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The impact of acquisitions on growth of European high-tech entrepreneurial firms

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Abstract

We aim to assess the impact of acquisitions on growth of European high-tech entrepreneurial firms. The paper explores whether firms acquired by a corporate investor enjoy higher growth than their non-acquired counterparts and whether the effect on target firm growth differs between foreign and domestic acquirers. It also explores whether firms acquired by a corporate investor outperform those acquired by a financial investor. Using a propensity-score matching approach and difference-in-differences regression, we estimate the effect of acquisitions on the cumulative growth of revenue and employment from the year before the acquisition to up to 5 years after, for a sample of 4714 acquisition targets from 5 EU countries between 2003 and 2015. Our results show that acquisitions have a positive effect on growth of high-tech entrepreneurial firms and that growth is not significantly different between firms acquired by an established company and those acquired by a financial buyer. The nationality of the acquirer does matter, however. Foreign-owned firms exhibit significantly higher cumulative revenue and employment growth than the ones with domestic acquirers.

Keywords: Firm growth; Entrepreneurial firms; Corporate acquisitions; Financial investors; Propensity-score Matching

JEL codes: G34, G24, D22, L26, F21

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1. Introduction

Financial resources are a critical issue for growing businesses (Brown, Mawson, & Mason, 2017), especially in the case of knowledge-intensive firms (Grilli, 2014). Knowledge-based firms have a number of characteristics that lead to information asymmetries on the financial markets and thus a funding gap: they invest in intangible assets, they lack sufficient collateral, customer bases are often more complex and take time to build, and they may continue to be loss-making for long periods after start-up (N. Wilson, Wright, & Kacer, 2018). Policy makers have sought to address this by supporting the seed and early stage financing (K. Wilson, 2015) and are now beginning to recognize the existence of a second "valley of death", referring to the second equity gap emerging beyond the initial revenue generating phase and affecting somewhat older and larger firms (N. Wilson et al., 2018). The Start-up and Scale-up initiative, launched recently by European Commission, emphasizes improved access to funding as one of the main elements in helping European start-ups scaling up into bigger firms (European Commission, 2016). Actions implemented to achieve this mainly deal with boosting venture capital (VC) investments (European Commission, 2016). Generally, VC financing is considered to be the most suitable form of financing for entrepreneurial firms from knowledge-intensive industries (Croce, Martí, & Murtinu, 2013). However, we aim to direct the attention to corporate acquisitions, for several reasons.

First, they are an important option for funding growth plans of entrepreneurial firms. Especially for scale-up challenges of technology-based firms, the alternative options for external equity are getting acquired by a financial buyer, going public or getting acquired by another company (Duruflé, Hellmann, & Wilson, 2017). VC markets in Europe are underdeveloped and it seems more and more difficult to obtain equity financing in later stages (Aernoudt, 2017). IPOs are on a decrease, not only in Europe but also in the US (Cotei & Farhat, 2018; Ewens & Farre-Mensa, 2017; Ritter, Signori, & Vismara, 2013), and play a relatively minor role in financing of growth phases of European firms (Duruflé et al., 2017). Being acquired is thus one of a few available options for entrepreneurial firms to ensure financing that is needed to continue developing the technology or product idea (Andersson & Xiao, 2016; Miozzo & DiVito, 2016). This is accompanied not only by a trend of large established firms buying younger, innovative companies as a way to attract knowledge and know-how (Lehmann & Schwerdtfeger, 2016) but also by acquisitions being increasingly done by SMEs, especially high-growth ones (Arvanitis & Stucki, 2014; Brown et al., 2017). Recent evidence also suggests that small firms increasingly prefer being acquired rather than growing independently (Gao, Ritter, & Zhu, 2013; Signori & Vismara, 2018).

Second, whereas a lot of research has been done on the effects of venture capital on VC-backed firm growth, there is only limited evidence available on acquisitions of high-tech start-ups and entrepreneurial firms and the effects this has on growth of these firms (Andersson & Xiao, 2016; Lehmann & Schwerdtfeger, 2016). Literature on acquisitions and mergers (M&As) typically focuses on larger companies, often publicly listed

(Haleblian, Devers, McNamara, Carpenter, & Davison, 2009), and studies more often focus on acquiring firms and less on acquired firms (Meglio & Risberg, 2011). Data availability is a potential reason for a lack of empirical research on this topic. As Erel et al. (2015) point out, such studies require financial data on target firms before and after the acquisition and in the United States such data are not publicly available for subsidiaries. Most European countries require such disclosure and as long as the target remains an independent subsidiary after the acquisition, it is possible to observe its financial statements after it happens. However, even for European firms the empirical evidence on what happens to entrepreneurial firms after the acquisition is rare. Recent entrepreneurship literature includes a study by Xiao (2015) focusing on different types of acquirers of new technology-based firms in Sweden. It examines their effect on growth of target firms, also adding the nationality of the acquiring firm to the analysis. It finds that acquisition by Swedish multinationals (MNEs) significantly improves the target firm growth, but only growth in employment, whereas acquisitions by foreign MNEs and domestic enterprises are not found to have any significant effect on growth in either employment or sales.

Third, two additional aspects of acquisitions might be of interest to policy makers. Cross-border or foreign acquisitions are subject to policy debates regarding their effects in many countries. Empirical evidence shows that governments are more likely to support domestic acquirers and oppose foreign ones in the cases of merger attempts in the EU countries (Dinc & Erel, 2013) and foreign investors are sometimes even labelled as “locusts” (Bena, Ferreira, Matos, & Pires, 2017). The evidence for such claims is not clear. Cross-border M&As are relatively under-investigated (Meglio & Risberg, 2011). So far, empirical studies on whether foreign investors, either in the form of corporate acquirors or financial investors, lead to a reduction or an increase in performance and innovation of the target firms provide a mixed picture (Bena et al., 2017; Devigne, Vanacker, Manigart, & Paeleman, 2013; Eliasson, Hansson, & Lindvert, 2017; Xiao, 2015).

Besides nationality of the acquirer, a distinction between corporate and financial investors is an interesting one to explore. If being acquired by another company or by a financial buyer are alternatives in terms of sources of additional finance for an entrepreneurial firm, then it is relevant to compare how successful the two options are in releasing the growth constraints of the firm. When it comes to a comparison of the effect of corporate acquisitions and acquisitions by financial investors on growth of the target firm, no empirical studies have been done, to the best of our knowledge. The closest comes the research comparing the effects of corporate venture capital (CVC) investors and independent venture capital (IVC) investors on growth of portfolio firms. CVC investments differ from corporate acquisitions; with the former the corporations seek minority equity stakes in young ventures whereas the acquisitions are control changing and involve taking over more than 50% ownership. However, CVC investments and acquisitions can be considered two alternative modes of pursuing external business development and firm growth (Tong & Li, 2011). Research comparing

CVC and IVC has shown that CVCs have longer investment horizons of patient capital and greater tolerance of failure which nurtures innovation of CVC-backed firms (Chemmanur, Loutskina, & Tian, 2014; Pahnke, Katila, & Eisenhardt, 2015) but are also less likely to pay attention to help firms grow compared to IVCs (Pahnke et al., 2015). The comparison of the effects of both on sales and employment growth of the portfolio firms has so far shown mixed results (Bertoni, Colombo, & Grilli, 2013; Standaert & Manigart, 2018).

This study aims to contribute to the existing entrepreneurship literature on acquisitions of high-tech (HT) entrepreneurial firms, defined as firms less than 20 years old and belonging to high-tech knowledge-intensive (HTKI) industries (similar to Croce et al., 2013). We address the following research questions. First, do HT entrepreneurial firms acquired by a corporate investor enjoy higher growth than their non-acquired counterparts. Second, does the effect on target firm growth differ between foreign and domestic acquirers. Third, do HT entrepreneurial firms acquired by a corporate investor outperform those acquired by a financial investor; in other words, do the effects on the target firm growth differ between corporate acquirers and financial investors. Financial buyers include VC funds and other types of private capital such as private equity funds, hedge funds and mutual funds, all of which have an increasingly large role in financing the scale-up stage of companies, at least in the US (Ewens & Farre-Mensa, 2017).

We construct a sample of 4714 acquisition targets from France, UK, Italy, Germany and Sweden between 2003 and 2015 that are unlisted at the time of acquisition and classify as HT entrepreneurial firms. A combination of Zephyr and Amadeus databases, both of them compiled by Bureau van Dijk, is used for this purpose. Zephyr database records information on M&As, initial public offerings (IPOs), private equity and venture capital deals. It is increasingly used in finance literature (see, for example, Tykvová, 2018; Tykvová & Borell, 2012; N. Wilson et al., 2018) but less so in entrepreneurship research, in spite of having an advantage of covering some smaller deals not included in alternative databases that cover M&As (Bollaert & Delanghe, 2015; Huyghebaert & Luypaert, 2010). Our paper estimates the effect of acquisitions on the cumulative growth of revenue and employment of acquired firms, from the year before the acquisition to up to 5 years after, using a propensity-score matching approach. We find that acquisitions have a positive effect on growth. There is a 2,3%-2,8% decrease in revenue and employment growth in the year of a corporate acquisition, followed by a steady acceleration of growth in the following years. After 5 years, acquired firms exhibit by 11%-13% stronger cumulative growth of revenue and 7-9% larger cumulative employment growth after 4 years, relative to matched control firms. In contrast to firms acquired by corporate acquisitions, firms acquired by a financial investor avert the dip in revenue in the initial post-acquisition period, but achieve similar cumulative growth differential.

Whereas research does not find that growth is significantly different between firms acquired by an established company and those acquired by a financial buyer, it does find that the nationality of the acquirer matters. Unlike domestic acquirers, foreign acquirers make no initial redundancies and prevent revenue from contracting in the first year after the acquisition. After 5 years, foreign-owned firms exhibit significantly higher cumulative revenue growth than the ones with domestic acquirers. They also achieve higher employment growth four years after the acquisition.

The remainder of the paper is structured as follows. Section 2 presents a brief review of the strands of literature this study contributes to. Section 3 describes our data and discusses our empirical strategy, while section 4 presents the findings. Section 5 concludes.

2. Background Literature

2.1. Corporate acquisitions and firm growth

Available empirical evidence on the effects of corporate acquisitions on growth of acquired entrepreneurial firms is scarce. Individual acquisitions will happen for different motives and acquisition motives were found to be related to post-acquisition performance, at least of acquiring firms (Rabier, 2017). When it comes to acquisitions of high-technology start-ups, evidence suggests that the prevailing motive for incumbent firms is increasingly to gain access to new technology or to diversify technological capabilities (Szücs, 2014). Some of the studies have thus examined the impact on innovation of acquired firms in the post-acquisition period, such as the one by Szücs (2014), but the research usually focuses on mergers, larger acquisition transactions and does not single out entrepreneurial firms. A study by Xiao (2015) is an exception that addresses this subset of firms and their post-acquisition growth. It sums up the possible positive and negative effects on the acquired new technology-based firms. The positive effects include the transfer of resources and management capabilities to the acquired firm, relaxation of financial constraints, replacement of inefficient management teams and decreased path dependency that can lead to discovery of new entrepreneurial opportunities, whereas costs arising from post-integration process can have a negative effect. What the study finds, examining Swedish entrepreneurial firms entering in HT manufacturing or knowledge-intensive business services sectors, is that acquisition improves growth of these firms but only when they are acquired by a Swedish MNE and only when it comes to growth in employment, not sales. The study also finds no significant effect on growth when the acquirer is a foreign MNE or a Swedish domestic enterprise (Xiao, 2015).

These strands of entrepreneurship and M&A literature seem to provide ample room for further research. This paper contributes to our understanding of the impact corporate

acquisitions have on growth of acquired firms, by setting up a large-scale multi-country empirical study of European HT entrepreneurial firms.

2.2. Cross-border acquisitions and firm growth

Some of the recent studies that focus on the impact of acquisitions on innovation have examined the effect of the acquirers' nationality, with mixed findings. Whereas a study of post-acquisition innovation of European firms after a foreign M&A found a decline in innovation output of the target firms (Stiebale, 2016), another study focusing on foreign acquisition of Swedish smaller firms found an increase in their share of high-skilled labour after being acquired by a foreign MNE (Eliasson et al., 2017). Widening the range of studies to financial investors, there is evidence that foreign ownership by institutional investors leads to increases in innovation output of publicly listed firms (Bena et al., 2017) and that cross-border VC investors are more beneficial to porfolio firm growth in the long run than domestic ones (Devigne et al., 2013). An already mentioned study by Xiao (2015), focusing on HT entrepreneurial firms, has shown that acquisitions by foreign MNEs do not help the acquired firms grow, but when an acquirer is a domestic MNE the effect on acquired firms' growth is positive. Again, we can conclude that the issue of cross-border acquisitions leaves room for additional research.

2.3. Acquisitions by financial investors and firm growth

Venture capital and private equity (PE) investors have a range of positive effects on their portfolio companies, attributed to professionalization and tightened post-investment governance of the target companies, provision of additional financial resources and reputational and legitimacy effects on the portfolio companies (Manigart & Wright, 2013). When it comes to studying entrepreneurial firms as portfolio companies of financial investors, there seem to be no studies of PE-backed firms, which is not surprising, given that the PE industry has only lately started to spread from more traditional industries with mature products and stable cash-flows to technology-based sectors (Ughetto, 2010). However, there is ample evidence on the impact of VC investments on growth of entrepreneurial firms and they strongly point to a positive impact.

A common conclusion of these studies is that the positive effect on growth is not due to selection effect (VCs selecting companies with future high growth prospects) but is a consequence of a treatment effect, i.e. the financial and non-financial value provided by the VCs. Using a longitudinal dataset of Italian new technology-based firms, Bertoni et al. (2011; 2013) found a large positive treatment effect of VC on their growth of sales and employment. Croce et al. (2013), studying a sample of 700 firms from 6 European countries, from medium- and high-tech industries and less than 20 years old, found higher productivity growth of VC-backed firms as compared to non-VC backed firms.

Some of the studies have compared the impact on portfolio firms by IVC and government venture capital (GVC) investments, with the results unfavourable for the latter. Grilli and Murtinu (2014) have found statistically significant and economically relevant impact of IVC on sales growth of European HT entrepreneurial firms but statistically negative and economically irrelevant impact of GVC. Bertoni and Tykvova (2015), examining European young biotech firms, concluded that GVCs, as stand-alone investors, have no impact on invention and innovation of these firms, but they do boost the impact of IVC investors when GVC and IVC syndicate.

Studies that compare the impact of financial and nonfinancial investors on target firms are rare. A paper by Brossard et al. (2013) is one such example, studying the impact of different types of institutional investors and of so-called strategic entities (such as corporations, individual investors, holding companies or government agencies) on R&D spending of large highly innovative European companies. A distinction is also made in this study between "patient" and "impatient" investors, the difference being whether their portfolio holding period is longer (or shorter) than 24 months, with around 20% of institutional investors classified as impatient. The study shows that firms in which impatient institutional investors (mainly hedge funds and mutual funds) dominate ownership, R&D ratios are lower.

When it comes to a comparison of the effect of corporate acquisitions and acquisitions by financial investors on growth of the target firm, no empirical studies have been done, to the best of our knowledge.

3. Data and empirical strategy

3.1. Data

This work draws on two data sources that needed to be linked. Data on mergers and acquisitions, private equity and venture capital deals were extracted 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, including IPOs. Only completed transactions are used in our empirical analysis (deals that are Completed or Completed Assumed). We restrict ourselves to transactions where the target firm comes from one of the five European countries - France, UK, Italy, Germany and Sweden – and to those for which information on both the acquirer and the target is available. We have excluded deals where the transaction is between a vendor and an acquiring firm since our aim was to detect deals where previously independent target firms get bought. We have also excluded deals where the target firm does not have a BvD identification number and when it belongs to the finance sector (NACE section K, i.e. financial and insurance activities) or public sector (NACE section O).

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 possesses more than 50% of

voting 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 (we wanted to capture the last acquirer with the control-changing deal). Based on the industry of the acquiring firm we categorize a deal as an acquisition by a financial investor (when investor belongs to NACE section K) or as a corporate acquisition (when investor comes from a non-financial industry). We also track the nationality of the acquiring firm. For our analysis, we need the data on 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 standing subsidiary. This implies our results will only apply to targets that do not become organizationally integrated with their buyer.

The second data source used was the Amadeus database, by the same data provider. Amadeus is a comprehensive database on European companies containing annual account items on around 21 million companies across Europe. Different historical vintages of Amadeus were used so that non-surviving firms were included.[3] 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; we use unconsolidated accounts, both for acquired and non-acquired firms. We restrict the analysis to the period 2003-2015 since filings for account year-ends in 2016 were not yet complete. Amadeus data were matched with the transaction data from Zephyr, using a common identification number. Our sample comprises some acquired firms for which not all necessary Amadeus data are observable so we needed to exclude the respective firms from our analysis. We restrict our analysis to target firms that are less than 20 years old at the time of the acquisition and belong to high-tech industry and knowledge intensive services (HTKI). We use the definition of HTKI used by Eurostat: high-tech manufacturing industries include NACE Rev. 2 codes 21 and 26, whereas knowledge-intensive services comprises codes 50 to 51; 58 to 63; 64 to 66; 69 to 75; 78; 80; 84 to 93 (Eurostat, 2016). We also restrict ourselves to firms that are not listed at the time of the acquisition. We obtain a final sample of 4714 acquisition targets. Table 1 reports the number and share of corporate and financial acquisitions across the five countries in our sample.

Table 1: Entrepreneurial HTKI target firms acquired by corporate acquirers and financial investors across countries

	Corporate acquisitions		Financial acquisitions		All acquisitions	
Country of the target firm	N. firms	%	N. firms	%	N. firms	%
	(1)	(2)	(3)	(4)	(5)	(6)
Germany	399	9.2%	36	9.5%	435	9.2%
France	919	21.2%	80	21.1%	999	21.2%
Italy	257	5.9%	32	8.4%	289	6.1%
Sweden	1,006	23.2%	86	22.6%	1,092	23.2%

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

United Kingdom	1,753	40.4%	146	38.4%	1,899	40.3%
Total	4,334	100%	380	100%	4,714	100%

Notes: The sample includes acquired target firms (when a control-changing acquisition happens, with the acquiring firm now possessing more than 50% of voting rights) that enter the Zephyr dataset between 2003 and 2015. Columns 2, 4 and 6 show the percentage of corresponding type of acquisitions calculated with respect to the total number of acquisitions in that category.

3.2. Matching

The aim of the paper is to evaluate the average impact of acquisition on entrepreneurial HTKI target firm growth τ years after the acquisition: $E(\Delta_{i,\tau}) = E(y_{i,\tau}^1 - y_{i,\tau}^0)$. Identification of the treatment effect faces the fundamental problem of the missing counterfactual. We only observe the size of the firm *i* being acquired ($y_{i,\tau}^1$), but not the outcome in absence of acquisition ($y_{i,\tau}^0$). 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 (Δ_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 on the treated by matching treated and non-treated units based on 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 & Murtinu, 2014; Szücs, 2014).

Propensity scores were estimated with a probit model on a set of explanatory variables: 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, debt leverage, cash flow per operating revenue, age of a firm, country dummies, 2-digit NACE industry dummies and year dummies. All regressors except dummy variables entered the probit

[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: $0<p(x)<1$ (for details, see Cerulli, 2015; Wooldridge, 2010).

in quadratic polynomial form to allow for more flexible functional form and achieve a better fit. Furthermore, we used the lagged values of these regressors in order 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 was an indicator of acquisition equal to 1 if a firm was acquired in the current year, 0 if there was no acquisition and missing for observations after the acquisition.

After the propensity score is estimated, we test whether the balancing property is satisfied by identifying the optimal numbers of blocks. The final optimal number of propensity-score blocks was equal to 24. After 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 were only 7 instances where one of the variables was not balanced within a block, which is in our opinion satisfactory given the number of variables included in probit model and number of propensity score blocks. In addition to ex-ante balancing test, we evaluate how well the acquired and control firms are balanced in the matched samples. If the treatment and comparison groups are poorly balanced, the propensity score needs to be respecified (Austin, 2009; Ho, Imai, King, & Stuart, 2007).

We estimate 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 (Heckman, Ichimura, & Todd, 1998; Smith & Todd, 2005). This estimator is similar to the classical DiD, but to its benefit 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). Average treatment effect on the acquired firms τ years after the acquisition is estimated as follows:

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

where N is the number of acquired firms, $i \in \{D\}$, C is the non-acquired set of control firms, $y_{i(j),t_0+\tau}^{D=1(D=0)}$ is the size (log of revenue or log of employment) of acquired (control) firm i (j) τ 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) the revenue or employment has grown in acquired firms compared to similar control firms from pre-acqusition year t_0*-1* to τ 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 tradeoff between the variance of the estimates and bias (Caliendo & Kopeinig, 2008; Dehejia & Wahba, 2002).

If the propensity score is estimated in a 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 & Imbens, 2016). For matched data, bootstrap methods provide unreliable estimates (Abadie & Imbens, 2008), and standard errors need to be calculated with the Abadie-Imbens (AI) method (Abadie & Imbens, 2016). They propose a bias-corrected estimation making Matching estimators N1/2 consistent and asymptotically normal and provide 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.

3.3. Difference-in-differences approach

After 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. 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 τ =0, 1, 2, … We combine the dynamic specification of Gibrat law panel data model with the DiD setting and estimate the following specification:

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

where $y_{i,t}$ is size (total revenue or employment) of firm i in year t and y_{i,t_0-1} is 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_τ 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 ($\tau=6+$). In this manner, we create an acquisition timeline, allowing us to track the effects of acquisition on firm growth over the timeframe. Parameter δ_τ is the estimate of

the treatment effect of acquisition on the growth of firm revenue or employment from pre-acqusition year t_0-1 to post-acquisition year $t_0+\tau$. In other words, it shows us by 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.

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 corporate acquisitions and firms acquired by financial acquirers, we define X as an indicator for financial as opposed to corporate acquisition. Next, to test for the differences in post-acquisition growth between domestic and foreign acquirers, we define X as an indicator for foreign as opposed to domestic acquisition. Finally, we define X as the number of employees in the pre-acqusition year t_0-1 and as the current age of the firm in order to test for the moderating effects of target firm size and age on subsequent growth.

4. Results

In Table 2, we report some descriptive statistics on total revenue, number of employees, capital-labour ratio, average wage, profit margin and age for acquired entrepreneurial HTKI firms and non-acquired entrepreneurial HTKI firms. We show summary statistics, such as mean, median and number of observations for each variable for the entire sample of entrepreneurial HTKI firms, acquired firms, non-acquired firms and for acquired firms one year before the acquisition. For every variable, we perform t-test on the difference-in-mean between the group of acquired firms and the non-acquired group. We find that acquired firms are larger, more capital intensive, more profitable, pay higher wages and are older than non-acquired entrepreneurial HTKI firms. Moreover, this advantage is present already before the firms were acquired. Acquired firms' size, profitability and average wage are higher in the post-acquisition period compared to pre-acquisition year. This evidence seems to suggest a non-random endogenous selection mechanism and a positive effect of acquisition on the growth of acquired entrepreneurial HTKI firms.

Table 2: Descriptive statistics for acquired and non-acquired firms

		Total sample	Acquired	Non-acquired	Pre acquisition
Revenue	Mean	5.80	8.59***	5.77	8.48***
	Median	5.69	8.72	5.67	8.55
	Obs	3,383,211	18,749	3,350,305	3,319
Employment	Mean	1.43	3.52***	1.41	3.44***
	Median	1.10	3.53	1.10	3.40
	Obs	2,968,495	18,072	2,936,817	3,174
Capital/Emp	Mean	2.53	2.88***	2.52	2.94***
	Median	2.47	2.76	2.46	2.84
	Obs	2,305,563	14,909	2,278,975	2,680
Average wage	Mean	3.48	4.14***	3.48	4.10***
	Median	3.61	4.17	3.61	4.13
	Obs	2,612,895	17,046	2,582,894	2,973
Profit margin	Mean	7.15	3.71***	7.19	2.26***
	Median	4.44	4.91	4.44	4.26
	Obs	3,007,734	17,021	2,977,723	3,003
Age	Mean	9.59	13.60***	9.57	11.07***
	Median	8.17	12.83	8.17	10.00
	Obs	3,460,612	18,886	3,427,455	3,341

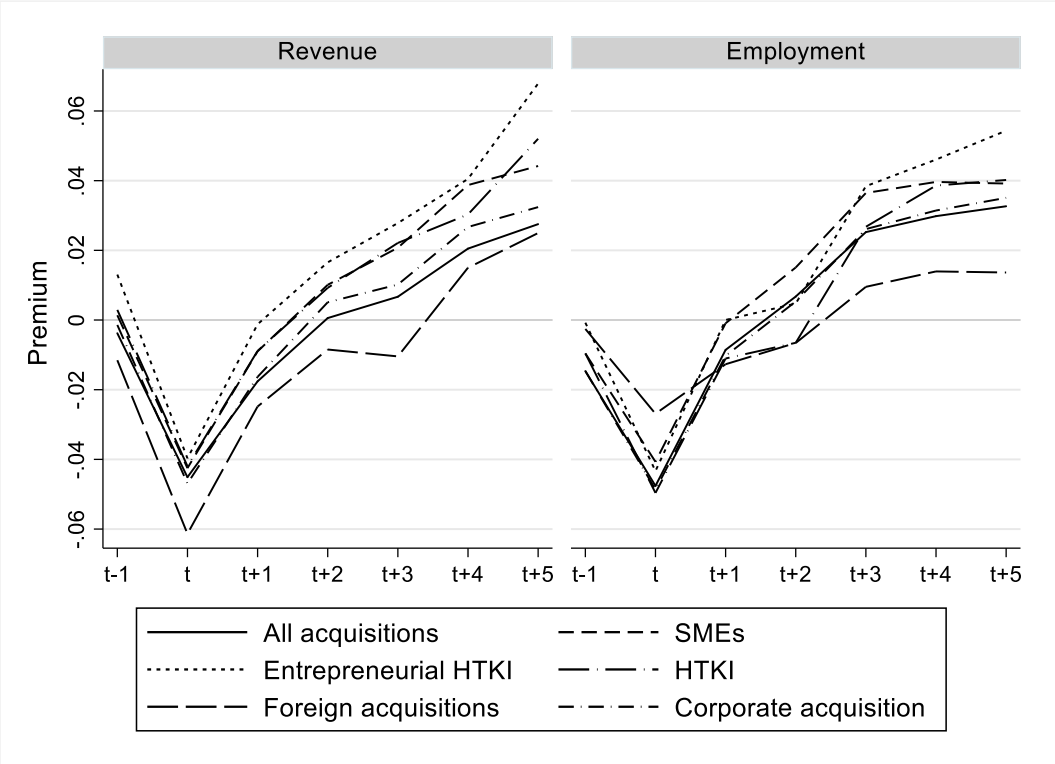
Notes: Column Acquired corresponds to acquisition year and post-acquisition period in the acquired group of firms. Column Pre acquisition refers to values of variables one year before the acquisition. Revenue is log of operating revenue; Employment is log of number of employees; Capital/Emp is log of fixed assets per employee; Average wage is log of average wage per employee per annum; Profit margin is (profit before tax/operating revenue)*100; Age is age of a firm in years. Data are expressed in thousand € and deflated by CPI (reference year: 2015). *** Represents statistical significance at 1% in the t-test on the difference-in-mean between the group of acquired firms and non-acquired group.

Before we analyse the effect of acquisition on entrepreneurial HTKI target firms, we provide evidence on the magnitude of the performance gap for a variety of acquisition targets. We report the differences in revenue and employment levels between acquired and non-acquired firms in Figure 1 for six groups of acquired firms (all acquired firms, small or medium sized target firms, targets form HTKI sectors, entrepreneurial HTKI targets, firms acquired by a foreign acquirer, and firms acquired by a corporate investor) in the period 2003-2015. Figures report the acquisition premia estimated from a regression of the form

$$\ln X_{i,t} = \alpha + \beta T_{\tau} + \gamma age_{i,t} + C_i + I_i + Y_t + \varepsilon_{i,t} \quad (3)$$

where $X_{i,t}$ is revenue or employment of firm i in year t, T_{τ} is a dummy equal to 1 if firm was acquired τ years ago, $age_{i,t}$ is age of a firm, and C_i, I_i and Y_t are dummies for country, 2-digit NACE industry and year, respectively. The acquisition premium, β, reveals the average percentage difference between acquired and non-acquired firms of the same age and in the same country, industry and calendar year.

Figure 1: Pre- and post-acquisition premia in revenue and employment, 2003-2015



Notes: Values in figures are coefficients β on an acquisition dummy in the regression specification (3). Regressions are estimated for each period *t-1* to *t+5* relative to acquisition year *t* separately.

In the year of acquisition, revenue and employment premia deteriorate to around -5%. Acquired firms recuperate by the second year after the acquisition and at the end of the 5th year exhibit higher relative values of revenue and employment than in the pre-acquisition year. The largest differences between acquired and non-acquired firms are found for the group of entrepreneurial HTKI firms, followed by SME targets and targets from the HTKI sectors. Entrepreneurial HTKI firms are larger in terms of revenue already one year before the acquisition, which is an indication of self-selection effect. Therefore, it is necessary to apply methods such as matching to account for ex-ante differences between treated and non-treated firms.

Table 3 presents the results from propensity score matching. The top half of the table reports the effects on the cumulative growth of revenue and the bottom half does the same for employment. First row shows the results of 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 no statistically significant difference in the pre-acquisition (t_0-1) revenue and employment growth rates between acquired and matched control firms. There is a slight but insignificant drop in both performance measures in the year of acquisition (t_0), followed by considerable improvement of revenue growth in the aftermath. By the end of the 5th year after the acquisition, entrepreneurial HTKI target firms increase their employment relative to pre-acquisition year by 11% more than controls. Employment growth effect is

significant only in the 4th year after the acquisition, but becomes smaller and insignificant in the following year.

Table 3: The impact of acquisition on European entrepreneurial HTKI firms' growth of revenue and employment

Total revenue:		t_0-1	t_0	t_0+1	t_0+2	t_0+3	t_0+4	t_0+5
1-NN	$ATET_\tau$	0.0146	-0.0097	**0.0429****	**0.0666*****	**0.0624****	**0.1321*****	**0.1058*****
A&I st.	st. err.	(0.012)	(0.012)	(0.018)	(0.022)	(0.027)	(0.033)	(0.039)
err.	N	1455	1875	1324	1075	880	680	588
	$ATET_\tau$	**0.0259****	**-0.0276****	0.0275	**0.0727*****	**0.0647****	**0.1183*****	**0.1340*****
1-NN	st. err.	(0.013)	(0.012)	(0.018)	(0.023)	(0.028)	(0.033)	(0.038)
	N	1576	2034	1437	1158	949	731	628
	$ATET_\tau$		-					
3-NN		0.0180*	**0.0284*****	0.0263*	**0.0601*****	**0.0485****	**0.1041*****	**0.1037*****
	st. err.	(0.011)	(0.010)	(0.015)	(0.020)	(0.024)	(0.028)	(0.032)
	N	1576	2034	1437	1158	949	731	628
	$ATET_\tau$	0.0160*	**-0.0233****	**0.0352****	**0.0762*****	**0.0714*****	**0.1080*****	**0.1053*****
Radius	st. err.	(0.010)	(0.010)	(0.014)	(0.018)	(0.022)	(0.026)	(0.029)
	N	1530	1979	1393	1121	914	704	605
	$ATET_\tau$	**0.0409*****	**-0.0240****	**0.0331*****	**0.0770*****	**0.0863*****	**0.1315*****	**0.1393*****
Kernel	st. err.	(0.009)	(0.009)	(0.014)	(0.018)	(0.021)	(0.025)	(0.028)
	N	1582	2038	1440	1162	952	732	631
Employment:		t_0-1	t_0	t_0+1	t_0+2	t_0+3	t_0+4	t_0+5
1-NN	$ATET_\tau$	-0.0018	-0.0130	0.0257	0.0084	0.0154	**0.0694****	0.0392
A&I st.	st. err.	(0.010)	(0.010)	(0.016)	(0.022)	(0.027)	(0.032)	(0.036)
err.	N	1438	1851	1293	1034	850	658	578
	$ATET_\tau$	0.0064	-0.0140	0.0107	0.0351	0.0292	**0.0867****	0.0494
1-NN	st. err.	(0.011)	(0.011)	(0.017)	(0.022)	(0.026)	(0.034)	(0.037)
	N	1558	2009	1401	1114	915	709	617
	$ATET_\tau$	0.0132	-0.0121	0.0076	0.0219	0.0271	**0.0662****	0.0317
3-NN	st. err.	(0.009)	(0.009)	(0.014)	(0.019)	(0.022)	(0.028)	(0.031)
	N	1558	2009	1401	1114	915	709	617
	$ATET_\tau$	0.0060	-0.0089	0.0127	0.0237	**0.0479****	**0.0778*****	0.0244
Radius	st. err.	(0.008)	(0.008)	(0.013)	(0.017)	(0.021)	(0.027)	(0.029)
	N	1509	1954	1358	1078	880	683	593
	$ATET_\tau$	**0.0267*****	-0.0130	0.0006	0.0092	0.0303	**0.0601****	0.0158
Kernel	st. err.	(0.008)	(0.008)	(0.013)	(0.017)	(0.020)	(0.026)	(0.028)
	N	1564	2013	1404	1118	918	710	619

Notes: Standard errors are in parentheses; *** p<0.01; **p<0.05; * p<0.1. 1-NN A&I st. err. refer to PSM estimates with Abadie and Imbens (2016) standard errors. Other PSM estimates impose exact matching within the same country, industry and year. t_0 is the year of acquisition.

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 2.5% drop in revenue in the year of acquisition, confirming premia estimates in Figure 1. After initial deterioration, cumulative revenue growth differential consistently increases and reaches 11%-14% 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 7% in the 4th year after the acquisition.

Next, we split the sample of acquired entrepreneurial HTKI firms into those acquired by financial investor and those acquired by a corporate acquirer (Table 4). To test for the presence of foreign ownership performance premium due to firm- specific comparative advantages (e.g. Caves, 1996; Dunning, 1988) or self-selection into FDI mechanism (Helpman, Melitz, & Yeaple, 2004), we also split the sample into foreign takeovers and domestic takeovers. In contrast to firms acquired by corporate acquirers, firms acquired by a financial investor avert the dip in revenue in the initial post-acquisition period, but achieve cumulative growth differential similar to corporate acquisitions. Due to low number of observations in the later periods, ATETs for revenue and employment growth in financial acquisitions are not statistically significant. Unlike domestic acquirers, foreign acquirers prevent revenue from contracting in the year of acquisition. After 5 years, foreign-owned firms exhibit significantly higher cumulative revenue growth (18%) than domestic acquirers (10%). They also achieve higher employment growth than domestic acquirers four years after the acquisition (12% vs. 6%). In general, foreign takeovers generate significant employment and revenue growth immediately after the acquisition year and yield more consistent and higher growth acceleration than domestic acquirers.

Table 4: The impact of acquisition on European entrepreneurial HTKI firms' growth of revenue and employment – Financial vs. Corporate and Domestic vs. Foreign

Total revenue:		t_0-1	t_0	t_0+1	t_0+2	t_0+3	t_0+4	t_0+5
	$ATET_\tau$	0.0072	-0.0050	0.0229	0.0822	0.1114	0.1011	**0.2881****
Financial	st. err.	(0.050)	(0.040)	(0.064)	(0.086)	(0.091)	(0.116)	(0.135)
	N	123	159	115	95	73	59	47
	$ATET_\tau$	**0.0275****	**-0.0295****	0.0279	**0.0718*****	**0.0608****	**0.1198*****	**0.1215*****
Corporate	st. err.	(0.013)	(0.012)	(0.019)	(0.024)	(0.030)	(0.035)	(0.040)
	N	1453	1875	1322	1063	876	672	581
	$ATET_\tau$	0.0289*	**-0.0332****	0.0225	0.0497*	0.0341	**0.1045****	**0.1040****
Domestic	st. err.	(0.016)	(0.015)	(0.023)	(0.030)	(0.036)	(0.043)	(0.049)
	N	987	1292	898	725	599	438	378
	$ATET_\tau$	0.0208	-0.0177	0.0359	**0.1111*****	**0.1171****	**0.1388*****	**0.1793*****
Foreign	st. err.	(0.020)	(0.020)	(0.031)	(0.038)	(0.047)	(0.053)	(0.061)
	N	589	742	539	433	350	293	250
Employment:		t_0-1	t_0	t_0+1	t_0+2	t_0+3	t_0+4	t_0+5
	$ATET_\tau$	0.0500	0.0367	0.0311	-0.0370	-0.0177	0.1388	0.1402
Financial	st. err.	(0.040)	(0.035)	(0.053)	(0.077)	(0.094)	(0.116)	(0.125)
	N	123	158	112	95	74	57	49
	$ATET_\tau$	0.0027	-0.0184*	0.0089	0.0418*	0.0333	**0.0822****	0.0416
Corporate	st. err.	(0.012)	(0.011)	(0.018)	(0.023)	(0.028)	(0.035)	(0.039)
	N	1435	1851	1289	1019	841	652	568
	$ATET_\tau$	0.0084	-0.0206	-0.0178	0.0043	-0.0207	0.0624	0.0123
Domestic	st. err.	(0.015)	(0.014)	(0.022)	(0.029)	(0.034)	(0.044)	(0.047)
	N	970	1270	873	690	575	423	367
	$ATET_\tau$	0.0032	-0.0028	**0.0577****	**0.0851****	**0.1136*****	**0.1227****	0.1038*
Foreign	st. err.	(0.016)	(0.016)	(0.025)	(0.034)	(0.042)	(0.053)	(0.059)
	N	588	739	528	424	340	286	250

Notes: Standard errors are in parentheses; *** p<0.01; **p<0.05; * p<0.1. 1-NN A&I st. err. refer to PSM estimates with Abadie and Imbens (2016) standard errors. Other PSM estimates impose exact matching within the same country, industry and year. t_0 is the year of acquisition.

Finally, 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 Equation (2). Target firms' growth rate of revenue in the year of acquisition is by 3% lower than that in control firms. In the following years the lapse of 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. The long-term effect (six years and above) is 17% of additional revenue growth. These estimates of growth dynamics in the aftermath of acquisition remain at similar levels after we control for other changes in firm ownership structure (column 2). Firms (either acquired or control) that have gone through minority acquisition, institutional buyout, merger with another company or have bought back shares exhibit higher growth of revenue after these changes. On the contrary, capital increase is associated with lower revenue growth. In column (3) we test whether financial investors produce different growth effects than corporate acquirers by including interaction terms with financial acquisition dummy. In the year of takeover, corporate acquisitions lead to 4.5% drop in revenue, whereas targets acquired by financial investors grow by 3.4% more than control firms. In the following post-acquisition years there is no statistically significant difference between financial and corporate acquisitions in growth dynamics, except in the 4th year when firms acquired by financial investors attain by 23% higher revenue than firms acquired by corporate acquirers. Similarly, foreign acquisitions avoid the drop in revenue in the acquisition year and yield higher cumulative growth of revenue in the following years. Larger and older firms attain less pronounced drop in revenue growth in the first year of employment. Smaller and younger target firms on average generate higher long-term cumulative growth of revenue. For example, having twice as many employees at the time of acquisition is associated with 4% lower cumulative revenue growth. Being 10 years older at the time of acquisition decreases the revenue growth effect by 16%.

Table 5: Revenue growth after acquisition

Total revenue:	baseline (1)	+controls (2)	fin. vs corp. (3)	for. vs dom. (4)	small vs large (5)	young vs old (6)
$revenue_{t0-1}$	0.958***	0.956***	0.956***	0.956***	0.960***	0.957***
	(0.00344)	(0.00345)	(0.00346)	(0.00345)	(0.00336)	(0.00345)
age_t	-0.00793***	-0.00786***	-0.00789***	-0.00787***	-0.00774***	-0.00727***
	(0.000671)	(0.000672)	(0.000672)	(0.000671)	(0.000671)	(0.000691)
$D*T_0$	-0.0290***	-0.0369***	-0.0446***	-0.0500***	-0.0887***	-0.0739***
	(0.0107)	(0.0108)	(0.0113)	(0.0130)	(0.0294)	(0.0245)
$D*T_1$	-0.0107	-0.0178	-0.0261	-0.0303	0.0521	-0.0131
	(0.0205)	(0.0206)	(0.0217)	(0.0251)	(0.0619)	(0.0495)
$D*T_2$	0.00567	-0.00176	-0.00844	-0.0110	0.0571	0.0435
	(0.0272)	(0.0272)	(0.0290)	(0.0329)	(0.0720)	(0.0675)
$D*T_3$	0.0158	0.00801	0.00534	-0.0212	0.0912	0.00141
	(0.0355)	(0.0355)	(0.0372)	(0.0435)	(0.0995)	(0.101)
$D*T_4$	0.0138	0.00603	-0.0165	-0.0725	0.112	0.0817
	(0.0458)	(0.0458)	(0.0490)	(0.0622)	(0.132)	(0.130)
$D*T_5$	0.0960*	0.0865	0.0694	0.0815	0.328	0.167

	(0.0533)	(0.0532)	(0.0558)	(0.0643)	(0.227)	(0.162)
$D*T_{6+}$	0.174***	0.168***	0.175***	0.122***	0.374***	0.461***
	(0.0373)	(0.0371)	(0.0384)	(0.0464)	(0.108)	(0.125)
			Fin*D*T_τ	Foreign*D*T_τ	ln(e_{t0-1})*D*T_τ	age*D*T_τ
$X*D*T_0$			0.0790**	0.0326	0.0139**	0.00296*
			(0.0316)	(0.0206)	(0.00688)	(0.00170)
$X*D*T_1$			0.0764	0.0310	-0.0180	-0.000333
			(0.0531)	(0.0390)	(0.0154)	(0.00311)
$X*D*T_2$			0.0702	0.0207	-0.0153	-0.00317
			(0.0618)	(0.0516)	(0.0179)	(0.00415)
$X*D*T_3$			0.0194	0.0758	-0.0221	0.000497
			(0.105)	(0.0674)	(0.0234)	(0.00602)
$X*D*T_4$			0.226**	0.193**	-0.0283	-0.00485
			(0.0935)	(0.0816)	(0.0331)	(0.00784)
$X*D*T_5$			0.176	0.0107	-0.0640	-0.00471
			(0.151)	(0.0997)	(0.0626)	(0.00889)
$X*D*T_{6+}$			-0.126	0.107	-0.0557**	-0.0158**
			(0.119)	(0.0669)	(0.0274)	(0.00664)
I(minority acq.)		0.156***	0.157***	0.151***	0.158***	0.154***
		(0.0352)	(0.0352)	(0.0352)	(0.0347)	(0.0352)
I(capital increase)		-0.172**	-0.174**	-0.166**	-0.165**	-0.171**
		(0.0716)	(0.0716)	(0.0717)	(0.0716)	(0.0718)
I(IPO)		-0.0695	-0.0638	-0.0858	-0.0970	-0.0710
		(0.110)	(0.109)	(0.116)	(0.114)	(0.111)
I(MBO)		-0.0711	-0.0721	-0.0681	-0.0705	-0.0751
		(0.0490)	(0.0490)	(0.0490)	(0.0493)	(0.0490)
I(MBI)		0.290	0.291	0.288	0.293	0.290
		(0.187)	(0.187)	(0.187)	(0.188)	(0.188)
I(IBO)		0.222***	0.220***	0.222***	0.223***	0.221***
		(0.0324)	(0.0323)	(0.0325)	(0.0326)	(0.0324)
I(merger)		0.433***	0.413***	0.441***	0.440***	0.430***
		(0.0818)	(0.0860)	(0.0800)	(0.0814)	(0.0822)
I(joint venture)		-0.0718	-0.0706	-0.0734	-0.0776	-0.0752
		(0.167)	(0.167)	(0.166)	(0.169)	(0.168)
I(share buyback)		0.365***	0.370***	0.348***	0.408***	0.382***
		(0.111)	(0.110)	(0.111)	(0.119)	(0.116)
N	42,369	42,369	42,369	42,369	42,267	42,369
R^2	0.772	0.773	0.773	0.773	0.773	0.773

Notes: All regressions are based on specification (2) and include controls for country, industry and year effects. Dummies T_0 to T_{6+} are included but not reported. I(·) denotes step indicator function with value 1 at the year of the ownership-related change and all subsequent years, and 0 otherwise. IPO stands for initial public offering, MBO for management buyout, MBI for management buy-in, IBO for institutional buyout. Standard errors are in parentheses and are robust for clustering on the firm-level; *** p<0.01; **p<0.05; * p<0.1.

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 the lost employment. Long-term effect (6 or more years after the acquisition) on cumulative growth of employment in acquired firms is 8%. Firms that have undergone management buyout, institutional buyout or merged with another company exhibit higher cumulative growth of

employment afterwards. Financial investors bring about significantly higher growth of employment during the first two years (+4% and +4%) compared to corporate takeovers (-3% and -5%). However, there is no difference in the long-term effect on employment between target firms acquired by financial and those acquired by corporate investors. Foreign acquisitions avoid the employment downturn in the first two years, whereas domestic takeovers lead to 4% and 7.5% decrease in employment growth in the acquisition year and the year after, respectively. Long-term employment growth effects decrease with the initial size of HTKI target firms. For example, having twice as many employees at the time of acquisition is associated with 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.

Table 6: Employment growth after acquisition

Employment:	baseline	+controls	fin. vs corp.	for. vs dom.	small vs large	young vs old
$employment_{t0-1}$	0.939***	0.938***	0.938***	0.938***	0.946***	0.938***
	(0.00283)	(0.00283)	(0.00283)	(0.00283)	(0.00292)	(0.00282)
age_t	-0.00573***	-0.00579***	-0.00581***	-0.00581***	-0.00569***	-0.00511***
	(0.000546)	(0.000544)	(0.000544)	(0.000544)	(0.000542)	(0.000571)
$D*T_0$	-0.0196*	-0.0227**	-0.0294**	-0.0427***	-0.0873***	-0.0351
	(0.0112)	(0.0113)	(0.0119)	(0.0137)	(0.0337)	(0.0252)
$D*T_1$	-0.0396**	-0.0431**	-0.0519**	-0.0753***	0.143**	-0.0240
	(0.0199)	(0.0200)	(0.0213)	(0.0260)	(0.0642)	(0.0436)
$D*T_2$	-0.0243	-0.0275	-0.0318	-0.0473	0.179**	0.101*
	(0.0249)	(0.0250)	(0.0267)	(0.0323)	(0.0698)	(0.0605)
$D*T_3$	0.0239	0.0206	0.0136	-0.0152	0.205***	0.0858
	(0.0287)	(0.0288)	(0.0304)	(0.0374)	(0.0785)	(0.0707)
$D*T_4$	0.0381	0.0345	0.0334	-0.00807	0.317***	0.117
	(0.0365)	(0.0366)	(0.0386)	(0.0496)	(0.109)	(0.0982)
$D*T_5$	0.0594	0.0550	0.0439	0.0559	0.274*	0.0839
	(0.0404)	(0.0403)	(0.0427)	(0.0498)	(0.154)	(0.116)
$D*T_{6+}$	0.0819***	0.0781**	0.0842***	0.0966**	0.488***	0.220**
	(0.0309)	(0.0308)	(0.0323)	(0.0389)	(0.0830)	(0.0968)
			Fin*D*T_τ	Foreign*D*T_τ	$\ln(e_{t0-1})$*D*T_τ	age*D*T_τ
$X*D*T_0$			0.0728**	0.0517**	0.0175**	0.00102
			(0.0285)	(0.0209)	(0.00797)	(0.00174)
$X*D*T_1$			0.0880*	0.0817**	-0.0481***	-0.00141
			(0.0456)	(0.0363)	(0.0173)	(0.00277)
$X*D*T_2$			0.0404	0.0503	-0.0536***	-0.00909**
			(0.0575)	(0.0454)	(0.0173)	(0.00379)
$X*D*T_3$			0.0751	0.0939*	-0.0484**	-0.00437
			(0.0728)	(0.0507)	(0.0188)	(0.00406)
$X*D*T_4$			-0.00554	0.103	-0.0743***	-0.00519
			(0.1000)	(0.0653)	(0.0279)	(0.00561)
$X*D*T_5$			0.121	-0.00472	-0.0571	-0.00159
			(0.100)	(0.0746)	(0.0409)	(0.00612)
$X*D*T_{6+}$			-0.0969	-0.0460	-0.109***	-0.00762
			(0.0723)	(0.0567)	(0.0215)	(0.00496)
I(minority acq.)		0.0326	0.0336	0.0288	0.0355	0.0311
		(0.0299)	(0.0299)	(0.0298)	(0.0296)	(0.0299)
I(capital increase)		0.0418	0.0397	0.0469	0.0553	0.0396

		(0.0724)	(0.0723)	(0.0726)	(0.0717)	(0.0723)
I(IPO)		-0.0986	-0.0941	-0.120	-0.166	-0.109
		(0.107)	(0.108)	(0.106)	(0.102)	(0.106)
I(MBO)		-0.0346	-0.0349	-0.0347	-0.0329	-0.0373
		(0.0386)	(0.0386)	(0.0386)	(0.0385)	(0.0385)
I(MBI)		0.290***	0.291***	0.286***	0.298***	0.293***
		(0.104)	(0.104)	(0.104)	(0.106)	(0.105)
I(IBO)		0.181***	0.179***	0.178***	0.182***	0.179***
		(0.0280)	(0.0280)	(0.0281)	(0.0281)	(0.0281)
I(merger)		0.175***	0.163***	0.177***	0.188***	0.171***
		(0.0605)	(0.0629)	(0.0587)	(0.0617)	(0.0607)
I(joint venture)		-0.240	-0.239	-0.243	-0.250	-0.241
		(0.166)	(0.166)	(0.165)	(0.167)	(0.165)
I(share buyback)		0.0627	0.0670	0.0489	0.162	0.111
		(0.134)	(0.134)	(0.133)	(0.153)	(0.141)
N	41,334	41,334	41,334	41,334	41,334	41,334
R^2	0.818	0.819	0.819	0.819	0.819	0.819

Notes: All regressions are based on specification (2) and include controls for country, industry and year effects. Dummies T_0 to T_{6+} are included but not reported. I(·) denotes step indicator function with value 1 at the year of the ownership-related change and all subsequent years, and 0 otherwise. IPO stands for initial public offering, MBO for management buyout, MBI for management buy-in, IBO for institutional buyout. Standard errors are in parentheses and are robust for clustering on the firm-level; *** p<0.01; **p<0.05; * p<0.1.

5. Discussion and conclusions

In this study we examine whether an acquisition by a corporate investor promotes the growth of unlisted European firms that are less than 20 years old and belong to high-technology knowledge-intensive sectors and whether the effect on growth differs from that of an acquisition by a financial buyer. The study also investigates 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 the acquisition to up to 5 years after, using a propensity-score matching approach and difference-in-differences regression.

Our results show that acquisitions have a positive effect on growth of HT entrepreneurial firms. There is a 2,3%-2,8% decrease in revenue and employment growth in the year of a corporate acquisition, followed by a steady acceleration of growth in the following years. After 5 years, acquired firms exhibit by 11%-13% stronger cumulative growth of revenue and 7-9% larger cumulative employment growth after 4 years, relative to matched control firms. In contrast to firms acquired by corporate acquisitions, firms acquired by a financial investor avert the dip in revenue in the initial post-acquisition period, but achieve similar cumulative growth differential.

Whereas research does not find that growth is significantly different between firms acquired by an established company and those acquired by a financial buyer, it does find that the nationality of the acquirer matters. Unlike domestic acquirers, foreign acquirers make no initial redundancies and prevent revenue from contracting in the

first year after the acquisition. After 5 years, foreign-owned firms exhibit significantly higher cumulative revenue growth than the ones with domestic acquirers. They also achieve higher employment growth four years after the acquisition.

Finally, 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. 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 8% lower effect on employment growth and 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 moderating effect on post-acquisition medium-term employment growth.

Our findings of are both research and policy relevant. First, the paper addresses corporate acquisitions as a possible source for funding growth plans of entrepreneurial firms in high-tech industries. A lot of attention has been directed to VC financing. However, especially for scale-up phases of firm growth, VC markets in Europe are underdeveloped and being acquired by an established company is thus one of a few available options. We show that acquisitions have a positive effect on growth of acquired entrepreneurial firms. By setting up a large-scale multi-country empirical study of European HT entrepreneurial firms, we contribute to entrepreneurship and M&A literature and to the scarce empirical evidence on the effects of corporate acquisitions on growth of these firms. Second, we find that growth is not significantly different between firms acquired by an established company and those acquired by a financial buyer. Given the emphasis that policy-makers put on boosting private VC investments in Europe, our analysis raises a question whether corporate acquisitions can be considered an alternative to weak VC markets and should deserve more attention, such as rethinking regulation that can encourage or discourage acquisitions. It also provides some empirical validation to recent policy initiatives to connect start-ups with mid-caps and larger enterprises, as a part of the Start-up and Scale-up Initiative (European Commission, 2016). Third, we contribute to the under-researched area of cross-border acquisitions of entrepreneurial firms. We find that in the case of a foreign acquirer the firm experiences higher post-acquisition growth in revenues and employment as compared to firms with a domestic acquirer. These results do not provide the rationale for the decision makers in policy to oppose foreign acquisitions, quite the opposite.

Our findings are subject to some limitations. The results only apply to the acquisition targets that did not become organizationally integrated with the acquiring firm. In the cases when the target firm does not remain an independent subsidiary, the relevant data is not available since it is not possible to observe its financial statements after the acquisition. In addition to this, 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. However, the available data sources do not include government-related grants that are available to firms on regional, national or EU-level.

Appendix:

Figure A1: Kernel density estimates of the propensity score before and after the matching

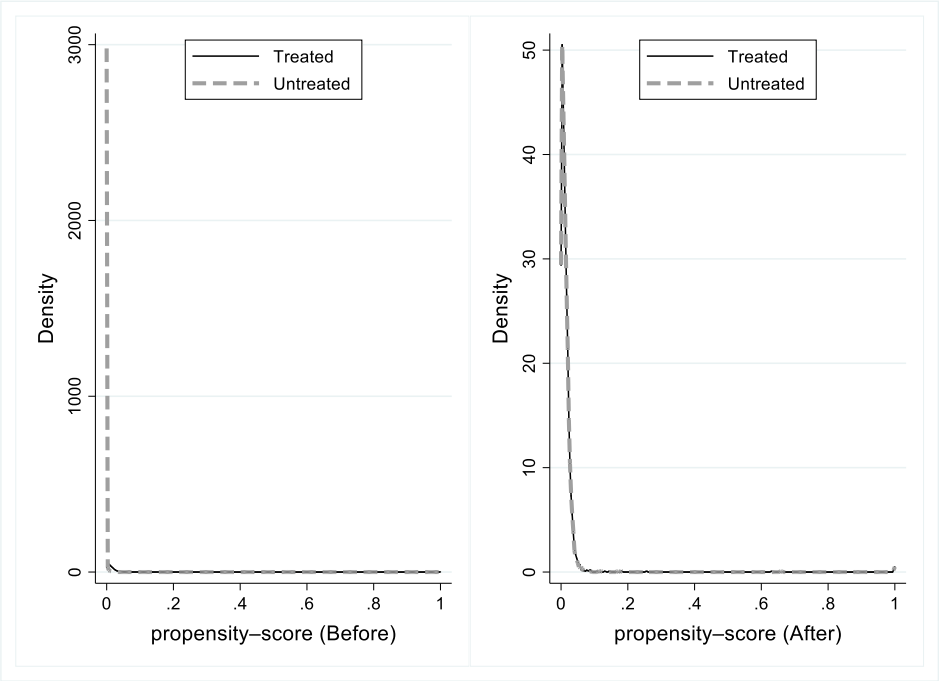


Table A1: Balancing property test before and after the matching

Variable	Unmatched/ Matched	Mean Acquired	Mean Control	%bias	%reduct |bias|	t-test t	t-test 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

Notes: 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 & Rubin, 1985).

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