ATET) using a Matching-DiD hybrid method, a combination of difference-in-differences approach with a propensity-score matching, following established practice in the field of acquisition (Chang et al., 2013; Schiffbauer et al., 2017; Szücs, 2014). This estimator is similar to the classical DiD, but does not demand the imposition of the linear-in parameters form of the outcome specification. In essence, it can be regarded as a nonparametric DiD, reweighting observations determined by a weighting function contingent on the specific matching strategy adopted (Cerulli, 2015). The benefit of using the hybrid method is that the DiD part controls for the selection on the time-invariant part of the unobservable heterogeneity by differencing out individual firms' fixed effects. Average treatment effect on the acquired firms $\tau$ years after the acquisition is estimated as follows:

$$\widehat{ATET}_{\tau} = \frac{1}{N}\sum_{i\in\{D\}}\left(\left(y^{D=1}_{i,t_0+\tau} - y^{D=1}_{i,t_0-1}\right) - \sum_{j\in C(i)} h(i,j)\left(y^{D=0}_{j,t_0+\tau} - y^{D=0}_{j,t_0-1}\right)\right) \tag{1}$$

where $N$ is the number of acquired firms, $i \in \{D\}$, $C$ is the non-acquired set of control firms, $y^{D=1(D=0)}_{i(j),t_0+\tau}$ is the size (log of revenue or log of employment) of acquired (control) firm $i$ ($j$) $\tau$ years after the acquisition year $t_0$, $h(i,j)$ are the matching weights that depend on the type of matching estimator. $ATET_{\tau}$ tells us by how much more (or less) revenue or employment has grown in acquired firms compared to similar control firms from pre-acquisition year $t_0$-1 to $\tau$ years after the acquisition year $t_0$. We apply nearest neighbour, 3-nearest neighbours, radius and kernel propensity score matching to test for the robustness of our results in the context of the trade-off between the variance of the estimates and bias (Caliendo and Kopeinig, 2008; Dehejia and Wahba, 2002).

If the propensity score is estimated in the first step before the matching, uncertainty from the estimation of the propensity score affects the large sample distribution of propensity score matching estimators. Ignoring this uncertainty leads to conservative standard errors on ATEs, and to either conservative or overly generous standard errors for ATT estimates, depending on the data-generating process (Abadie and Imbens, 2016). For matched data, bootstrap methods provide unreliable estimates (Abadie and Imbens, 2008), and standard errors need to be calculated with the Abadie-Imbens (AI) method (Abadie and Imbens, 2016). They propose a bias-corrected estimation making matching estimators N1/2 consistent and asymptotically normal and providing an estimation of the correct asymptotic variance. To generate even more comparable control groups, we impose strict matching within the same country, same 2-digit NACE industry and the same year. Data requirements for propensity score estimation are wide, in the scope of the variables, the use of lagged regressors, and in the strict matching of targets and controls on the identical country-year-industry triplet. As a result, the working sample of acquired firms is reduced from 4714 to 2187.

### 3.3. Difference-in-differences approach

Having created the matched sample of acquired firms and the corresponding control groups, we estimate the effect of acquisitions on revenue and employment growth in a DiD regression setting.[5] For each acquired firm and their matched controls we construct a window around the acquisition year $t_0$ and use observations from $t_0$-1 to $t_0+\tau$, where $\tau = 0, 1, 2, \ldots$ In this way, we apply a time-variant treatment DiD framework with post-treatment effects and recalibrate all acquisition calendar years to technical years $t$ where $t_0$ denotes calendar years when acquisition took place. For each target's control firm, we do the same translation to technical time. We combine the dynamic specification of Gibrat law panel data model with the DiD setting and estimate the following specification:

[5] We choose DiD over the FE estimator because the condition under which the consistency of DID is achieved is less restrictive than that required for the FE estimator (Cerulli, 2015, pp. 197–198). Another advantage of the former method is also that DiD with panel data can be easily extended to the case of dynamic treatment by introducing lags and leads, as we do in the article.

**Table 2**
Descriptive statistics for acquired and non-acquired high-tech scaleups before and after matching.

| | | Before matching | | | After matching | |
|---|---|---|---|---|---|---|
| | | Acquired | Non-acquired | Acquired – pre-acquisition | Matched acquired | Matched controls |
| Revenue | Mean | 9.15 *** | 6.34 | 9.02 *** | 9.05 | 9.10 |
| | Median | 9.14 *** | 6.08 | 9.09 *** | 9.12 | 9.19 |
| | Obs | 13,140 | 1915,995 | 2303 | 2187 | 2187 |
| Employment | Mean | 3.89 *** | 1.63 | 3.77 *** | 3.81 | 3.81 |
| | Median | 3.88 *** | 1.39 | 3.78 *** | 3.81 | 3.85 |
| | Obs | 13,140 | 1915,995 | 2303 | 2187 | 2187 |
| Capital/Emp | Mean | 2.77 *** | 2.52 | 2.86 *** | 2.86 | 2.75 * |
| | Median | 2.70 *** | 2.48 | 2.79 *** | 2.81 | 2.76 |
| | Obs | 13,140 | 1915,995 | 2303 | 2187 | 2187 |
| Average wage | Mean | 4.12 *** | 3.50 | 4.10 *** | 4.10 | 4.11 |
| | Median | 4.14 *** | 3.58 | 4.13 *** | 4.13 | 4.11 |
| | Obs | 13,140 | 1915,995 | 2303 | 2187 | 2187 |
| Profit margin | Mean | 3.44 *** | 4.35 | 2.17 *** | 1.96 | 4.11 *** |
| | Median | 4.93 *** | 3.57 | 4.26 | 3.99 | 4.14 *** |
| | Obs | 13,140 | 1915,995 | 2303 | 2187 | 2187 |
| Age | Mean | 13.85 *** | 9.99 | 11.53 *** | 12.64 | 12.76 |
| | Median | 13.08 *** | 8.92 | 10.58 *** | 11.67 | 12.08 |
| | Obs | 13,140 | 1915,995 | 2303 | 2187 | 2187 |

Note: Column Acquired corresponds to acquisition year as well as post-acquisition period in the acquired group of firms. Columns Acquired – pre-acquisition, Matched acquired and Matched controls refer to values of variables one year before the acquisition. Revenue is the log of operating revenue; Employment is the log of the number of employees; Capital/Emp is the log of fixed assets per employee; Average wage is the log of average wage per employee per annum; Profit margin is (profit before tax/operating revenue)*100; Age is the age of a firm in years. Data are expressed in thousand € and deflated by CPI (reference year: 2015). *** (*) Represents statistical significance at 1% (10%) in the 2-sided t-test on the difference-in-means and in the Mann–Whitney U test for the equality of distributions between the group of acquired firms and the non-acquired group.

$$\ln y_{i,t} = \beta_0 + \beta_1 \ln y_{i,t_0-1} + \beta_2 age_{i,t} + \sum_{\tau=0}^{6+} \gamma_\tau T_\tau + \sum_{\tau=0}^{6+} \delta_\tau (D^* T_\tau) + C_i + I_i + Y_t + \varepsilon_{i,t} \quad (2)$$

where $y_{i,t}$ is the size (total revenue or employment) of firm $i$ in year $t$ and $y_{i,t_0-1}$ is the size of firm $i$ one year before the acquisition year $t_0$. Controlling for constant pre-acquisition firm size enables us to estimate the post-acquisition cumulative effect on firm growth from year $t_0$-*1* to $t_0+\tau$. This is equivalent to DiD treatment effect from the non-parametric PSM estimation above. As in the standard DiD setting, we include a set of dummies $T_\tau$ that indicate the specific post-acquisition period. $T_0$ designates the period in which the acquisition took place for the acquired firms and the corresponding counterfactual period in the matched controls. Likewise, $T_{6+}$ indicates periods 6 or more years after the acquisition year and hence enable us to estimate the long-term effect. A set of dummies of the outmost importance, $D^*T_\tau$, designate whether a firm was acquired in the current year ($\tau = 0$), one year ago ($\tau = 1$) and so on, or 6 or more years ago ($\tau = 6+$). There is no agreed timescale to measure acquisition performance in the literature (Meglio and Risberg, 2011). We follow prior research (Eliasson et al., 2017; Szücs, 2014; Xiao, 2015) and take a longer-term perspective, following the target firm for up to five years after the acquisition.

In this manner, we create an acquisition timeline, allowing us to track the effects of acquisition on firm growth over the timeframe. Parameter $\delta_\tau$ is the estimate of the treatment effect of acquisition on the growth of firm revenue or employment from pre-acquisition year $t_0$-*1* to post-acquisition year $t_0+\tau$. In other words, it shows us how much more (or less) acquired firms grew in size compared to similar non-acquired firms during the same period. Finally, we also control for firm age and include country dummies ($C_i$), industry dummies ($I_i$) and calendar year dummies ($Y_t$) that capture time-varying macroeconomic shocks common to all countries, industries and firms. $Y_t$ dummies also control for mediating effect of the business cycle on the growth of firms.

To control for possible moderating factors and the differences between the types of acquisitions, we further augment the above specification with the additional set of interactions $\sum_{\tau=0}^{6+} \theta_\tau (X^* D^* T_\tau)$. To test for the differences in the evolution of revenue and employment growth between domestic and foreign acquirers, we define $X$ as an indicator for foreign as opposed to domestic acquisition. And, we define $X$ as the number of employees in the pre-acquisition year $t_0$-*1* and as the current age of the firm to test for the moderating effects of target firm size and age on subsequent growth.

## 4. Results

In Table 2, we report descriptive statistics on total revenue, number of employees, capital-labour ratio, average wage, profit margin and age for both acquired and all available – and thus not necessarily comparable – non-acquired high-tech scaleups. First, we list statistics for the firms before PSM, followed by descriptives for the matched sample of acquired and non-acquired control firms in the last two columns. We present summary statistics including mean, median and number of observations for each variable for the entire sample of high-tech scaleups, acquired firms, non-acquired firms and acquired firms one year prior to acquisition. For every variable, we perform a t-test on the difference-in-mean between the group of acquired firms and the non-acquired group.

**Table 3**
The impact of acquisition on European high-tech scaleups' growth of revenue and employment – Pooled sample.

| Panel A Total revenue: | | $t_0$ | $t_0+1$ | $t_0+2$ | $t_0+3$ | $t_0+4$ | $t_0+5$ |
|---|---|---|---|---|---|---|---|
| 1-NN | $ATET_\tau$ | -0.0199 * | **0.0491** *** | **0.0791** *** | **0.0872** *** | **0.1169** *** | 0.0738 * |
| A&I st. err. | st. err. | (0.012) | (0.018) | (0.022) | (0.028) | (0.033) | (0.039) |
| | N | 1835 | 1275 | 1019 | 833 | 640 | 566 |
| 1-NN | $ATET_\tau$ | **-0.0278** ** | 0.0328 * | **0.0648** *** | **0.0574** ** | **0.1133** *** | **0.1201** *** |
| | st. err. | (0.012) | (0.018) | (0.023) | (0.029) | (0.034) | (0.039) |
| | N | 1990 | 1383 | 1097 | 897 | 688 | 603 |
| 3-NN | $ATET_\tau$ | **-0.0290** *** | 0.0283 * | **0.0498** ** | 0.0454 * | **0.1077** *** | **0.0874** *** |
| | st. err. | (0.010) | (0.015) | (0.020) | (0.024) | (0.028) | (0.032) |
| | N | 1990 | 1383 | 1097 | 897 | 688 | 603 |
| Radius | $ATET_\tau$ | **-0.0236** ** | **0.0381** *** | **0.0708** *** | **0.0753** *** | **0.1119** *** | **0.0959** *** |
| | st. err. | (0.010) | (0.014) | (0.018) | (0.022) | (0.026) | (0.030) |
| | N | 1936 | 1341 | 1062 | 864 | 663 | 580 |
| Kernel | $ATET_\tau$ | **-0.0241** ** | **0.0351** ** | **0.0708** *** | **0.0880** *** | **0.1396** *** | **0.1301** *** |
| | st. err. | (0.009) | (0.014) | (0.017) | (0.022) | (0.025) | (0.029) |
| | N | 1994 | 1386 | 1101 | 900 | 689 | 605 |
| Panel B Employment: | | $t_0$ | $t_0+1$ | $t_0+2$ | $t_0+3$ | $t_0+4$ | $t_0+5$ |
| 1-NN | $ATET_\tau$ | -0.0021 | 0.0168 | 0.0152 | 0.0460 * | 0.0520 | 0.0609 * |
| A&I st. err. | st. err. | (0.010) | (0.016) | (0.021) | (0.026) | (0.033) | (0.036) |
| | N | 1835 | 1275 | 1019 | 833 | 640 | 566 |
| 1-NN | $ATET_\tau$ | -0.0114 | 0.0115 | 0.0350 | 0.0342 | **0.0963** *** | 0.0514 |
| | st. err. | (0.010) | (0.017) | (0.022) | (0.026) | (0.034) | (0.037) |
| | N | 1990 | 1383 | 1097 | 897 | 688 | 603 |
| 3-NN | $ATET_\tau$ | -0.0100 | 0.0082 | 0.0199 | 0.0287 | **0.0717** ** | 0.0329 |
| | st. err. | (0.009) | (0.014) | (0.018) | (0.022) | (0.028) | (0.031) |
| | N | 1990 | 1383 | 1097 | 897 | 688 | 603 |
| Radius | $ATET_\tau$ | -0.0069 | 0.0137 | 0.0244 | **0.0508** ** | **0.0836** *** | 0.0325 |
| | st. err. | (0.008) | (0.013) | (0.017) | (0.020) | (0.026) | (0.028) |
| | N | 1935 | 1340 | 1061 | 862 | 663 | 580 |
| Kernel | $ATET_\tau$ | -0.0112 | 0.0010 | 0.0091 | 0.0319 | **0.0636** ** | 0.0185 |
| | st. err. | (0.008) | (0.013) | (0.016) | (0.019) | (0.025) | (0.027) |
| | N | 1994 | 1386 | 1101 | 900 | 689 | 605 |

Note: Standard errors are in parentheses; *** p<0.01; **p<0.05; * p<0.1. 1-NN A&I st. err. refer to nearest neighbour PSM estimates with Abadie and Imbens (2016) standard errors. Other PSM estimates impose exact matching within the same country, industry and year. 1(3)-NN refers to 1(3)-nearest neighbour(s) PSM, Radius and Kernel are radius and kernel PSM methods. $ATET_\tau$ is the average treatment effect on the treated years after the acquisition. $t_0$ is the year of acquisition.

We find that acquired firms are larger, more capital intensive, more profitable, pay higher wages and are older than non-acquired high-tech scaleups (comparison between Acquired and Non-acquired columns in Table 2). Moreover, this advantage is already present before the firms were acquired (see Pre-acquisition and Non-acquired columns in Table 2). This evidence seems to suggest a non-random endogenous selection mechanism. Therefore, it is necessary to apply methods such as matching to account for ex-ante differences between treated and non-treated firms. We also find that size, profitability and average wage are higher for target firms post-acquisition than in the pre-acquisition year. This suggests a positive effect of acquisition on the growth of acquired high-tech scaleups. After matching, there is no statistically significant difference in means and medians of all the variables in the year prior to acquisition, with the exception of profit margin.

Table 3 presents the results from propensity score matching, using the acquisition timeline from the acquisition year up to five years after the acquisition. The size of the sample differs along the timeline, reflecting the availability of firm data for the years after the acquisition. Panel A of the table reports the effects on the cumulative growth of revenue and Panel B reports the results for employment. Row 1 (1-NN A&I st. err.) shows the results of the nearest neighbour PSM that calculates standard errors adjusted for the first-step estimation of the propensity-score, as suggested by Abadie and Imbens (2016). There is a slight but insignificant drop in revenue and employment growth in the year of acquisition ($t_0$), followed by considerable improvement in revenue growth in the aftermath. By the end of the 5th year post-acquisition, high-tech scaleups increase their revenue relative to the pre-acquisition year by 7% more than controls. In contrast to the revenue effects, the employment growth effect is significant only in the 4th year after the acquisition but becomes smaller and insignificant in the following year.

The rows that follow present ATET estimates from four different PSM methods, where we additionally impose strict matching of treated and control firms within the same country, 2-digit industry and year. This allows us to compare firms not only similar in terms of propensity to be acquired but also sharing the same country and industry environment and period. The results identify a temporary 2.4–2.9 % drop in revenue growth in the year of acquisition. After initial deterioration, cumulative revenue growth differential consistently increases and reaches 9 %– 13 % in period $t_0+5$. On the other hand, employment growth in acquired firms is indistinguishable from the control group and only turns significantly positive at the level of 6–10 % in the 4th year after the acquisition. In the 5th year after acquisition, the effect on employment growth decreases to 3 % and becomes statistically insignificant.

**Table 4**
The impact of acquisition on European high-tech scaleups' growth of revenue and employment – Domestic vs. Foreign.

| Total revenue: | | $t_0$ | $t_0+1$ | $t_0+2$ | $t_0+3$ | $t_0+4$ | $t_0+5$ |
|---|---|---|---|---|---|---|---|
| Domestic | $ATET_\tau$ | -0.0278 * | 0.0175 | 0.0422 | 0.0878 ** | 0.0990 ** | 0.0571 |
| | st. err. | (0.015) | (0.022) | (0.030) | (0.034) | (0.043) | (0.052) |
| | N | 1165 | 798 | 634 | 526 | 382 | 341 |
| Foreign | $ATET_\tau$ | -0.0143 | 0.0505 | 0.1140 *** | 0.0934 ** | 0.1480 *** | 0.1055 * |
| | st. err. | (0.020) | (0.031) | (0.037) | (0.047) | (0.053) | (0.061) |
| | N | 670 | 477 | 385 | 307 | 258 | 225 |
| Employment: | | $t_0$ | $t_0+1$ | $t_0+2$ | $t_0+3$ | $t_0+4$ | $t_0+5$ |
| Domestic | $ATET_\tau$ | -0.0144 | -0.0261 | -0.0153 | 0.0337 | 0.0398 | 0.0669 |
| | st. err. | (0.012) | (0.021) | (0.028) | (0.033) | (0.041) | (0.049) |
| | N | 1165 | 798 | 634 | 526 | 382 | 341 |
| Foreign | $ATET_\tau$ | 0.0137 | 0.0656 *** | 0.0378 | 0.0677 * | 0.0604 | 0.1362 ** |
| | st. err. | (0.015) | (0.024) | (0.033) | (0.039) | (0.050) | (0.062) |
| | N | 670 | 477 | 385 | 307 | 258 | 225 |

Note: Standard errors are in parentheses; *** p<0.01; ** p<0.05; * p<0.1. ATETs are 1-NN PSM average treatment effect on the treated estimates with Abadie and Imbens (2016) standard errors. $t_0$ is the year of acquisition.

**Table 5**
Revenue growth after acquisition.

| Total revenue: | baseline (1) | for. vs dom. (2) | small vs large (3) | young vs old (4) |
|---|---|---|---|---|
| $revenue_{t0-1}$ | 0.958 *** | 0.958 *** | 0.961 *** | 0.958 *** |
| | (0.00344) | (0.00344) | (0.00335) | (0.00344) |
| $age_t$ | -0.00793 *** | -0.00794 *** | -0.00782 *** | -0.00737 *** |
| | (0.000671) | (0.000670) | (0.000671) | (0.000689) |
| $D*T_0$ | -0.0290 *** | -0.0458 *** | -0.0933 *** | -0.0669 *** |
| | (0.0107) | (0.0129) | (0.0294) | (0.0244) |
| $D*T_1$ | -0.0107 | -0.0269 | 0.0497 | -0.00797 |
| | (0.0205) | (0.0251) | (0.0618) | (0.0493) |
| $D*T_2$ | 0.00567 | -0.00871 | 0.0518 | 0.0448 |
| | (0.0272) | (0.0328) | (0.0719) | (0.0673) |
| $D*T_3$ | 0.0158 | -0.0176 | 0.0856 | -0.000308 |
| | (0.0355) | (0.0435) | (0.0991) | (0.101) |
| $D*T_4$ | 0.0138 | -0.0678 | 0.104 | 0.0839 |
| | (0.0458) | (0.0623) | (0.132) | (0.130) |
| $D*T_5$ | 0.0960 * | 0.0868 | 0.316 | 0.171 |
| | (0.0533) | (0.0644) | (0.226) | (0.162) |
| $D*T_{6+}$ | 0.174 *** | 0.128 *** | 0.374 *** | 0.473 *** |
| | (0.0373) | (0.0466) | (0.108) | (0.125) |
| | | Foreign*$D*T_\tau$ | $\ln(e_{t0-1})*D*T_\tau$ | age*$D*T_\tau$ |
| $X * D*T_0$ | | 0.0418 ** | 0.0173 ** | 0.00303 * |
| | | (0.0205) | (0.00683) | (0.00169) |
| $X * D*T_1$ | | 0.0399 | -0.0155 | -0.000196 |
| | | (0.0390) | (0.0153) | (0.00310) |
| $X * D*T_2$ | | 0.0333 | -0.0119 | -0.00274 |
| | | (0.0516) | (0.0179) | (0.00415) |
| $X * D*T_3$ | | 0.0861 | -0.0185 | 0.00114 |
| | | (0.0674) | (0.0233) | (0.00597) |
| $X * D*T_4$ | | 0.200 ** | -0.0243 | -0.00450 |
| | | (0.0818) | (0.0332) | (0.00784) |
| $X * D*T_5$ | | 0.0199 | -0.0580 | -0.00442 |
| | | (0.1000) | (0.0623) | (0.00888) |
| $X * D*T_{6+}$ | | 0.108 | -0.0541 ** | -0.0161 ** |
| | | (0.0671) | (0.0274) | (0.00663) |
| N | 42,369 | 42,369 | 42,267 | 42,369 |
| $R^2$ | 0.772 | 0.773 | 0.773 | 0.773 |

Note: All regressions are based on specification (2) and include controls for country, industry and year effects. D denotes dummy for acquired firms, $T_n$ are dummies for periods n years after the acquisition year, X is one of the three moderator variables: Foreign acquisition indicator, log of employment and firm age. Dummies $T_0$ to $T_{6+}$ are included but not reported. Standard errors are in parentheses and are robust for clustering on the firm-level; *** p<0.01; **p<0.05; * p<0.1.

**Table 6**
Employment growth after acquisition.

| Employment: | baseline<br>(1) | for. vs dom.<br>(2) | small vs large<br>(3) | young vs old<br>(4) |
|---|---|---|---|---|
| $employment_{t0-1}$ | 0.939 *** | 0.939 *** | 0.947 *** | 0.939 *** |
| | (0.00283) | (0.00282) | (0.00293) | (0.00282) |
| $age_t$ | -0.00573 *** | -0.00575 *** | -0.00562 *** | -0.00505 *** |
| | (0.000546) | (0.000545) | (0.000544) | (0.000572) |
| $D*T_0$ | -0.0196 * | -0.0410 *** | -0.0908 *** | -0.0323 |
| | (0.0112) | (0.0137) | (0.0336) | (0.0251) |
| $D*T_1$ | -0.0396 ** | -0.0728 *** | 0.140 ** | -0.0215 |
| | (0.0199) | (0.0259) | (0.0643) | (0.0435) |
| $D*T_2$ | -0.0243 | -0.0456 | 0.174 ** | 0.104 * |
| | (0.0249) | (0.0323) | (0.0698) | (0.0605) |
| $D*T_3$ | 0.0239 | -0.0129 | 0.202 ** | 0.0884 |
| | (0.0287) | (0.0374) | (0.0785) | (0.0704) |
| $D*T_4$ | 0.0381 | -0.00463 | 0.313 *** | 0.119 |
| | (0.0365) | (0.0496) | (0.109) | (0.0983) |
| $D*T_5$ | 0.0594 | 0.0591 | 0.267 * | 0.0869 |
| | (0.0404) | (0.0499) | (0.154) | (0.117) |
| $D*T_{6+}$ | 0.0819 *** | 0.101 *** | 0.487 *** | 0.225 ** |
| | (0.0309) | (0.0391) | (0.0831) | (0.0969) |
| | | $Foreign*D*T_\tau$ | $\ln(e_{t0-1})*D*T_\tau$ | $age*D*T_\tau$ |
| $X * D*T_0$ | | 0.0550 *** | 0.0194 ** | 0.00104 |
| | | (0.0208) | (0.00793) | (0.00175) |
| $X * D*T_1$ | | 0.0840 ** | -0.0464 *** | -0.00133 |
| | | (0.0363) | (0.0173) | (0.00277) |
| $X * D*T_2$ | | 0.0538 | -0.0516 *** | -0.00903 ** |
| | | (0.0454) | (0.0173) | (0.00379) |
| $X * D*T_3$ | | 0.0962 * | -0.0467 ** | -0.00432 |
| | | (0.0506) | (0.0189) | (0.00404) |
| $X * D*T_4$ | | 0.103 | -0.0723 *** | -0.00514 |
| | | (0.0653) | (0.0279) | (0.00562) |
| $X * D*T_5$ | | -0.00251 | -0.0538 | -0.00151 |
| | | (0.0747) | (0.0409) | (0.00612) |
| $X * D*T_{6+}$ | | -0.0474 | -0.108 *** | -0.00768 |
| | | (0.0567) | (0.0215) | (0.00496) |
| N | 41,334 | 41,334 | 41,334 | 41,334 |
| $R^2$ | 0.818 | 0.819 | 0.819 | 0.818 |

Note: All regressions are based on specification (2) and include controls for country, industry and year effects. D denotes dummy for acquired firms, $T_n$ are dummies for periods n years after the acquisition year, X is one of the three moderator variables: Foreign acquisition indicator, log of employment and firm age. Dummies $T_0$ to $T_{6+}$ are included but not reported. Standard errors are in parentheses and are robust for clustering on the firm-level; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Next, we split the sample of acquired high-tech scaleups into foreign and domestic takeovers (Table 4), to test for the presence of a foreign ownership performance premium. In comparison to their foreign counterparts, the targets of domestic acquirers experience a significant contraction of 3 % in revenue in the year of acquisition, take longer (3 years after acquisition) to realise significant revenue growth and exhibit lower cumulative revenue growth after year 5. After 5 years, foreign-owned targets exhibit significantly higher cumulative revenue growth (11 %) than the targets of domestic acquirers (6%).

The difference between foreign and domestic acquirers is much more evident in post-acquisition employment change. The targets of domestic acquirers experience no significant increase in employment growth post acquisition. In contrast, the targets of foreign acquirers achieve significantly higher employment growth than their domestic counterparts each year following the year of acquisition, rising from 7 % in year 1–14 % in year 5. Thus, the disaggregate analysis demonstrates that the employment generation potential of acquisitions is primarily attributable to foreign rather than domestic acquirers.

In general, foreign takeovers generate significant employment and revenue growth within two years of acquisition and yield more consistent and higher growth acceleration than domestic acquirers.

We estimate a difference-in-differences regression on the matched sample of acquired and control firms in order to test for possible moderating factors of the effect of acquisition on firm growth. Table 5 shows results for revenue growth. In column (1) we report estimates of the baseline Eq. (2). Looking at the $D*T_\tau$ coefficients, target firms' growth rate in revenue is 3 % lower than that in control firms, in the year of acquisition. In the following years, the drop in revenue growth disappears and growth increases above that of control firms. By the end of the 5th year, revenue in acquired firms has grown by almost 10 % more than in control firms. In this model, we test for the long-term effects of acquisition for year 6 and beyond (Table 5: $D*T_{6+}$). The long-term effect is 17 % of additional revenue growth. In column (2) we test whether foreign acquirers produce different growth effects than domestic acquirers by including interaction terms with a foreign acquisition dummy. Foreign acquisitions avoid the drop in revenue in the acquisition year and yield higher cumulative growth of revenue in the following years, confirming the key finding from Table 4 on the superior growth

performance of targets of foreign-owned acquirers. Larger and older firms attain a less pronounced drop in revenue growth in the first year of acquisition. Smaller and younger target firms on average generate higher long-term cumulative growth in revenue. For example, having twice as many employees at the time of acquisition is associated with a 4% lower cumulative revenue growth. Being 10 years older at the time of acquisition decreases the revenue growth effect by 16%.

Finally, we present results for employment dynamics after acquisition using DiD regression approach (Table 6). In the year of acquisition and one year later, employment growth is 2 % and 4 % lower than in control firms, respectively (column (1)). In the following years, acquired firms catch up on lost employment. The long-term effect (6 or more years after the acquisition) on the cumulative growth of employment in acquired firms is 8 %. Foreign acquisitions avoid the employment downturn in the first two years, whereas domestic takeovers result in a 4 % and 7 % decrease in employment growth in the acquisition year and the year after, respectively. Long-term employment growth effects decrease with the initial size of high-tech target firms. For example, having twice as many employees at the time of acquisition is associated with an 8% lower effect on employment growth. Age of the acquired firm does not have a moderating role on the effect of acquisition on long-term employment growth.

To address the issue of survivorship bias, we estimate an extended linear regression model that allows us to control for sample selection in addition to the endogenous treatment assignment (Appendix D). With this, we address a concern that there could be differences between domestic and foreign acquisitions in terms of the likelihood that the target firm will be absorbed by the acquirer (or even dissolved), rather than continue to operate as a separate reporting entity. The results show that for the pooled sample of both domestic and foreign acquisitions there is a positive effect on the cumulative growth of employment and revenue after the acquisition. In terms of revenue growth, targets acquired by foreign acquirers outperform domestic acquisitions, whereas for employment growth there is no systematic difference in the cumulative growth rates between the two groups. We have greater confidence in the PSM results because in the extended linear regression model we cannot impose comparison with counterfactuals from the same country, industry and year.

## 5. Discussion and conclusions

In this study, we examine whether an acquisition promotes the growth of unlisted European firms that belong to high-technology knowledge-intensive sectors. We also investigate whether the effect on target firm growth differs between foreign and domestic acquirers. We estimate the effect of acquisitions on the cumulative growth of revenue and employment from the year before, up to five years post-acquisition, using a propensity-score matching approach and difference-in-differences regression.

Overall, our results show that acquisitions have a positive effect on the growth of high-tech scaleups, once firms have time to adjust to this significant event. There is a 2.4 %− 2.9 % decrease in revenue growth and no significant change in employment growth in the year of an acquisition, followed by a steady acceleration in revenue growth in the following years. After five years, acquired firms record 9 %− 13 % stronger cumulative growth in revenue and 6–10 % larger cumulative employment growth after four years, relative to matched control firms. We find that the nationality of the acquirer matters, particularly in terms of employment effects. Unlike domestic acquirers, foreign acquirers prevent revenue from contracting in the first year after the acquisition. After 5 years, foreign-owned targets exhibit significantly higher cumulative revenue growth than the targets of domestic acquirers. They also achieve higher employment growth whilst their domestic counterparts register no significant increase in employment post-acquisition. The targets of foreign acquirers registered 14 % additional employment growth in year 5 compared to non-acquired control firms, which indicates that the post-acquisition employment growth is attributable to this cohort. This indicates differences between cross-border acquisitions of high-tech and non-high-tech firms. Conn et al. (2005) also report that in cross border acquisitions involving high-tech firms both announcement and long run returns are positive. It suggests that "foreignness" is less of a liability in the high-tech sector (McCarthy and Aalbers, 2016).

The evidence for an initial disruption in revenue and employment growth is an important finding as it indicates that even in successful 'simple sales', where targets have significant structural independence from the acquirer, there is a period of adjustment as highlighted in the strategic management literature (Meglio and Risberg, 2011). This is corroborated by case studies of the acquisition process of high-tech start-ups in Israel that show that the first year is when founders report experiencing the greatest disruption to activities.[6] Revenue disruption is less evident amongst foreign acquirers which might reflect the difference in both the acquisition and integration strategies of foreign versus domestic acquirers including; motives for acquisition, prior acquisition experience, and pre-acquisition alliances (Porrini, 2004) that lead to better revenue performance. Equally, geographic distance might mitigate 'unnecessary structural integration' (Puranam et al., 2009) and therefore imply less disruption in the targets of foreign acquirers. Further examination of the factors contributing to this disparity in the critical first year post acquisition is an important area for further research.

We also estimate a difference-in-differences regression on the matched sample of acquired and control firms in order to test for possible moderating factors of the effect of acquisition on firm growth. Smaller and younger target firms on average generate higher long-term cumulative growth of employment and revenue. Having twice as many employees at the time of acquisition is associated with an 8% lower effect on employment growth and a 4% lower cumulative revenue growth. Being 10 years older at the time of acquisition decreases the revenue growth effect by 16%, while age does not have a moderating effect on post-acquisition medium-term employment growth.

[6] The founder of a successfully acquired firm reported: "Once we got acquired we got stuck. For a whole year we were stuck. We didn't do anything! It was all about integration with the platforms …"

Our findings are subject to some limitations. The results only apply to acquisition targets that were not absorbed into the acquiring firm, as the required data is not available for absorbed firms post acquisition. An OECD study of Belgian M&As indicates that the number of firms that are absorbed, at 14 %, is relatively low (Dumont et al., 2017). Ceteris paribus, our findings are important, as they document the impact of acquisition on the growth of independent high-tech scaleups that are generally under-examined in favour of high-tech scaleups that grow organically or so-called 'fast growth firms' (Eurostat-OECD, 2007). We argue that in a high-tech setting, being acquired is an important option to secure the risk capital needed to continue developing the technology (Andersson and Xiao, 2016; Miozzo and DiVito, 2016).

A potentially greater concern is the impact of survivorship bias which could hinder our ability to make causal implications especially when it comes to the effects between different types of acquisitions. Accounting for the survivor bias due to the non-random dissolution of targets would require estimating the selection process. Unfortunately, the Zephyr database does not provide any variables needed for such first stage selection estimation. However, the figures for dissolutions are similar across the acquisition type. In the merged sample of acquired firms, 21 % are dissolved sometime after the deal and the share is similar for domestic (23 %) and foreign acquirers (18 %). The fact that foreign acquisitions end up in dissolution less frequently, introduces a downward bias on our foreign acquisition premium estimates and further strengthens our conclusions regarding Hypothesis 2. Our additional analysis that controls for sample selection in addition to the endogenous treatment assignment has also shown that targets acquired by foreign acquirers outperform domestic acquisition.

In addition, we did not control for government-related funding that is available to entrepreneurial firms as another possible source of finance. In the propensity score matching procedure, when looking for a control group of non-acquired firms, we did include other sources of funding that can also have an impact on firm growth, such as debt financing and internal financial resources.

Our findings are relevant to researchers, policymakers and managers. First, from a policy perspective, the EU, OECD and World Economic Forum agree that scaleups are the key drivers of innovation, economic growth and competitiveness, creating flexible, sustainable and innovative employment opportunities (European Commission, 2016; World Economic Forum, 2020; European Commission, 2021; OECD, 2018). We provide important evidence on post-acquisition growth in high-tech scaleups using a large-scale multi-country European sample. It suggests that matching targets to acquirers with complementary assets and deep pockets can enable the scaling process and in turn long term revenue and employment growth in the economy. Thus accepting that many high growth start-ups will be acquired might lead to better support structures, advice and training for their founders. Whilst sources of risk capital for early stage investments such as business angels and crowdfunding are becoming more accessible, the EU is still at a significant disadvantage to the United States in terms of later stage risk finance (AFME, 2017; European Investment Bank, 2019). Accordingly, a more accessible and liquid high-tech M&A market has the potential to provide an alternative source of growth capital for high-tech scaleups and an exit mechanism for early stage investors. The European Investment Fund (EIF, 2021) reports that the European IPO and M&A markets remain underdeveloped and that firms face difficulties finding potential European buyers, especially large-ticket buyers. In response, a working group of Europe's leading entrepreneurs have called for the development of a €100 billion sovereign tech fund to enable the scaling of deep technology and innovative enterprises (Bloomberg, 2021).

Second, we contribute to the under-researched area of cross-border acquisitions of high-tech scaleups. Contrary to received wisdom, we find that the targets of foreign acquirers experience higher post-acquisition growth in revenues and employment compared to the targets of domestic acquirers. We find no support for policy makers or unions to oppose foreign acquisitions, quite the opposite, at least in the context of privately held high-tech scaleups.

Third, the important 'takeaway' for managers in both targets and acquirers relates to the importance of the first year in planning and managing the post-acquisition integration process. In examining the performance effects on an annual basis, we can observe the timing of the adjustment process. We find that growth dips in the first year, then stabilizes and accelerates in the years following acquisition. This suggests that the adjustment process is complex and that managing the first year is important in realizing the growth dividend. Overall, taking a longer term perspective enables a greater understanding of the revenue and employment effects of acquisitions.

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## CRediT authorship contribution statement

**Anže Burger:** Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Validation, Formal analysis. **Teresa Hogan:** Writing – original draft, Writing – review & editing. Conceptualization. **Patricia Kotnik:** Conceptualization, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition, Methodology, Project administration. **Sandeep Rao:** Methodology, Data curation, Writing – review & editing. **Mustafa Erdem Sakinç:** Conceptualization, Data curation, Investigation.

## Declarations of interest

None.

## Data Availability

The authors do not have permission to share data.2

## Appendix A

Acquirer cumulative abnormal returns.
See Table A.1 and Table A.2.

**Table A.1**
Cumulative Abnormal Returns (CARs) of acquiring firms.

| | (1)<br>3 days<br>[− 1,+ 1] | (2)<br>5 days<br>[− 2,+ 2] | (3)<br>11 days<br>[− 5,+ 5] | (4)<br>21 days<br>[− 10,+ 10] | (5)<br>31 days<br>[− 15,+ 15] |
|---|---|---|---|---|---|
| CAR | **0.0153** *** | **0.0168** *** | **0.0171** *** | **0.0198** *** | **0.0313** *** |
| | (0.00213) | (0.00255) | (0.00305) | (0.00562) | (0.00883) |
| Observations | 1619 | 1619 | 1619 | 1619 | 1619 |
| R-squared | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

The table presents the Cumulative Abnormal Returns (CARs) market model using the MSCI world index for window periods $[t_{-n}, t_{+n}]$ of three days [− 1,+ 1], five days [− 2,+ 2], eleven days [− 5,+ 5], twenty one days [− 10,+ 10] and thirty one days [− 15,+ 15] that include the announcement date at $t_0$ as the event date. For the market model, we consider the estimation period of 240 days prior to the event date i.e, $t_{-300}$ to $t_{-60}$.
Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Note: Of the 4714 acquisitions, there were 3383 acquirers in the whole sample of our study. We run the event study for 1619 announcements because of the limitation of data availability. We map the deals data of all the acquirers from Zephyr using the ISIN of the acquirers with the closing market price data from Thomson Eikon database. The market price data of 1288 acquirers were available, with some acquires engaging in multiple acquisitions.

**Table A.2**
Cumulative Abnormal Returns (CARs) for Domestic Versus Foreign Acquisitions.

| (1)<br>Window | (2)<br>Observations | (3)<br>Domestic Acquirers<br>CAR | (4)<br>Foreign Acquirers<br>CAR | (5)<br>Difference<br>in CAR | (6)<br>p-value | (7)<br>t-stat |
|---|---|---|---|---|---|---|
| 3 days [− 1,+ 1] | 1619 | 0.0207 | 0.0061 | **0.0146** *** | 0.0009 | 3.3286 |
| 5 days [− 2,+ 2] | 1619 | 0.0225 | 0.0071 | **0.0155** *** | 0.0034 | 2.9291 |
| 11 days [− 5,+ 5] | 1619 | 0.0206 | 0.0112 | 0.0094 | 0.1378 | 1.4847 |
| 21 days [− 10,+ 10] | 1619 | 0.0249 | 0.0110 | 0.0139 | 0.2331 | 1.1929 |
| 31 days [− 15,+ 15] | 1619 | 0.0428 | 0.0116 | **0.0312** * | 0.0885 | 1.7043 |

The table presents the 3 days, 5 days, 11 days, 21days and 31 days CAR of domestic [column 3] and Foreign [column 4] acquirers, and the difference between the CAR of the two groups of acquirers. Domestic acquirers' CAR is significantly higher (1.46% and 1.55%) than the foreign acquirers' CAR in the short term 3 days and 5 days window periods at 1% significance level. Longer windows show no significant difference, while the 31 days window shows a positive difference of about 3.12% at 10% significance level.

## Appendix B

See Table B.1.

**Table B.1**
Variable Definitions.

| Variable | Definition |
|---|---|
| Revenue | Operating revenue turnover, price deflated with base year 2015, log transformed in the empirical analysis |
| Employment | Number of employees, log transformed in the empirical analysis |
| Capital/Emp | Fixed assets per employee, price deflated with base year 2015, log transformed in the empirical analysis |
| Average wage | Average cost of employee per annum, price deflated with base year 2015, log transformed in the empirical analysis |
| EBITDA/Emp | Earnings before interest, taxes, depreciation, and amortization (EBITDA) per employee, price deflated with base year 2015, log transformed in the empirical analysis |
| Profit margin | (Profit before tax/operating revenue)* 100, expressed as an index number |
| Leverage | ((Noncurrent liabilities + Current liabilities)/Total assets)* 100, expressed as an index number |
| Cash flow/ Revenue | Cash flow per operating revenue |
| Age | Age of a firm in years |

## Appendix C

Propensity score matching.
See Fig. C.1 and Table C.1.

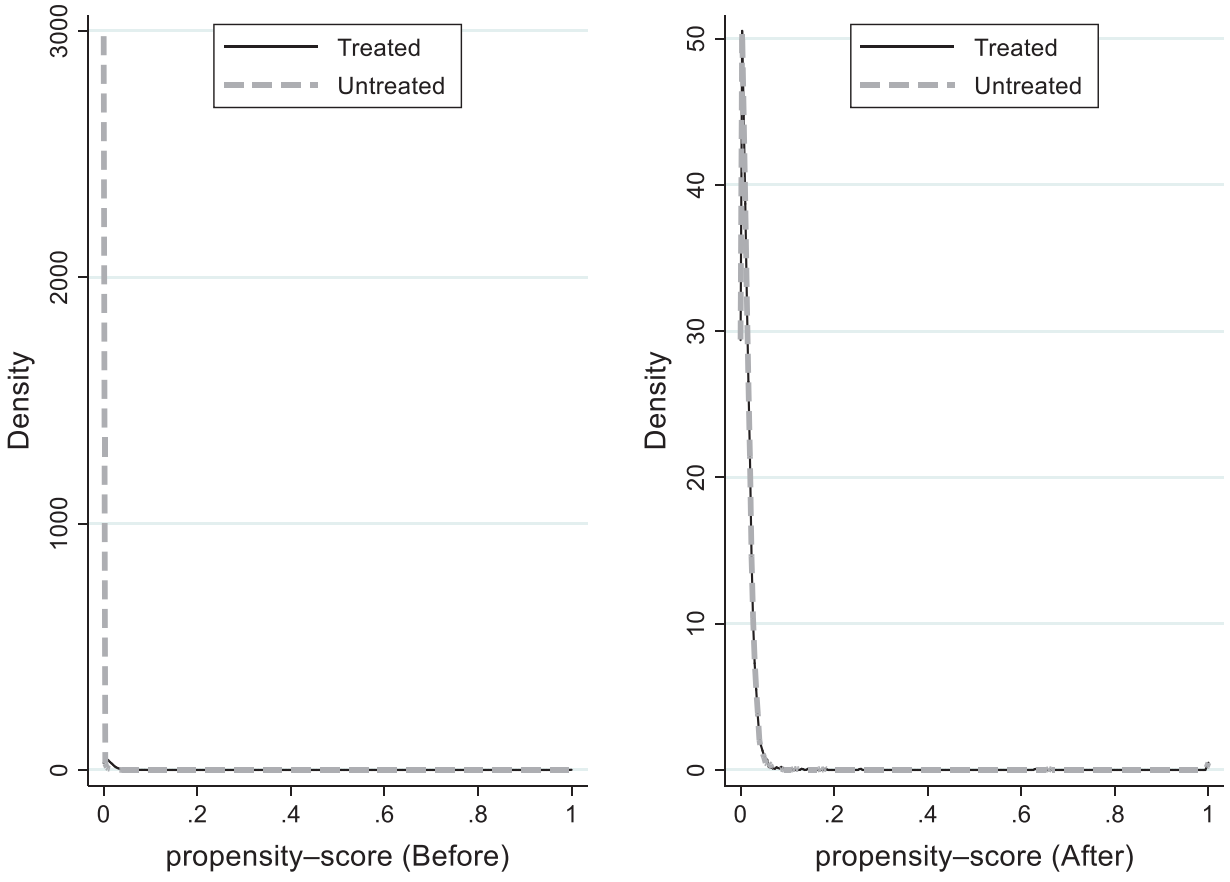


**Fig. C.1.** Kernel density estimates of the propensity score before and after the matching.

**Table C.1**
Balancing property test before and after the matching.

| Variable | Unmatched/ Matched | Mean | | %bias | %reduct \|bias\| | t-test | |
|---|---|---|---|---|---|---|---|
| | | Acquired | Control | | | t | Prob |
| propensity score$_t$ | U | 0.018 | 0.002 | 31.2 | | 27.63 | 0.000 |
| | M | 0.016 | 0.016 | 0.1 | 99.6 | 0.03 | 0.973 |
| operating revenue$_{t-1}$ | U | 9.002 | 6.457 | 157.9 | | 67.76 | 0.000 |
| | M | 8.998 | 9.080 | -5.1 | 96.8 | -1.7 | 0.089 |
| employment$_{t-1}$ | U | 3.759 | 1.720 | 137 | | 61.6 | 0.000 |
| | M | 3.765 | 3.809 | -3 | 97.8 | -0.95 | 0.340 |
| capital/emp $_{t-1}$ | U | 2.743 | 2.530 | 11.4 | | 5.23 | 0.000 |
| | M | 2.735 | 2.737 | -0.1 | 99.1 | -0.03 | 0.976 |
| average wage $_{t-1}$ | U | 4.099 | 3.527 | 82.5 | | 31.47 | 0.000 |
| | M | 4.095 | 4.116 | -3 | 96.3 | -1.22 | 0.224 |
| EBITDA/emp $_{t-1}$ | U | 58.467 | 24.577 | 5.6 | | 5.03 | 0.000 |
| | M | 54.567 | 97.302 | -7 | -26.1 | -1.11 | 0.269 |
| profitmargin $_{t-1}$ | U | 2.585 | 4.970 | -12.2 | | -6.3 | 0.000 |
| | M | 2.529 | 3.615 | -5.5 | 54.5 | -1.67 | 0.095 |
| leverage $_{t-1}$ | U | 79.085 | 71.743 | 8 | | 3.38 | 0.001 |
| | M | 79.187 | 75.407 | 4.1 | 48.5 | 1.67 | 0.096 |
| cash flow/revenue $_{t-1}$ | U | 5.003 | 7.056 | -11.9 | | -6.34 | 0.000 |
| | M | 4.964 | 6.001 | -6 | 49.5 | -1.79 | 0.073 |
| age $_{t-1}$ | U | 12.538 | 11.103 | 22.5 | | 10.15 | 0.000 |
| | M | 12.553 | 12.841 | -4.5 | 79.9 | -1.42 | 0.155 |

Note: The test corresponds to the nearest-neighbour matching with additional constraints that acquired and control firms belong to the same country, same 2-digit industry and the same year. Variable values correspond to the period just before the acquisition. Operating revenue, employment, capital per employee and average wage are expressed in logarithms. t-tests are based on a regression of the variable on a treatment indicator and test for equality of means in the two samples. The standardised % bias is the % difference of the sample means in the treated and non-treated sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (see Rosenbaum and Rubin, 1985).

## Appendix D

Addressing the issue of survivorship bias.

**Table D.1**
Effect of acquisition on revenue and employment growth controlling for sample selection and the endogeneity of acquisitions.

| Total revenue: | | $t_0$ | $t_0+1$ | $t_0+2$ | $t_0+3$ | $t_0+4$ | $t_0+5$ |
|---|---|---|---|---|---|---|---|
| All acquisitions | $ATET_\tau$ | 0.238 | 1.106 ** | 1.000 *** | 1.388 *** | 1.202 *** | 1.660 *** |
| | st. err. | (0.149) | (0.453) | (0.011) | (0.374) | (0.024) | (0.161) |
| | $N_{treated}$ | 1895 | 1639 | 1492 | 1351 | 1187 | 1074 |
| | N | 1210,633 | 1080,567 | 985,741 | 829,058 | 673,582 | 572,866 |
| Domestic acquirers | $ATET_\tau$ | 0.168 | 2.479 | 0.983 | 0.919 | 1.076 *** | 3.157 *** |
| | st. err. | (0.257) | (1.618) | (1.384) | (63.47) | (0.044) | (0.147) |
| | $N_{treated}$ | 1211 | 1042 | 965 | 885 | 776 | 706 |
| | N | 1209,949 | 1079,970 | 985,214 | 828,592 | 673,171 | 572,498 |
| Foreign acquirers | $ATET_\tau$ | 0.207 | 1.288 *** | 1.234 *** | 1.505 *** | 1.142 *** | 1.328 |
| | st. err. | (0.267) | (0.029) | (0.050) | (0.284) | (0.054) | (240.4) |
| | $N_{treated}$ | 687 | 597 | 527 | 466 | 411 | 368 |
| | N | 1212,005 | 1079,525 | 984,776 | 828,173 | 672,806 | 572,160 |
| Employment: | | $t_0$ | $t_0+1$ | $t_0+2$ | $t_0+3$ | $t_0+4$ | $t_0+5$ |
| All acquisitions | $ATET_\tau$ | 0.176 | 1.102 *** | 1.276 | 1.100 *** | 1.598 *** | 1.707 *** |
| | st. err. | (0.128) | (0.270) | (228.4) | (0.022) | (0.038) | (0.030) |
| | $N_{treated}$ | 1866 | 1639 | 1497 | 1361 | 1200 | 1082 |
| | N | 1188,421 | 1082,642 | 988,872 | 833,294 | 678,603 | 578,426 |
| Domestic acquirers | $ATET_\tau$ | 0.150 | 0.958 | 0.643 | 1.148 *** | 0.640 ** | 1.986 *** |
| | st. err. | (0.193) | (255.4) | (140.0) | (0.016) | (0.309) | (0.044) |
| | $N_{treated}$ | 1186 | 1041 | 963 | 890 | 787 | 710 |
| | N | 1187,741 | 1082,044 | 988,338 | 832,823 | 678,190 | 578,054 |
| Foreign acquirers | $ATET_\tau$ | 0.216 | 0.598 | 0.740 | 0.712 | 1.293 *** | 1.559 *** |
| | st. err. | (0.199) | (357.7) | (3.82) | (4.69) | (0.057) | (0.048) |
| | $N_{treated}$ | 680 | 598 | 534 | 471 | 413 | 372 |
| | N | 1187,235 | 1081,601 | 987,909 | 832,404 | 677,816 | 577,716 |

Note: Columns $t_0$ to $t_0$+5 denote the cumulative growth rate of revenue or employment from one year prior to acquisition to $\tau$ years after the acquisition ($y_{i(t0+\tau)} \equiv \ln\left(y_{i,t0+\tau}\right) - \ln\left(y_{i,t0-1}\right)$ for $\tau = 0, 1, \ldots, 5$). The top (bottom) half of the table reports the results for the revenue (employment) growth as the outcome variable. First, we report the average treatment effects on the treated (ATET) for the total sample of acquired firms, followed by the subsample of only domestic and lastly the subsample of only foreign acquisitions. Ntreated and N denote the number of acquired targets and the total number of observations in each regression, respectively. ***, **, * represent statistical significance at 1%, 5% and 10%.

See Table D.1.

As a robustness check, we estimate an extended linear regression model that allows us to control for sample selection in addition to the endogenous treatment assignment. We estimate a linear regression of outcome y on covariates $\boldsymbol{x}$:

$$y^0_{i(t0+\tau)} = \boldsymbol{x}_i\beta_0 + \varepsilon_{0i}$$

$$\boldsymbol{y}^1_{i(t0+\tau)} = \boldsymbol{x}_i\beta_1 + \varepsilon_{1i} \text{ where}$$

$$y_{i(t0+\tau)} = (1 - D_i)y^0_{i(t0+\tau)} + D_i y^1_{i(t0+\tau)}$$

$$D_i = 1(z_{Di}\alpha_D + \varepsilon_{Di} > 0)$$

$$s_i = 1(z_{si}\alpha_s + \varepsilon_{si} > 0)$$

where $y_{i(t0+\tau)}$ is the cumulative growth rate of revenue or employment from one year prior to acquisition to $\tau$ years after the acquisition ($y_{i(t0+\tau)} \equiv \ln\left(y_{i,t0+\tau}\right) - \ln\left(y_{i,t0-1}\right)$ for $\tau = 0, 1, \ldots, 5$) and vector $\boldsymbol{x}_i$ contains variables that explain firm $i$'s growth rate: size in $t_0$-1 (log employment for revenue equation and log revenue for employment equation), capital-employment ratio, log average wage, EBITDA per employee, profit margin, leverage, cashflow per operating revenue and age (all in $t_0$-1) and vector of country and year dummies. The treatment $D_i$ takes two values, $D_i = 1$ for acquisition and $D_i = 0$ otherwise, indexing the potential outcomes of the main outcome $y_{i(t0+\tau)}$: $y^1_{i(t0+\tau)}$ and $y^0_{i(t0+\tau)}$, respectively. We assume an endogenous treatment $D_i$. We use a probit model for binary acquisition treatment with covariates $z_{Di}$, whereby we employ the same variables and the same polynomial specification as in the Propensity score matching estimation. We assume that variance and correlation parameters are potential-outcome specific. The outcome $y_{i(t0+\tau)}$ is observed if $s_i = 1$ and is not observed if $s_i = 0$. $z_{si}$ are covariates that affect selection: log revenue, log employment, profit margin, dummy for acquirer and target belonging to the same industry, dummy for financial acquirer, dummy for foreign acquirer, year, 2-digit industry and country dummies. For the acquired firms ($D_i = 1$), we estimate the average treatment effect on the treated (ATET):

$$ATET_1 = E\left(y^1_{i(t0+\tau)} - y^0_{i(t0+\tau)} \middle| D_i = 1\right) = E\{TET_1(\boldsymbol{x}_i, D_i = 1)|D_i = 1\}$$

where for the treatment effect on the treated (TET) of the acquired firms we have

$$TET_1(\boldsymbol{x}_i, D_i = 1) = E\left(y^1_{i(t0+\tau)} - y^0_{i(t0+\tau)} \middle| \boldsymbol{x}_i, D_i = 1\right) = \boldsymbol{x}_i\beta_1 - \boldsymbol{x}_i\beta_0 + E(\varepsilon_{1i}|\boldsymbol{x}_i, D_i = 1) - E(\varepsilon_{0i}|\boldsymbol{x}_i, D_i = 1)$$

The outcome errors and the treatment error $\varepsilon_{Di}$ are multivariate normal with mean 0 and covariance $\Sigma_j = \begin{bmatrix} \sigma_j^2 & \sigma_j\rho_{jD} \\ \sigma_j\rho_{jD} & 1 \end{bmatrix}$, so for potential outcome $j = 0, 1$ we can decompose $\varepsilon_{ji}$ such that $\varepsilon_{ji} = \sigma_j\rho_{jD}\varepsilon_{Di} + \psi_{ji}$ where $\psi_{ji}$ has mean 0 and is independent of $D_i$. It follows that

$$TET_1(\boldsymbol{x}_i, D_i = 1) = \boldsymbol{x}_i\beta_1 - \boldsymbol{x}_i\beta_0 + (\sigma_1\rho_{1D} - \sigma_0\rho_{0D})E(\varepsilon_{Di}|\boldsymbol{x}_i, D_i = 1)$$

From this, ATET can be obtained if one takes the expectation of these conditional predictions over the covariates to get population-averaged parameters. The estimation is performed using Stata command eregress.

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