Private Company Discount: The European Case

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Abstract: The common approach to valuing privately-held companies is to compute the acquisition multiples of comparable listed companies and apply a discount for the lack of marketability. In our study, we adopt the acquisition approach and attempt to estimate private company discount by comparing the transaction multiples of private and public companies. We find that, on average, private companies sell at a discount of 28% for revenue multiples and 29% for earnings multiples to listed firms. We also demonstrate that applying the same acquisition discount across all private targets is not appropriate. Company and transaction characteristics, as well as industry membership and market conditions influence the size of the discount. This study is unique in that it examines the impact of institutional factors in a cross-sectional analysis. Companies operating in more efficient financial markets experience lower than average acquisition discounts.

JEL classification: G20; G24; G34
Keywords: Private company discount; Marketability discount; Private companies

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I Introduction

Private companies differ from public companies in many ways. For instance, unlike public companies, privately-held firms are not required to disclose their financial information to the public since they are not traded on the stock exchange. Furthermore, owners of public companies can easily trade their holdings in the open market at low transaction costs, while investors in private firms face liquidity constraints and pay considerable costs to access liquidity. Investors treat transparency and liquidity as a valuable resource and are willing to pay a higher price for assets that have a ready market. Marketability costs are priced into the valuation of private companies and, consequently, privately-held firms achieve lower valuations than comparable public firms on average. Marketability is only one source of the discount for private companies. Greater information asymmetries and the riskier nature of private businesses also influence transaction multiples. We consider all these factors and attempt to quantify the size of private company discount, as well as to identify important determinants of the acquisition discount for private companies.

Empirical evidence on private company discount can be grouped around four main research streams. First set of studies compares prices of restricted stocks in private placements to prices of publicly traded stocks of the same issuer. Given that restricted stocks are considered to be equivalent to publicly traded stocks, any difference in price is attributed to the discount for lack of marketability. The main weakness of the restricted stock studies is that they only reflect marketability and ignore other determinants of the private placement discount. The second set of studies looks at IPO pricing and compares it to company valuation in transactions when the company was private. These studies, however, suffer from a selection bias since only successful firms proceed with the IPO. Another approach considers returns of private equities to returns of investors in publicly traded stocks. The difference in returns, however, does not reflect only the discount for lack of marketability of private assets, but also services that private equities provide to private companies. Acquisition studies address the issues with the earlier empirical work and compare prices of privately-held firms to prices of comparable public firms. The matching quality is vital in these studies, given that any price variation could reflect differences in firms characteristics rather than private company discount. The main critique of these studies is the relatively small sample size, which is below hundred in some of the best known studies. Furthermore, most commonly cited studies are more than ten years old and analyse private company discount on a sample of transactions that occurred up to early 2000s, questioning the relevance of these estimates in the post-crisis environment. In addition, all the major studies are primarily focused on the U.S. transactions, disregarding cross-country variation in private company discount. Finally, some of the earlier studies have trimmed the sample substantially as a way to deal with outliers, raising concerns of the generalizability of the results.

For the purpose of our research, we employ the acquisition approach and extend the existing empirical work to account for the weaknesses of the earlier studies and investigate the European case. In

particular, we expand the sample size by leveraging the greater information availability on private firms in Europe relative to the U.S.. While the information on the U.S. private companies is not readily available, private companies in Europe report their financials in national company registers that are available to the general public. Zephyr database provides modelled transaction multiples which are estimated using the information from the national company registers when deal details are not disclosed. Hence, we use the modelled multiples alongside the reported multiples as means to increase our sample size and improve the representativeness of the entire universe of transactions.

We study a sample of European[1] transactions in the period from 1997 to 2015. Our sample is unique in that even though it constitutes a geographic and political unit, it is composed of 28 countries with different macroeconomic and market conditions. This setup allows us to study cross-country variability of the private company discount, which was not the subject of earlier studies. In addition, we attempt to find a more appropriate method to deal with the skewness of our data distribution, and thus we log transform our data.

Using revenue multiples, we find that private companies sell at a discount of 23% to 32% on average compared to public peers. Earnings multiples indicate a wider range of discount estimates from 13% to 47%. Our analysis on log transformed data suggests a discount in the range from 24% to 36% for the enterprise value multiples. However, we find a premium for one of the six multiples when we use log transformed data: deal to earnings before interest, taxes, depreciation and amortization (EBITDA) indicates a premium of 9% for private companies. Results of our cross-sectional analysis demonstrate that characteristics of private targets, transaction features and market conditions can partly explain the variability of private company discount. In particular, profitable and large firms experience a lower discount than loss-making firms with smaller asset base. Furthermore, when cash is used as a method of payment, owners of private firms are willing to accept a greater discount given the immediate provision of liquidity. We also find a weak support for the relation between the business cycle and private company discount. Recessions seem to increase the cost of accessing liquidity and as a result the acquisition discount increases during contractionary periods. High volatility in the markets appears to have a greater impact on valuation multiples of public firms, with private firms lagging behind public companies. Hence, private company discount decreases when the market volatility increases. Our analysis of cross-country differences suggests that companies based in countries with greater financial market efficiency experience a lower discount. The robustness check shows that our results are consistent when we control for heteroscedasticity and the presence of influential observations.

The remainder of the paper is organised as follows: section II provides an overview of the existing empirical work and briefly assesses the merits and weaknesses of these studies; in section III, we

[1] We consider transactions involving companies based in European Union countries.

present our hypothesis; section IV presents the data collection process and descriptive statistics for sample transactions; section V describes our matching process, valuation multiples and research methodology; section VI summarizes our main findings on the existence of private company discount and interpretation of results; in section VII, we present our cross-sectional analysis of acquisition discounts and describe the explanatory variables used in the regression; section VIII reports our regression results and explains cross-sectional and time series variation of private company discount; in section IX, we test the robustness of our findings and section X provides a conclusion and suggestions for further research.

II Literature review

Valuation or private companies poses challenges for practitioners and academics given that there is no ready market for these assets, and, consequently, no observable prices. The usual approach to valuing a privately-held firm is to estimate the valuation multiples of comparable public companies as a benchmark and apply a discount for the lack of marketability. Since an acquisition discount is not directly observable, several different methods have been developed to estimate private company discount (PCD).

I The restricted stock approach

One way to quantify the marketability discount is to find the difference between the price of a restricted stock and its freely tradable counterpart since restricted shares are considered to be equivalent to the publicly traded shares. If securities are privately placed with a few institutional investors, these shares do not need to be registered with the US Securities and Exchange Commission (SEC). According to Rule 144 of the SEC Securities Act, shareholders have a one-year-holding period before they are allowed to resell the restricted stock in the open market. Companies issuing restricted shares together with traded registered shares typically offer a price discount on the restricted shares to compensate investors for the lack of liquidity. Some of the most cited private placement studies are presented in the following paragraphs.

Pratt and Niculita (2008) examine 12 empirical studies, covering several hundred restricted stock transactions spanning the late 1960s through 1998. The first of these studies was conducted by the SEC and finds an average price discount for restricted stocks of 25.8%. Subsequent studies estimate a discount between 20% (Johnson, 1999) and 45% (Pittock and Stryker, 1983). Oliver and Meyers (2000) and Johnson (1999) identify firm-specific characteristics that influence the valuation of restricted stocks, whereas SEC (1971) and Trout (1977) recognize the choice of a stock exchange as an important determinant of the size of discount for restricted securities. The most widely cited study on restricted stock discount, written by Silber (1991), reports an average discount of 33.8%, consistent with earlier studies. For his research, Silber uses a sample of 69 companies with private placements and finds that firms with high revenues, earnings and market capitalization experience lower than average discounts on restricted stocks. Furthermore, he shows that private placement discounts tend to be higher when the block of restricted stock is large relative to the total number of shares outstanding. A synopsis of restricted stock studies are presented in Table 1, as reported by Pratt and Niculita (2008).

Table 1: Pratt and Niculita (2008): Summary of Restricted Stock Studies

Empirical Study[a]	Years Covered in Study	Average Price Discount (%)
SEC overall average (1971)	1966 – 1969	25.8
SEC nonreporting OTC companies (1971)	1966 – 1969	32.6
Gelman (1972)	1968 – 1970	33
Trout (1977)	1968 – 1972	33.5
Moroney (1973)	1969 – 1972[b]	35.6
Maher (1976)	1969 – 1973	35.4
Standard Research Consultants (1983)	1978 – 1982	45[c]
Willamette Management Associates	1981 – 1984	31.2[c]
Silber (1991)	1981 – 1988	33.8
FMV Opinions, Inc. (1994)	April 1992	23
Management Planning, Inc. (2000)	1980 – 1996	27.1
Johnson (1999)	1991 – 1995	20
Columbia Financial Advisors (2000)	1996 – April 1997	21
Columbia Financial Advisors (2000)	May 1997 – 1998	13

[a] For the full list of literature references please refer to References
[b] No specific years were given in the published account
[c] Median discounts

One major drawback of using restricted stock approach to estimate the illiquidity discount is that the discount arises from a variety of factors, marketability being only one of them. The discount may be a compensation to private placement investors who are providing other services, such as advisory services to the issuing company (Koeplin et al., 2000). To isolate the service difference and improve the accuracy in measuring the illiquidity discount, Hertzel and Smith (1993) compare unregistered private placements facing restriction on marketability to registered private placements of equity. They show that the private placement discount is 13.5% higher for restricted stock than for registered stock. However, the weakness of this approach is that it compares companies with different characteristics with one another. Bajaj et al. (2001) control for these differences across companies and find a marketability discount of only 7.2%. In our paper, we adopt a similar approach and attempt to control for company-specific characteristics between the comparable targets.

Critics additionally argue that marketability discount is an unreliable measure of illiquidity of privately-held firms given that restricted stocks become marketable after a specific holding period, whereas private companies may be restricted for a much longer period of time or may never become marketable (Dodel, 2009). Moreover, as noted by Hertzel and Smith (1993), the discounts found in the restricted stock research may be flawed due to selection bias. Companies that make private placements tend to be smaller, riskier and less healthy than a typical company. Finally, Damodaran (2005) suggests that the restricted stock studies often have small sample sizes and substantial standard errors in the estimates. Hence, the private placement discounts estimates need to be considered with caution.

II The pre-IPO approach

An alternative way to quantify the illiquidity discount is to compare the price at which the stock is initially offered to the public (IPO price) to the price of the same stock in private transactions prior to the IPO (Damodaran, 2005). The difference between the pre-IPO and IPO price is considered to be illiquidity discount. In his research, Emory (1997) studies private stock transactions which occurred up to five months prior to the IPOs in various time periods from 1981 through 2000. He examines 543 transactions and finds a mean price discount of 46% for private offerings. Willamette Management Associates (2005) conduct a similar study by extending the time frame of transactions to three years prior to IPOs and attempt to include only transactions that are on an arms-length basis (Pratt and Niculita, 2008). These studies indicate a mean discount that range from 18% (2000) to 56% (1979).

Pre-IPO approach to estimating the illiquidity discount has been subject to certain criticisms. One of the weaknesses of this approach is the presence of a self-selection bias when the sample of transactions is composed. The IPO studies exclude by definition firms that fail to go public, and thus they misrepresent the entire population of private companies. A benchmark for comparison (IPO price) is necessary to measure the discount for lack of liquidity, therefore, the studies include only successful firms and exclude troubled ones. Furthermore, transactions prior to the IPO are likely to be performed by inside investors, such as venture capitalists, who provide some kind of services to the firm. Hence, the discount may be a reflection of compensation for these services rather than the discount for lack of liquidity (Dodel, 2009).

Neither the restricted stock studies nor the pre-IPO studies control for differences between the controlling and non-controlling interest. Therefore, the discount they find may reflect not only the lack of marketability of the stock but also the level of ownership. We attempt to control for this issue by explicitly omitting transactions that involve acquisition of minority interest, and focus solely on control transactions.

III The private equity approach

An alternative method to estimate the marketability discount is to compare the returns earned by private equity investors to returns earned by investors in public stocks. The private equity approach computes the difference between the two returns and assigns this difference to illiquidity discount. Investments made by private equity and venture capital investors are often illiquid, and hence investors need to discount the value of private businesses to reflect the lack of marketability (Damodaran, 2005). Adopting this approach, Ljungqvist and Richardson (2003) show that private equity investors generate excess returns of 5% to 8% compared to investors in public stocks. They suggest that excess returns of private equity investors are a compensation for holding an illiquid

investment. In their analysis, Dasa, Jagannathanb, and Sarina (2003) employ a more direct approach to estimating the illiquidity discount and calculate the expected exit multiples and gains from private equity investments of venture and buyout funds at different stages of firms life cycle. They find a higher private equity discount of around 80% for early-stage firms and a lower discount of only 11% for late-stage businesses. The results are not surprising since early-stage companies are relatively more illiquid than the late-stage companies. However, the discounts Dasa et al. (2003) estimate cannot be attributed merely to the lack of marketability. Venture capitalists provide valuable services to their portfolio companies, so part of the discount reflects a compensation for provision of these services. Furthermore, some of the additional return may be a premium for the lack of diversification since private equity investors are often not diversified (Damodaran, 2005). The private equity approach is tailored to specific situations and investors, limiting the generalizability of the results. In our research, we attempt to include a broader range of companies, and in turn improve the representativeness and applicability of the illiquidity discount.

IV The acquisition approach

Koeplin, Sarin, and Shapiro (2000) address the limitations of the existing private company discount (PCD) studies and propose the acquisition approach as a more direct way to measure the discount. The acquisition method compares transaction multiples of private and public companies and attributes the difference to PCD. We adopt similar approach as it allows us to capture more than just the discount for lack of marketability, but also the discount associated with other characteristics of private firms. One such factor is the inferior information quality of private firms, as described in De Franco, Gavious, Jin, and Richardson (2011a). Therefore, PCD estimated in Koeplin et al. and in our paper is a more comprehensive measure than the marketability discount found in prior research.

One of the major issues in Koeplin et al. is a seriously reduced sample size. Their study examines PCD on a sample of 84 domestic (U.S.) and 108 foreign transactions for which SDC reports sufficient data in the period between 1984 and 1998. Hence, transactions included in the sample are only a small proportion of the entire universe of transactions. We seek to improve the representativeness of our sample by including modelled ratios in our analysis, i.e. we include both reported transaction pricing details, as well as estimated multiples provided by Zephyr.

Koeplin et al. match each private transaction to a public transaction in the same country, year and 4-digit SIC code. If there are several public transactions that meet these three criteria, they select the acquisition of a public company with similar revenue size as the private company. We adopt similar matching criteria, however we match each private transaction to a portfolio of several public transactions rather than to a single acquisition of a public firm (Kooli, Kortas, and L'her, 2003). Matching a private transaction to a single public transaction is possibly a biased procedure as any

pricing differences could arise from differences in company characteristics, rather than differences in companies public status.

Koeplin et al. further calculate four valuation multiples (Enterprise Value to EBIT, Enterprise Value to EBITDA, Enterprise Value to Sales and Enterprise Value to Book Value) for private and public transactions in the sample. They measure PCD as below:

$$\text{Private company discount} = 1 - \frac{\text{Private company multiple}}{\text{Public company multiple}}$$

Koeplin et al. find evidence of PCD for both domestic and foreign transactions. Private transaction multiples are on average lower than comparable public multiples in the sample, indicating the existence of a discount for private targets. Their results are presented in Table 2.

Table 2: Koeplin et al. (2000): Estimates of Private Company Discounts

	Private Targets		Public Targets		Discount [a]	
	Mean	Median	Mean	Median	Mean	Median
DOMESTIC (U.S.) TRANSACTIONS						
Enterprise Value/EBIT	11.76	8.58	16.39	12.37	28.26***	30.62***
Enterprise Value/EBITDA	8.08	6.98	10.15	8.53	20.39***	18.14***
Enterprise Value/Book	2.35	1.85	2.86	1.73	17.81***	-7.00
Enterprise Value/Sales	1.35	1.13	1.32	1.14	-2.28	0.79
FOREIGN TRANSACTIONS						
Enterprise Value/EBIT	16.26	11.37	28.97	12.09	43.87***	5.96**
Enterprise Value/EBITDA	11.96	7.1	25.91	9.28	53.85**	23.49*
Enterprise Value/Book	2.41	1.35	3.7	1.68	34.86	19.64
Enterprise Value/Sales	2.63	1.35	4.59	1.63	42.7	17.18

[a] John D. Emory, Sr., ASA, John D. Emory, Jr., and F.R. Dengel, III. Business Valuation Review, December 2002.

Kooli, Kortas, and L'her (2003) adopt a similar approach to Koeplin et al. (2000), however account for the pitfalls of using a single public transaction as a benchmark. The major difference between the two studies is that Kooli et al. compose a portfolio of comparable public transactions as opposed to selecting a single comparable public transaction. Kooli et al. recognise that selecting only one public comparable is a potentially noisy procedure, and therefore adopt the portfolio approach suggested by Brav, Geczy, and Gompers (2000). The rationale behind the portfolio methodology is that median public multiples behave better and the impact of firm-specific characteristics is minimised when the entire universe of comparable transactions is considered. We employ a similar approach and construct a portfolio of comparable public transactions. However, instead of computing the median of the benchmark portfolio, we calculate the geometric mean of the acquisition multiples of public companies. Dittmann and Maug (2008) demonstrate that geometric mean is less biased than arithmetic mean or median. We take logs to remove the skewness of the acquisition multiples exactly as the geometric mean does before averaging. The second transformation in equation IV

shows that the geometric mean can be interpreted as the retransformed arithmetic mean, applied to the log-transformed multiples ratios.

The main contribution of *Block (2007)* is the breakdown of PCD by industry. We examine differences in PCD across industries, as the nature of the assets that the company holds, as well as the business risk profile, could be important determinants of PCD.

Officer (2007) provides an additional insight into the theory of private company discount and expands it to include unlisted subsidiaries. The main purpose of his study is to examine how liquidity needs of the sellers of private companies and unlisted subsidiaries influence the sale prices. Officer finds evidence that acquisition discounts for unlisted targets increase when liquidity in the debt market deteriorates, e.g. when credit spread increases. Additionally, he shows that acquisition discount for unlisted targets increases when bargaining power of sellers is low, which coincides with the times of tight credit conditions and sellers greater liquidity needs. Similarly, we examine the extent to which the availability of alternative sources of liquidity and market conditions affect the size of PCD.

Paglia and Harjoto (2010) propose using trading multiples of public companies as benchmarks as opposed to acquisition multiples. Their primary concern with the transaction multiples is the quality of the matching procedure and small sample sizes in some of the earlier studies. While their approach results in a more precise matching procedure, it nevertheless compares two very distinct set of prices. Trading multiples do not capture control premiums paid in transactions with transfer of control rights. Hence, we opt for acquisition multiples and constrain our sample solely to control transactions to ensure that any difference in prices is not attributed to different acquiring stakes but to PCD.

III Hypothesis

Existing empirical literature gives strong support in favour of private company discount. Market for private firms is less liquid and more opaque, making private firms a potentially riskier alternative relative to a comparable public target. Firstly, owners of public firms are able to trade their holdings in a liquid and transparent market for public securities, while owners of private firms experience higher transaction costs. They can obtain liquidity through a costly IPO, in which they face high fees and the risk of under-pricing (Logue, 1973; Ibbotson, 1975; Block and Stanley, 1980), or through a private transaction, which tends to be less competitive than a public bid. Secondly, low transparency and scarce information reduce the appeal of the private firms and bidders adjust their prices downwards to reflect this additional risk. These views are represented in the following hypothesis:

H1: On average, private firms sell at lower acquisition multiples than comparable public firms.

Our additional hypotheses pertain to factors that influence the size of the private company discount. As described above, private firms operate in an opaque environment, where information is scarce and not easily accessible. Partial explanation for the lower transparency of unlisted firms is that they tend to be smaller than their public peers and do not have the critical size to justify the cost of information production. Hence, we use company size as a proxy for information asymmetry (Hansen, 1987; Martin, 1996). Firm size does not only lead to economies of scale of reporting, but also increases analyst coverage and improves the liquidity of the company's stock. Therefore, we expect the firm size to have a positive impact on the valuation of private company.

H2: Large privately-held firms are discounted less than small private firms.

Similarly to large private firms, we expect profitable unlisted firms to command higher valuations, and consequently sell at lower discounts. Profitable firms have a safer risk profile than loss-making firms; they do not only improve owners prospect by generating immediate profits, and thus avoiding financial distress, but also by increasing the likelihood of a successful IPO or a subsequent sale in the future.

H3: Profitable firms sell at a lower discount than loss-making firms.

Illiquidity has been long-documented as an important source of a private company discount. Owners of private firms experiencing liquidity constraints are willing to accept a discount on their ownership stakes for the provision of liquidity by the acquirers. Buyers offer different levels of liquidity, depending on the form of payment. Cash provides immediate liquidity to the sellers of private firms and is therefore preferable over stocks for owners in need of liquidity. We expect owners of private

firms to accept larger discounts on their holdings in cash deals relative to stock deals. From the perspective of the bidders, they perceive stock deals as a way to mitigate the information asymmetry problem. Stock deals involve risk sharing between sellers and acquirers, and therefore can increase bidders's willingness to offer a higher price (Shleifer and Vishny, 2003). We formalise these theories in the following hypothesis:

H4: Private firms experience greater discounts in cash deals relative to stock deals.

Recent research papers consider the differences in the bidding behaviour of financial sponsors and strategic buyers and come to contradictory conclusions. Gorbenko and Malenko (2014) find that, on average, trade acquirers are willing to pay a higher price for targets than financial sponsors. This phenomenon has been long recognised and explained in the existing literature by the notion that strategic acquirers can afford to pay more due to potential synergies that may not be captured by a private equity fund (Thompson and O'Brien, 2005). Contrary to Gorbenko and Malenko study, Hege, Lovo, Slovin, and Sushka (2011) find evidence that financial acquirers value targets higher in corporate asset sales, reflecting funds superior restructuring skills. We recognise the merits of both views and expect variation in acquisition discounts across the two different types of buyers.

H5: Private company discount can be partly explained by the acquirer type.

The following hypotheses relate broader macroeconomic and market conditions to the private company discount. As Damodaran (2005) points out, what matters is not only how illiquid an asset is, but also when it is illiquid. Private companies are less liquid than public companies in general, but their illiquidity exacerbates even more when the cost of obtaining liquidity increases - in times of recessions and weak equity markets. Firstly, privately-held companies get hit harder by economic uncertainty (Sahin et al., 2011) and adverse financial conditions as they rely more heavily on external financing (Shourideh and Zetlin-Jones, 2012). Consequently, the risk profile of unlisted targets deteriorates in recessions and bidders apply a greater discount. Secondly, weak equity markets preclude the possibility of a successful IPO and limit the recourse to liquidity for the sellers. Strong IPO markets, on the contrary, offer an alternative provision of liquidity to the owners of privately-held companies and reduce their willingness to accept a discount in a private transaction (Officer, 2007).

H6: Private company discount increases when the cost of obtaining liquidity increases.

In addition, we consider how the private company discount varies with the volatility of the public markets. Hall (2009) suggests an upward adjustment of the discount for lack of marketability in times of unprecedented market volatility. In our study, we are interested in a more general relationship between the volatility of public markets and the acquisition discount. We expect the valuations

of private companies to follow the valuations of public securities, however with a time lag. Hence, increased volatility in bear markets could have a greater downward impact on public companies than private companies, contrary to Hall's proposition. To the extent that increased volatility could have a greater impact on either of the public and private companies, we remain agnostic about the nature of the relationship.

H7: Private company discount varies with the volatility of the stock market.

Earlier research has suggested several other hypothesis. Block (2007) finds evidence that industry membership partly explains private company discount. Liquidity of the company's assets and leverage levels, among others, vary across industries and can influence the size of PCD. Kooli et al. (2003) and Paglia and Harjoto (2010) examine the variability of the acquisition discount across years. We additionally look into differences across countries and how institutional factors[3] interplay with the discount. Our sample is unique in that, even though it is extracted for a unified geographic region, it is composed of subsamples of 28 member countries, which allows us to study cross-country differences in the acquisition discount. Previous acquisition studies were mainly focused on the U.S. transactions and hence did not have the set-up to examine the impact of institutional factors on PCD. We consider institutional factors because they shape the environment in which companies conduct their businesses. Companies operating in countries with more efficient financial markets are expected to have smaller acquisition discounts. More efficient markets are better at allocating capital and ensuring that private companies can obtain credit at fair terms. Given that private companies rely more heavily on bank financing (Santikian, 2014), we expect them to perform better and achieve higher valuations in efficient financial markets.

H8: Acquisition discount varies across industries, years and countries.

The following section presents our data collection process and descriptive statistics. Our findings are presented in the sections *Findings on the private company discount* and *Results of the cross-sectional regression analysis.*

[3]We thank our professor Laurent Bach for suggesting us to consider institutional factors as determinants of private company discount variability.

IV Data

I Sample selection process

Our sample of private and public transactions, and respective transaction details, are collected from Zephyr, a Bureau Van Dijk database. Zephyr provides information on M&A, IPO, private equity and venture capital deals from 1997 to present. For the purpose of our research, we collect data on completed acquisitions of European Union targets for the period from 1997 to 2015. We exclude all acquisitions of financial firms (firms with one-digit SIC code 6, apart from the SIC code 65) and regulated utilities (firms with two-digit SIC code 49 and 46) from our sample. Companies operating in these industries are omitted from our analysis due to the unique balance sheet structure of financial companies[4] (Damodaran, 2005) and lack of competition and public comparables for regulated utilities[5], traditionally owned and controlled by the government (Geddes, 1998). We also screen out transactions that involve acquisition of minority interest as in Koeplin et al. (2000). We focus solely on control transactions to eliminate the effect of control premiums on multiples; acquisitions involving transfer of control demand a control premium and result in higher multiples. Comparing controlling transactions to acquisitions of minority stakes would distort our results. Additionally, we consider only companies with annual revenues of $10 million or larger as they are considered potential candidates for listing on the public markets (Paglia and Harjoto, 2010). Finally, we eliminate deals with missing data and arrive to an initial sample of 5,137 private and 848 public transactions. In some instances, Zephyr reports only partial information on the transaction, so our sample size varies across different multiples.

Table 3 contains summary statistics of the six acquisition multiples, which we use in our analysis in the remainder of the paper. Since the approach we employ is entirely based on multiples, we spend a considerable amount of time computing, analysing and completing the respective information. In addition to the acquisition multiples reported by Zephyr, we calculate the transaction multiples using the available financial data (Dodel, 2009). For the purpose of our analysis, we use the calculated multiples due to their lower variance.

[4]Damodaran (2005) suggests that EV/EBITDA and EV/EBIT are inappropriate to use to value financial services companies because of difficulties in estimating the value or the operating income of banks and insurance firms. Therefore, the multiples he recommends to use to value financial services companies are equity multiples such as P/E, P/B and P/S.

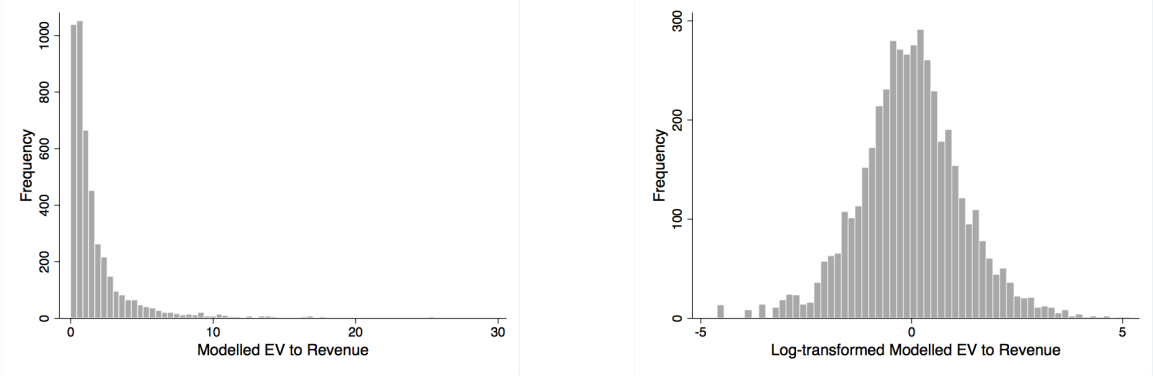
[5]Geddes (1998) describes regulated utilities as being privately owned and in almost all case having been granted legally enforced monopolies over their service territories.

Table 3: Summary Statistics for the Raw Acquisition Multiples

This table presents summary statistics for raw acquisition multiples. Deal to Revenue, Deal to EBITDA, EV to Revenue, EV to EBITDA, Modelled EV to Revenue and Modelled EV to EBITDA are multiples extracted from Zephyr. Multiples in the right-hand part of the table are calculated using transaction and company details reported by Zephyr. Value in the top row represents mean acquisition multiple for private and public firms in our raw sample. Number in the parenthesis is the sample median and number in the square brackets is the number of observations in the subsample. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

			Calculated	
	Private Targets	**Public Targets**	**Private Targets**	**Public Targets**
Deal to Revenue	2.2***	5.3	2.1***	4.0
	(0.9)***	(1.6)	(0.9)***	(1.1)
	[4927]	[788]	[4927]	[798]
Deal to EBITDA	43.9***	136.6	20.0**	27.5
	(9.4)***	(11.9)	(8.5)	(8.0)
	[4875]	[782]	[4624]	[764]
EV to Revenue	3.3***	9.0	3.4***	9.1
	(1.4)***	(2.7)	(1.4)***	(2.8)
	[671]	[62]	[672]	[62]
EV to EBITDA	83.4	42.0	31.6	41.3
	(11.7)***	(17.7)	(11.5)***	(17.8)
	[667]	[65]	[635]	[64]
Modelled EV to Revenue	2.2***	5.6	2.4***	5.6
	(1.0)***	(1.7)	(1.0)***	(1.7)
	[4363]	[735]	[4369]	[741]
Modelled EV to EBITDA	39.4***	143.0	22.5***	41.7
	(10.1)***	(13.2)	(9.7)***	(13.0)
	[4327]	[733]	[4106]	[714]

The raw acquisition multiples are not particularly interesting in their own due to presence of extreme outliers in both tails of the distribution. For example, the average of the EV to EBITDA multiple reported by Zephyr for acquisitions in the privately held target category is 83.4, with a maximum value of 12,333 and a minimum of 0. Additionally, Figure 1a shows that the distribution of the raw acquisition multiples is highly skewed to the right, with means substantially exceeding medians. To remove the skewness and make the distribution as normal as possible, we use log transformation. If the original sample follows a lognormal distribution, log-transformed data follows a normal or near-normal distribution (Feng, Wang, Lu, Chen, He, Lu, and Tu, 2014) as shown in Figure 1b. We further address the skewness of our data in Section V.



(a) Modelled EV to Revenue

(b) Log-transformed Modelled EV to Revenue

Figure 1: Frequency Distribution

II Winsorization

Figure 1a suggests the presence of outliers, i.e. observations that are unusually large or unusually small compared to the rest of the data (Newbold and Carlson, 2007). Outliers do not affect the median, but can have a large impact on the mean. The distribution of our sample is asymmetrical as it is bound on the left by zero since a multiple is always a positive number. Presence of unusually large outliers in the right tail of the distribution magnifies the upward bias inherent in the use of arithmetic average. There is of course the possibility that the outlier is an error, however we assume that the values are genuine but extreme. For instance, unusually low earnings in a year prior to transaction could inflate the earnings multiple. Therefore, we address the outliers in the data for both the private and public transactions. There are several ways to treat genuine outliers. Outliers can be treated as any other observation and be included in the analysis if they do not severely distort the results. Given the impact of outliers on our mean estimates, we look for a more appropriate solution. Eliminating the data would partly solve the problem, however it would also eliminate high observations from analysis all together and result in a downward biased mean. We aim to have a robust dataset, insensitive to outliers, thus we opt for winsorization to keep the valuable observations, but reduce their impact on our results. We winsorize the data separately for both listed and unlisted transactions for each multiple at 2.5% and 97.5%[5]. As a result, any data value above the 97.5th percentile of the sample data is replaced by the 97.5th percentile, and accordingly any value below the 2.5th percentile is replaced by the 2.5th percentile. The assumption is that the estimates can be improved if the outliers are brought closer to the mean of the distribution.

The winsorization method allows us to use larger samples than the previous studies on private com-

[5]We repeat our analysis once with a stronger winsorization at 5% and 95% and once with a weaker winsorization at 1% and 99% and obtain identical results. We therefore only report the results for the 2.5% winsorization in our paper.

pany discount. The outlier approach adopted by Officer (2007), for example, discards all private company premiums exceeding 100%. Due to the high variation across both private and public multiples, often caused by modest accounting fundamentals, the chance of exceeding the 100% limit on a per-observation basis is relatively high (De Franco et al., 2011b). Hence, a large number of multiples gets truncated, in turn reducing the total sample size. Winsorizing the data helps us ensure that we have more matched pairs and thus obtain more robust results.

III Descriptive statistics

Table 4 presents the descriptive statistics of the sample and a univariate test of means and medians between the private and public targets. The total assets of the privately held companies (median of $30 million) are significantly lower than the total assets of the publicly traded companies (median of $154 million). The much higher mean however is evidence of extreme numbers in the upper end of the distribution. Additionally, the median deal value of the public firms appears to be nearly four times larger than the median deal value of the private firms. We also find that listed targets have higher revenue compared to the unlisted targets. All three margin ratios - profit margin, operating margin and EBITDA margin - show that, on average, public companies have higher margins. Higher ROE and ROA ratios of the private targets, however, imply that private businesses are more efficient in utilising their resources to generate profit and create value for the shareholders than public businesses. Finally, we find that the asset turnover ratio of the unlisted firms is significantly higher than the one of the listed firms, indicating that private companies are deploy their assets to generate revenue more efficiently.

Table 4: Descriptive Statistics of Sample Companies

The table below summarizes descriptive statistics for the private and public firms in our sample. Total assets, deal value and earnings values are reported by Zephyr. EBITDA, operating and profit margin are calculated by dividing EBITDA, EBIT and net profit, respectively, by the target's revenues. Asset turnover is a ratio of target's revenues to total assets. Return on assets (ROA) is calculated as net profit divided by total assets, and return on equity (ROE) is a ratio of net profit to equity. Top row reports the aithmetic mean of the private and public companies in the sample. The number in parenthesis is the sample median and square brackets indicates the number of observations. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Values in the most right-hand column represent t-statistics and z-score.

	Private Targets	Public Targets	T-test (Z-test)
Total assets ($ million)	267.5	1140.0	-4.04***
	(30.0)	(154.0)	-23.62***
	[4927]	[811]	
Deal value ($ million)	224.6	959.8	-6.11***
	(36.5)	(114.0)	-14.22***
	[4962]	[811]	
Revenue ($ million)	282.8	568.9	-1.14***
	(39.0)	(96.0)	-15.22
	[4958]	[811]	
EBITDA ($ million)	27.8	95.7	-3.26***
	(4.0)	(12.0)	-16.53***
	[4961]	[811]	
EBIT ($ million)	17.7	56.1	-2.57**
	(2.0)	(6.0)	-11.73***
	[4933]	[809]	
Net profit ($ million)	12.7	28.7	-1.49
	(2.0)	(5.0)	-11.56***
	[4790]	[801]	
EBITDA margin	14%	18%	-7.22***
	(10%)	(12%)	-6.32***
	[4958]	[811]	
Operating margin	10%	13%	-6.52***
	(7%)	(8%)	-4.67***
	[4618]	[732]	
Profit margin	9%	20%	-4.67***
	(5%)	(7%)	-7.50***
	[4233]	[683]	
Asset turnover	1.8	1.1	11.32***
	(1.5)	(0.8)	18.74***
	[4922]	[811]	
ROA	10%	8%	3.37***
	(7%)	(5%)	4.92***
	[4227]	[683]	
ROE	39%	32%	1.01
	(20%)	(12%)	9.44***
	[4089]	[669]	

V Methodology

The acquisition approach followed in our study is comprised of a three-step procedure. The first step consists of finding a matching portfolio for each acquisition of a private target; then we identify the most appropriate multiples for the purpose of our analysis; and finally we compute the private company discount using equation I.

I Acquisition multiples method

The traditional comparable method compares acquisition multiples of private companies to the trading multiples of public peers (Berger, 1995; Kim and Ritter, 1999). In their research, Kaplan and Ruback (1995) adopt three different multiples used as a performance measure of comparable companies: comparable company, comparable transaction and comparable industry transaction. They find that *comparable company* multiples yield the highest estimation errors, while the *comparable industry transaction* method results in the lowest average valuation errors. Therefore, we adopt the comparable industry transaction method, using transaction multiples of companies in the same industry.

II Matching company technique

We adopt Koeplin et al. (2000) approach to match transactions of private and public companies of similar size, in the same industry and acquired at around the same time. Instead of matching private company to a single public company, we construct a portfolio of comparable public companies as in Kooli et al. (2003). Selecting a single transaction is a potentially noisy procedure for matching firm risk characteristics. Hence, we use a public portfolio to control for differences in firm characteristics.

Construction of matching portfolios is a key feature of our approach, therefore we carefully examine our data to cluster public transactions based on company characteristics. First, we apply the same search criteria in Zephyr as for the unlisted firms to find listed European companies that belong to the primary two-digit SIC-code of the private target. Matching by SIC-code is widely used in empirical research, and thus allows us to better compare our results to other PCD studies. Public transaction enters matching portfolio if its acquisition date is within a four-year window around the announcement date of the private acquisition (Officer, 2007). We allow acquisitions of listed companies to enter into multiple comparable portfolios to increase our sample size.

III Valuation multiples

When selecting the acquisition multiples, we consider multiples that can be applied to both listed and unlisted targets. It is difficult to identify ex ante which valuation measures are most suitable for the purpose of our research. We analyse six different valuation multiples reported by Zephyr: Deal Value to Revenue, Deal Value to EBITDA, EV to Revenue, EV to EBITDA, Modelled EV to Revenue and Modelled EV to EBITDA[7]. For each multiple the numerator represents the price paid for the target and the denominator is the revenue or the EBITDA of the target in the year prior to the acquisition.

We concentrate on sales and earnings multiples as they are the most commonly used multiples among practitioners and academia, and they are not affected by the capital structure of the company. Various studies have examined the accuracy of different valuation techniques. Kaplan and Ruback (1995) compute valuations for a number of highly leveraged transactions using multiple comparable analysis methodology and compare it to valuations derived from the discounted cash flow (DCF) analysis. They find that both the DCF and the comparable transaction method generate reliable estimates, however, EBITDA multiples of companies in the same industry generate the lowest valuation errors.

Forecasting the cash flows of young companies is often difficult, therefore Kim and Ritter (1999) adopt the multiple approach for the valuation of IPO companies. They find that among the five multiples used (Price to Earnings, Market to Book Value, Price to Sales, EV to Sales, and EV to EBITDA), the EBITDA multiple generates the most precise valuation. Additionally, Lie and Lie (2002) use ten different multiples to evaluate the most precise measure of company value. They find that the EBITDA multiple generally yields better estimates than does the EBIT multiple since EBITDA is not affected by the company's accounting policy. Furthermore, EBITDA is preferred over the net income as it is not distorted by the capital structure of the company. In contrast, the net income is computed net of interest expenses and taxes, implying that two identical companies with different capital structures would have different valuation multiples. In addition, EBITDA can be a good proxy of company's cash flow available to service debt and pay dividends, if future capital expenditures are assumed to be in line with depreciation. Finally, EBITDA multiples are the least-distorted earnings metric because depreciation schedules do not precisely reflect the actual deterioration of asset value.

The other three valuation multiples we consider are sales multiples. Although EBITDA earnings multiples have emerged as the most commonly used performance metrics (Finnerty and Emery, 2004), the sales multiples are a good alternative in some instances. When evaluating a new acqui-

[7]Zephyr reports several additional valuation multiples, such as deal value to total assets, deal value to shareholders funds, etc. For brevity of our analysis, and because the additional variables do not add much texture to our research, we omit these multiple from the paper.

sition target, the bidder is interested in the price they have to pay for additional dollar of sales. Hence, these multiples are often strongly correlated with the expected operational profitability. Furthermore, sales multiples eliminate the problem of negative valuation multiples (De Franco et al., 2011b). A limitation of studies using just earnings multiples is that they exclude loss-making enterprises. This limitation is more acute when the research embraces periods of unfavourable financial market conditions, which often leads to a decline in net earnings as well as negative profits.

Apart from the traditional enterprise value ratios we use two additional numerators - deal value and modelled enterprise value - to increase our sample size, and thus better represent the population of transactions. Detailed definitions of all the different valuation metrics are provided in Table 5.

Table 5: Description of Valuation Multiples Provided by Zephyr

Deal value	Deal value of a transaction is the consideration paid for the actual stake acquired. In the case of a listed company, the deal value is calculated by multiplying the number of shares in issue by the offer price per share.
Enterprise value	Enterprise value of a transaction is the price paid for 100% of the shares and the publicly disclosed debt of the target at the time of the deal. For listed companies the enterprise value is calculated by multiplying the total number of target shares outstanding by the offering price and then adding the book value of target interest bearing financial liabilities less the cash & cash equivalents.
Modelled enterprise value	Modelled enterprise value of a transaction is an alternative of the "true" enterprise value if a sufficient financial data on the target company is available. It is calculated by adding the short-term and long-term financial debt to the book value of targets equity less the cash & cash equivalents.
Revenue multiples	Deal to Revenue and (Modelled) EV to Revenue. Revenue is the annual sales volume net of all discounts and sales taxes for the 12 months ending on the date of the last day of the most recent financial year prior to the announcement of the transaction.
EBITDA multiples	Deal to EBITDA and (Modelled) EV to EBITDA. EBITDA is the target companys earnings before interest, taxes, depreciation and amortization for the 12 months ending on the date of the last day of the most recent financial year prior to the announcement of the transaction.

IV Measuring acquisition discounts

Once we chose the most appropriate multiples for the purpose of our analysis, we compute the acquisition discounts. We calculate the private company discount as the percentage difference between the transaction multiple of the private company and the average corresponding transaction multiple

of the public reference portfolio. Following Koeplin et al. (2000), for each acquisition multiple, k (k = 1 to 6), we measure the private company discount for our original and log-transformed data according to equations I and II, respectively:

$$\text{PCD}_k = 1 - \frac{\text{Private company multiple}_k}{\text{Average public portfolio multiple}_k} \tag{1}$$

$$\ln \text{PCD}_k = 1 - \exp\left(\ln \text{Private company multiple}_k - \ln \text{Average public portfolio multiple}_k\right) \tag{2}$$

The PCD is a positive number if the private company multiple is less than the average public portfolio multiple, and a negative number if the acquisition multiple for the unlisted target is more than the average valuation multiple of comparable publicly traded targets.

Consistent with Officer (2007), we compare the average portfolio multiple to the private transaction multiple to calculate PCD. Academic literature offers several alternative measures to improve the accuracy of the comparable valuation method. One of the most widely accepted approaches, also adopted by Kooli et al. (2003), is the use of median portfolio multiple. Lie and Lie (2002) show that medians are less biased than arithmetic averages. Alternatively, Baker and Ruback (1999) and Liu et al. (2002) argue that the harmonic mean improves the accuracy of the comparable valuation technique compared to the simple mean and median of the reference portfolio. The harmonic mean is always lower than the simple mean, thus we expect our public portfolio multiples to be overestimated. To deal with this issue, we also calculate the geometric mean. Dittmann and Maug (2008) show that the geometric mean is less biased upward than the arithmetic mean. Therefore, to improve the accuracy of our results we employ the geometric mean - we compute it as a retransformed simple mean of the natural logarithms of public multiples and then compare it to the logarithmic values of the private targets. The two different averaging methods are calculated using expressions III and IV.

$$\text{Arithmetic mean: } \bar{x}_j^A = \frac{1}{n}\sum_{i=1}^{n} x_i \tag{3}$$

$$\text{Geometric mean: } \bar{x}_j^G = \prod_{i=1}^{n} x_i^{1/n} = \exp\left(\frac{1}{n}\sum_{i=1}^{n} \ln x_i\right) \tag{4}$$

We consider the transaction multiple x_i of a public company and aim to create an average transaction reference multiple $\bar{x}_j$ of a target firm j, for which a set of comparable firms is available.

VI Findings on the private company discount

We evaluate the significance of our results using a dependent t-test. Newbold and Carlson (2007) suggest using matched pairs of observations when the pairs are positively correlated, making the variance of the difference smaller. The dependent t-test assumes that there are no significant outliers in the difference between the matched pairs and that the distribution of the differences between the matched pairs is normally distributed. However, we find that differences between the matched pairs are heavily skewed with the presence of outliers. Hence, to evaluate the robustness of our results we also perform the Wilcoxon signed rank test. This is a nonparametric test that does not make assumptions about the underlying probability distribution of the sampled population. The results of the dependent t-test and Wilcoxon test on our six multiples are presented in the following paragraphs.

Table 6 reports mean and median multiples of privately-held firms and respective public portfolios for each of the observed multiples. The results indicate that, on average, unlisted firms sell at lower multiples than corresponding public companies. That is, there is sufficient evidence that privately-held targets sell at a discount to comparable public targets. Private company discount is statistically significant at 1% across all the acquisition multiples.

The mean estimates of private company discount for revenue multiples range from 23% for the Deal to Revenue to 32% for Modelled EV to Revenue. Discount estimates for EBITDA multiples are more dispersed and range from 13% for Deal to EBITDA multiple to 47% for Modelled EV to EBITDA. Our results are consistent with the findings in earlier acquisition studies. In the median multiples case, discount estimates exceed mean estimates, similarly to Officer (2007) and Paglia and Harjoto (2010). Private company discount ranges from 35% for Deal to Revenue multiple to 56% for Modelled EV to Revenue. As discussed previously, we consider modelled multiples to increase the size of our sample and its representativeness of the entire population of transactions. The number of observed matched pairs varies across different multiples, depending on the availability of information in Zephyr.

Table 6: Estimates of Private Company Discount

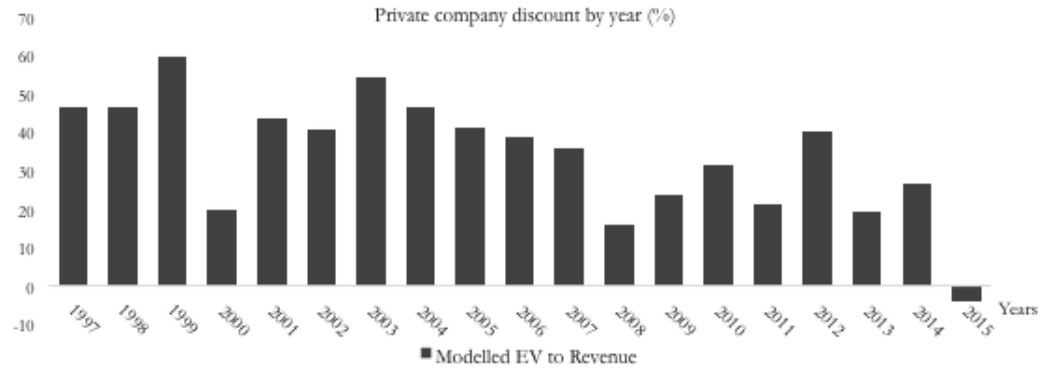
This table reports acquisition discount estimates for a sample of European transactions in the period from 1997 to 2015. Panel A reports means and median PCD estimated on the original data. Panel B reports the same statistics for log transformed data. Acquisition discount is estimated as a percentage difference between the private and public acquisition multiples in Panel A, and as a log difference in Panel B. Discounts are calculated for six different multiples (Deal to Revenue, Deal to EBITDA, EV to Revenue, EV to EBITDA, Modelled EV to Revenue and Modelled EV to EBITDA) calculated using transaction data reported by Zephyr. A positive number indicates presence of a private company discount and a negative number indicates private company premium. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Values in the most right-hand column represent the number of observations for each of the multiples.

	Private Targets		Public Targets		Discount		
	Mean	Median	Mean	Median	Mean	Median	Number of matched pairs
PANEL A: Original data							
Deal to Revenue	1.6	0.9	2.1	1.5	23%***	39%***	4473
Deal to EBITDA	13.3	8.5	15.4	13.2	13%***	35%***	4168
EV to Revenue	2.3	1.5	3.3	2.8	29%***	46%***	247
EV to EBITDA	15.7	10.3	29.4	21.1	47%***	51%***	244
Modelled EV to Revenue	1.7	1.0	2.5	2.3	32%***	56%***	3898
Modelled EV to EBITDA	14.8	9.8	20.4	19.3	27%***	49%***	3641
PANEL B: Log-transformed data							
Deal to Revenue	-0.2	-0.1	-0.2	-0.2	0%	-4%**	4473
Deal to EBITDA	2.1	2.1	2.0	2.1	-9%***	-7%***	4168
EV to Revenue	0.3	0.4	0.8	0.9	36%***	39%***	247
EV to EBITDA	2.4	2.3	2.9	3.0	39%***	48%***	244
Modelled EV to Revenue	0.0	0.0	0.3	0.4	28%***	32%***	3898
Modelled EV to EBITDA	2.3	2.3	2.6	2.6	24%***	27%***	3641

Results for log-transformed data are in line with the discount estimates on the original data for EV and modelled EV multiples, ranging from 24% to 39% (Table 6). Furthermore, median multiples of log-transformed data yield discounts that are very close to mean estimates. Acquisition discounts based on deal multiples, however, deviate from the acquisition discounts obtained from the original non-transformed data. The discount estimate for Deal to Revenue multiple is not significant and Deal to EBITDA estimate suggests presence of a private company premium. We consider results for deal multiples with caution, though, given the inherent bias in the deal value as reported by Zephyr. Deal value represents the consideration paid for the percentage acquired, implying that for two identical companies, deal value would be higher for the company that was acquired in full.

Given that private companies are more often acquired in full than public companies, the private company discount may reflect differences in deal structures of public and private companies, rather than valuation differences.

PANEL A: Private company discount over time



PANEL B: Number of observations in each year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Modelled EV to Revenue	20	30	21	58	74	136	180	261	397	431	497	344	142	222	270	191	183	223	218

Figure 2: Private Company Discount over Time

We next consider how the private company discount evolves over time. Figure 2 presents acquisition discounts for Modelled EV to Revenue[8] for each year in the sample. The results suggest that acquisition discount has decreased in the recent years, and even turned into a premium in the last year of our sample. Expansion of the private equity activity and improved access to funding for private companies could partially explain a decline in the discount. We examine factors that influence the size of the discount later in this paper. While there is sufficient evidence that the discount has diminished since the early 2000s, acquisition discounts in the first few years have limited interpretability due to a small sample size. Panel B of the Figure 2 shows number of observations for the selected multiples in each year. In the first three years of our sample, which coincides with the first three years of Zephyrs coverage of M&A transactions, the number of observations is below 50. Hence, any inference based on such small sample size has only limited weight in the overall interpretation of our results.

[8]We present here only Modelled EV to Revenue multiple for brevity reasons. For the results on other multiples please refer to Appendix A. Choice of multiples was made based on the highest number of observations, which becomes increasingly important when we look at discounts for each year in the sample. Selecting EV / EBITDA multiple could yield below 5 observations for some years. Any interpretation based on such low sample size would not be meaningful.

We additionally consider variability of acquisition discounts across industries. Our results are presented in Table 7. We find statistically significant private company discount for each of the observed industries for at least one of the multiples, except for agriculture & mining. Lack of significance for agriculture & mining could be partially explained by the relatively small number of observations compared to other industries. The acquisition discount varies across different industries and multiples. Majority of the discount estimates, however, fall within a more narrow range from 20% to 40%, consistent with our finding on the whole sample. Overall, our results suggest that there is little variability of acquisition discounts across different industries. We further study differences across industries in our cross-sectional analysis.

Table 7: Mean Estimates of Private Company Discount by Industry

This table reports private company discount for each of the seven industry groups. Numbers below the industry groups in italics refer to SIC codes included in the category. Discounts are estimated using six different acuiqisition multiples. Acquisition discounts are calculated as a log difference between the acquisition multiples of matched private and public companies. Top row reports average PCD for the industry group and number in the parenthesis indicates number of matched pairs in the industry subsample. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Agriculture & Mining *01-14*	**Construction** *15-17*	**Manufacturing** *20-39*	**Real Estate** *65*	**Services** *70-88*	**Transportation & Communication** *40-49*	**Wholesale & Retail Trade** *50-59*
Deal to Revenue	1%	-35%*	-7%*	41%***	1%	2%	11%*
	(37)	(143)	(1859)	(91)	(1193)	(439)	(711)
Deal to EBITDA	-35%	-14%	-12%*	-1%	-9%**	-22%***	9%*
	(35)	(136)	(1741)	(88)	(1108)	(415)	(645)
EV to Revenue	27%	N/A	41%***	44%	56%	-10%	-9%
	(1)	(0)	(107)	(5)	(67)	(54)	(13)
EV to EBITDA	17%	N/A	36%***	55%***	59%***	21%*	-6%
	(1)	(0)	(110)	(7)	(60)	(54)	(12)
Modelled EV to Revenue	23%	41%***	25%***	44%***	31%***	29%***	22%***
	(30)	(127)	(1623)	(75)	(1065)	(353)	(625)
Modelled EV to EBITDA	1%	53%***	23%***	11%	24%***	15%**	24%***
	(31)	(122)	(1502)	(75)	(995)	(350)	(566)

Cross-country analysis shows that private companies in Great Britain, Germany, Belgium and Portugal experience the lowest acquisition discounts on average compared to other countries in our sample. On the other end of the spectrum are privately-held firms in the Netherlands, Czech Republic, Finland and Hungary. Companies in these countries seem to experience the largest discounts in our sample transactions. Please refer to Appendix B for the overview of private company discount for all the countries in our sample. We examine cross-country variation and sources of these differences to a greater extent in our cross-sectional regression analysis.

Finally, to evaluate the robustness of our results, we compute the discount using the data between the 25th and 75th percentile. This approach, also known as mid-mean (Tukey), allows us to use only the central half of our sample, and thus eliminate extreme values in the two tails of the distri-

bution. Overall, we find even higher private company discount in the range between 27% and 48%, confirming the robustness of our earlier findings. We present our results in Appendix C.

VII Cross-sectional regression analysis

Our results support the hypothesis of the existence of private company discount (H1) and provide an estimation of its size. In this section, we proceed with cross-sectional analysis to identify factors that influence the size of the discount and explain the cross-sectional variation of the discount. We are primarily interested in identifying determinants of acquisition discounts, rather than developing a model that predicts the size of a discount for out of sample firms. Any such regression model would only have limited predictive power given the uncertainty about the time variability of the coefficients and differences in characteristics of sample and out of sample firms (Feldman, 2002). Nevertheless, finding statistically significant factors would imply that applying mean or median acquisition discount, without considering other relevant determinants, would generate significant prediction errors.

We conduct a regression with the private company discount as our dependent variable and several explanatory variables representing the target characteristics, market conditions and institutional factors. We also measure PCD as a log difference between acquisition multiples, given the more normalised distribution of log differences relative to percentage differences . Our regression model is presented below:

$$\begin{aligned} \text{PCD}_j = \alpha + \beta_1 \text{Assets} + \beta_2 \text{Profitability} + \beta_3 \text{Acquiror Type} + \beta_4 \text{Method of Payment} \\ + \beta_5 \text{Business Cycle} + \beta_6 \text{IPO Volume} + \beta_7 \text{VIX Index} + \beta_8 \text{Market Efficiency} \end{aligned} \tag{5}$$

$$\begin{aligned} \ln \text{PCD}_j = \alpha + \beta_1 \ln \text{Assets} + \beta_2 \ln \text{Profitability} + \beta_3 \ln \text{Acquiror Type} + \beta_4 \ln \text{Method of Payment} \\ + \beta_5 \ln \text{Business Cycle} + \beta_6 \ln \text{IPO Volume} + \beta_7 \ln \text{VIX Index} + \beta_8 \ln \text{Market Efficiency} \end{aligned} \tag{6}$$

Private company discount is estimated using Modelled EV to Revenue and Modelled EV to EBITDA[9]. We run separate regressions, interchanging between acquisition discounts estimated using the two different multiples.

The first set of explanatory variables considers firm's characteristics as potential determinants of private company discount. We use book value of target's assets as a measure of the target size. Book values are extracted from Zephyr and expressed in USD. Given the right-skewed distribution of assets, we log-transform the data for the purpose of the regression and use the variable *Log Assets*. We next consider the impact of target's profitability on the size of the discount. *Profitability* is a dummy variable that takes the value of 1 if the target company has positive profits and 0 if it is a loss-making firm. We additionally consider the target industry and introduce dummy variables indicating the industry in which the business operates. We group targets in seven broader industry

[9]We do not consider Deal to Revenue and Deal to EBITDA multiples given the inherent bias in deal multiples as described in Section VI.

groups (from 1 to 7) based on their two-digit SIC code.

The second group of variables looks at various transaction features. We differentiate between two types of acquirers: strategic acquirers and financial sponsors. Strategic acquirers have different economic motives from financial buyers and we expect this to be reflected in the purchase price. Acquirers with a two-digit SIC code 60, 61, 62, 63, 64 or 67 are defined as financial acquirers while all the other acquirers are treated as strategic buyers. We construct a dummy variable *Acquirer type* that takes the value of 1 if the acquirer is a financial sponsor and 0 if it is a strategic buyer. We additionally control for the method of payment in acquisitions of private targets. If the private company discount reflects the cost of liquidity, we would expect larger acquisition discount for cash deals relative to stock bids, given the immediate provision of liquidity to the sellers. *Method of payment* is a dummy variable that takes the value of 1 if the transaction is a cash deal and 0 if the acquirer has paid in stock.

The last set of variables looks at broader macroeconomic and market conditions. To examine the variation of the private company discount in different points of the economic cycle we adopt the chronology of recessions and expansions published by CEPR for the euro area business cycles[10]. CEPR based Recession Indicator identifies peaks and troughs of the economic cycle and respective quarters of expansion and quarter of recession. We construct a dummy variable *Business cycle* that takes the value of 1 for the periods of recession and the value of 0 for expansionary periods. We additionally measure the volume of IPOs as a proxy for the ease of accessing liquidity for the owners of private companies. Times of low IPOs are associated with times when private companies do not have access to equity markets at favourable terms, hence they are forced to consider other unfavourable arrangements (Lerner et al., 2003). *IPO volume* is a variable that measures the number of IPOs in each year scaled by the total number of listed firms the year before (Lowry, 2003). Please see Appendices D and E for description of variable construction. We also use the *VIX Index* as a measure of the volatility of public markets. Private markets follow the pricing trends of the public markets, however with a time lag. Hence, the VIX index is a more precise measure of the volatility of the public stock market rather than private market.

Finally, we introduce institutional factors as means of explaining the cross-country variability of the acquisition discount. To the extent that private companies operating in efficient financial markets have better access to credit and obtain financing at more favourable terms, we expect them to achieve higher valuations. We measure financial market efficiency following the approach adopted by Formosa (2008). The *Financial market efficiency* index incorporates three distinct measures: financial freedom index, interest rate spread and interest margin to gross income. Formosa additionally considers banking concentration ratio, however we exclude it from our index given the debate in

[10]The CEPR Euro Area Business Cycle Dating Committee identifies and publishes the chronology of recession and expansions of the euro area since 1970. We use the euro area as a proxy for the European Union.

the research community as to whether the banking concentration impairs or improves the financial market efficiency (Shepherd, 1982; Demsetz, 1973; Peltzman, 1977; Berger, 1995). Financial freedom is one of the components of the Index of Economic Freedom[11] measuring banking efficiency and the independence of the banking sector from the government interference. The second measure, the interest rate spread[12], is sourced from the World Banks World Development Indicators catalogue. The interest rate spread measures the difference between the lending rate and the deposit rate. Low interest rate spreads are expected in efficient financial markets. The third measure is the interest margin to gross income[13], IMFs Financial Soundness Indicator, which measures the share of the net interest earnings within the gross income. High interest margins indicate inefficiencies in the market. Detailed information on the construction of the composite index is presented in Appendix F.

We estimate the coefficients of our regression model using the ordinary least squares (OLS) method on a sample of private transactions from 1997 to 2015. Our findings are reported in the following section.

[11]Index of Economic Freedom is provided by Heritage Foundation and measures economic freedom of 186 countries based on trade freedom, business freedom, investment freedom, and property rights.

[12]Interest rate spread is defined by the World Bank as the interest rate charged by banks on loans to private sector customers minus the interest rate paid by commercial or similar banks for demand, time, or savings deposits.

[13]IMF defines interest margin to gross income as the relative share of net interest earningsinterest earned less interest expenseswithin gross income. It is calculated by using net interest income as the numerator, and gross income as the denominator.

VIII Results of cross-sectional regression analysis

Results in section VI suggest that our estimates of private company discount are reasonably robust, consistent with our hypothesis H1. On average, private companies are acquired at a discount to public companies, with the discount size ranging from 13% to 47% for non-transformed data and from 24% to 39% for log-transformed data (Table 6). The univariate statistics in Table 8 are supportive of hypotheses H4 and H8, namely the method of payment and financial market efficiency hypothesis.

For both ratios, Modelled EV to Revenue and Modelled EV to EBITDA, discounts for unlisted firms are larger when the bidder pays in cash, ranging from 25% to 30%, than when the bidder exchanges own stock for equity in private firm, in which case the discount ranges from 19% to 26%. These results are consistent with the findings of Officer (2007) that sellers of private companies accept greater acquisition discount if they are provided with immediate liquidity. Furthermore, Financial market efficiency also has a significant impact on PCD. The acquisition discount is between 22% and 26% when the Financial market efficiency index is above its sample median, and between 25% and 29% when it is below the sample median. Efficient financial market provides private companies with easy access to credit, allowing them to fund their investments at competitive terms relative to public companies. Hence, owners of private firms can obtain liquidity at favorable terms in efficient financial markets, making them less likely to accept large acquisition discounts. The Modelled EV to Revenue and Modelled EV to EBITDA multiples show inconsistent results for the PCD in the recession, while high IPO volume seems to be associated with larger discounts than in weak equity markets, contrary to what we expect.

Additionally, we examine private company discount in a multivariable regression to control for company and transaction characteristics, market conditions and country-specific institutional framework. We run regression for two multiples, Modelled EV to Revenue and Modelled EV to EBITDA, and for their log transformed equivalents. The regression results, presented in Table 9, are consistent with several of our hypotheses. All regression models show statistically significant positive intercept, indicating that after we control for independent variables, private targets still receive lower valuations on average than listed companies. We should note, however, that the intercept does not quantify the size of PCD given that, by definition, the intercept is the expected mean when all the other independent variables are equal to zero. In our specific case, intercept is not meaningful when all the other variables are equal to 0 as that would imply, among others, IPO volume of 0. As in Kooli et al. (2003), we find negative relationship between the liquidity discount and the size of the company, as measured by target asset size. The company size is a proxy for the liquidity of the target, as well as information asymmetry. Large companies have the critical size to justify reporting costs and receive greater analyst coverage, alleviating information asymmetry problem. Furthermore, stocks in large firms are more liquid than stocks in private firms, lowering the cost of obtaining liquidity for the private owners.

Table 8: Average Acquisition Discounts for Subsamples on Log-transformed Data

The table below reports log private company discount on different subsamples based on a method of payment, business cycle, IPO volume and financial market efficiency. Cash cateogry includes all bids where the acquirer paid in cash, while the non-cash transactions represent stock deals. Business cycle is a CEPR based Regression Indicator dating contractionary and expansionary periods. Transactions are categorised based on their announcement date. IPO volume is measured as the number of IPOs in each year scaled by the total number of listed firms the year before. Financial market efficiency index is composed of financial freedom index, interest rate spread and interest margin to gross income. Number in the top row reports the subsample PCD estimate and number in the parenthesis refers to the number of observations. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Modelled EV to Revenue	**Modelled EV to EBITDA**
Method of payment		
Cash	30%***	25%***
	(1468)	(1362)
Non-cash	26%***	19%***
	(351)	(332)
Business cycle		
Recession	25%***	27%***
	(598)	(555)
Non-recession	28%***	23%***
	(3300)	(3086)
IPO volume		
IPO volume >time-series median	33%***	25%***
	(2166)	(2031)
IPO volume <= time-series median	20%***	22%***
	(1732)	(1610)
Financial market efficiency		
Market efficiency >sample median	26%***	22%***
	(2018)	(1872)
Market efficiency <= sample median	29%***	25%***
	(1880)	(1769)

We also find evidence that *Profitability*[14] influences the size of PCD. Profitable firms are considered less risky, hence bidders apply lower discounts for firms with positive profits relative to loss-making firms.

As described above, deal characteristics may also affect the level of private company discount. Consistent with the results in Table 8, *Method of payment* has positive and significant coefficient in

[14]We exclude the profit variable from the EBITDA multiples due to the mechanical relationship between the EBITDA and EBITDA multiples.

all four regressions. Given that cash provides greater level of liquidity than a stock swap does, our results imply that the acquisition discount partly reflects acquirers provision of liquidity to the seller. Alternatively, bidders are willing to pay higher price for a private target in stock deals given that the transaction risk is shared between the bidder and the seller. We do not find support, however, that financial sponsors apply different level of discount for private targets than strategic acquirers.

Table 9: OLS Regression Analysis for Private Company Discount

This table reports results of the OLS regression with private company discount as a dependanat variable. PCD is estimated using Modelled EV to Revenue and Modelled EV to EBITDA multiples for both the original and the log-transformed data. Log Assets represents log transformed book values of target assets expressed in USD and extracted from Zephyr. Profitability is a dummy variable that takes the value of 1 if the target company has positive profits and 0 if it is a loss-making firm. Acquirer type is an indicator variable that takes the value of 1 if the acquirer is a financial sponsor and 0 if it is a strategic buyer. Method of payment is also an indicator variable that takes the value of 1 if the transaction is a cash deal and 0 if the acquirer has performed a stock swap. Business cycle is a variable based on CEPR Recession Indicator that takes the value of 1 if the transaction accnoncement date belongs to the recession period and the value of 0 for expansionary periods. IPO volume is measured as the number of IPOs in each year scaled by the total number of listed firms in the year before. VIX Index is a measure of the implied volatility of S&P 500 index options traded at CBOE. Financial market efficiency is an indicator variable that takes the value of 1 for observations above the sample median and the value of 0 for the values below the median. Numbers in the top row represent estimated coefficients from the OLS regression and numbers in the parenthesis refer to t-statistic. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

			Log-transformed	
	Modelled EV to Revenue	**Modelled EV to EBITDA**	**Modelled EV to Revenue**	**Modelled EV to EBITDA**
Intercept	1.79***	1.39***	1.23***	1.35***
	(3.74)	(5.09)	(4.88)	(6.20)
Log Assets	-0.33***	-0.17***	-0.16***	-0.15***
	(-7.71)	(-7.19)	(-6.93)	(-7.89)
Positive Income (Profitability) (1/0)	-0.22*		-0.29***	
	(-1.70)		(-4.30)	
Financial Sponsor (Acquiror Type) (1/0)	-0.20	-0.03	-0.08	0.01
	(-1.34)	(-0.31)	(-1.01)	(0.16)
Cash (Method of Payment) (1/0)	0.27*	0.17**	0.15*	0.12*
	(1.81)	(1.99)	(1.86)	(1.71)
Recession (Business Cycle) (1/0)	0.47**	0.22*	0.10	0.26***
	(2.34)	(1.92)	(0.96)	(2.91)
IPO Volume	4.22	-1.81	3.91**	0.25
	(1.14)	(-0.85)	(2.00)	(0.15)
VIX Index	-0.03***	-0.02***	-0.01***	-0.02***
	(-3.77)	(-4.91)	(-2.67)	(-4.90)
Financial Market Efficiency (1/0)	-0.59	-0.57**	-0.23	-0.46**
	(-1.20)	(-2.06)	(-0.87)	(-2.09)
Observations	1744	1672	1744	1672
Adjusted R2	4.3%	4.0%	4.8%	4.8%

Additionally, we find sufficient evidence that macroeconomic and market conditions affect the size of PCD. Positive coefficient of the *Business cycle* indicates that the acquisition discount becomes larger in the periods of recession, as expected. Contraction in the economy and financing constrains increase the cost of liquidity for private companies, forcing the owners of private companies to accept higher discounts. We find only mild support for our hypothesis that the acquisition discount decreases when the alternative sources of liquidity are available, namely when the equity markets are performing strongly. *IPO volume*, a proxy for the ease with which the owners of private companies can access the equity market, has positive and significant coefficient at 5% only for the log transformed Modelled EV to Revenue. One explanation can be that the IPO volume does not capture properly the liquidity effects as we have expected it to and a more appropriate measure should be considered. Furthermore, we consider PCD across different volatility environments. *VIX index* is a proxy for the implied volatility of the public market. Our results show a negative relationship between the VIX index and private company discount, suggesting that private company discount decreases in times of high market volatility. Private firms are not traded in the open market and do not have observable prices. Hence, valuation of private firms is less volatile than prices of public stocks. Any downward shock on the prices of public stocks would be transferred to the private market with a time lag, implying that acquisition discount temporarily decreases until the valuations of public firms fully reflect the trends of the public market.

The efficiency of the financial market in which private target is based impacts the size of private company discount. Negative coefficient of *Financial market efficiency* indicates that private companies experience lower discount in countries with a more efficient financial market. Easier access to financing and more favorable financing terms have a positive impact on the valuation of private companies, leading to a lower discount. Similar to Kooli et al. (2003), we examine industry participation as a potential explanatory variable in our cross-sectional analysis. Due to multicollinearity of our industry dummy variables, we drop one of the variables from our regression. We exclude *Manufacturing* since discount estimates for the manufacturing companies are close to the sample average in Table 7. Thus, we use manufacturing as a benchmark industry and measure all other industries against it. The regression results indicate that construction, transportation & communication and real estate companies have acquisition discounts that are significantly different from the manufacturing industry. Table 10 presents the regression results with industry dummies as independent variables.

Overall, the adjusted R^2 of all four of our regressions are relatively low, ranging from 4.3% to 4.8%. Our regression model has low explanatory power, implying that our explanatory variables explain only a small proportion of the overall variability in PCD. Nevertheless, statistically significant coefficients imply the existence of relationship between the PCD and our independent variables.

Table 10: OLS Regression Analysis for Private Company Discount - Log transformed Modelled EV to Revenue

This table reports results of the OLS regression with private company discount as a dependanat variable. PCD is calculated as a log difference between the Modelled EV to Revenue multiples of private and public companies. Log Assets represents log transformed book values of target assets expressed in USD and extracted from Zephyr. Profitability is a dummy variable that takes the value of 1 if the target company has positive profits and 0 if it is a loss-making firm. Industry groups are dummy variables indicating industry participation. Manufacturing industry is a reference industry and, hence, omitted from the regression. Numbers in the top row represent estimated coefficients from the OLS regression and numbers in the parenthesis refer to t-statistic. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Intercept	0.95***	1.12***	1.12***
	(16.71)	(17.45)	(15.91)
Log Assets	-0.18***	-0.17***	-0.18***
	(-11.83)	(-11.33)	(-11.63)
Positive Income (Profitability) (1/0)		-0.25***	-0.25***
		(-5.48)	(-5.53)
Agriculture & Mining			0.10
			(0.43)
Construction			0.27**
			(2.26)
Manufacturing (omitted)			
Transportation & Communication			0.17**
			(2.20)
Wholesale & Retail Trade			-0.06
			(-0.96)
Real Estate			0.45***
			(2.91)
Services			0.03
			(0.63)
Observations	3897	3788	3788
Adjusted R2	3.4%	4.2%	4.6%

IX Robustness of regression results

Given the high variability across both private a public multiples, and the fact that we do not discard matched pairs when the private company premium exceeds 100%, we expect presence of premiums above the 100% threshold in our sample. We do not consider these extreme observations as data entry errors, so we do not have a compelling reason to omit them from our analysis. However, it is

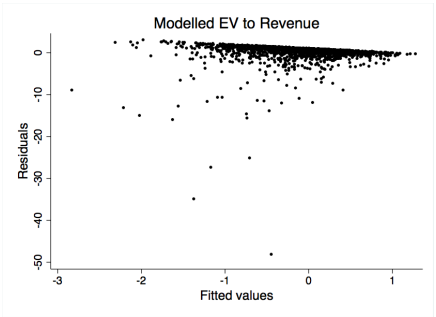
Table 11: Robust Regression Analysis for Private Company Discount

This table reports results of the robust regression analysis with private company discount as a dependanat variable. PCD is estimated using four different multiples. Log Assets represents log transformed book values of target assets expressed in USD and extracted from Zephyr. Profitability is a dummy variable that takes the value of 1 if the target company has positive profits and 0 if it is a loss-making firm. Acquirer type is an indicator variable that takes the value of 1 if the acquirer is a financial sponsor and 0 if it is a strategic buyer. Method of payment is also an indicator variable that takes the value of 1 if the transaction is a cash deal and 0 if the acquirer has performed a stock swap. Business cycle is a variable based on CEPR Recession Indicator that takes the value of 1 if the transaction accnoncement date belongs to the recession period and the value of 0 for expansionary periods. IPO volume is measured as the number of IPOs in each year scaled by the total number of listed firms in the year before. VIX Index is a measure of the implied volatility of S&P 500 index options traded at CBOE. Financial market efficiency is an indicator variable that takes the value of 1 for observations above the sample median and the value of 0 for the values below the median. Numbers in the top row represent estimated coefficients from the robust regression and numbers in the parenthesis refer to t-statistic. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

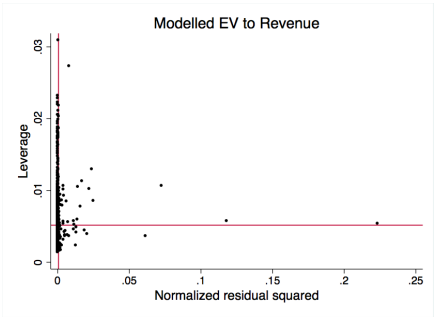
			Log-transformed	
	Modelled EV to Revenue	**Modelled EV to EBITDA**	**Modelled EV to Revenue**	**Modelled EV to EBITDA**
Intercept	0.73***	0.75***	1.18***	1.20***
	(7.38)	(7.73)	(4.95)	(6.15)
Log Assets	-0.04***	-0.06***	-0.16***	-0.15***
	(-0.04)	(-7.50)	(-7.62)	(-8.79)
Positive Income (Profitability) (1/0)	-0.10***		-0.31***	
	(-3.81)		(-4.79)	
Financial Sponsor (Acquiror Type) (1/0)	0.01	0.03	-0.10	0.02
	(0.31)	(0.96)	(-1.41)	(0.32)
Cash (Method of Payment) (1/0)	0.04	0.03	0.15**	0.13**
	(1.33)	(1.00)	(1.97)	(2.16)
Recession (Business Cycle) (1/0)	-0.03	0.07*	0.03	0.17**
	(-0.72)	(1.82)	(0.31)	(2.16)
IPO Volume	0.82	0.21	4.19**	0.20
	(1.07)	(0.28)	(2.27)	(0.13)
VIX Index	0.00	0.00***	-0.01**	-0.02***
	(-1.38)	(-2.69)	(-2.31)	(-4.87)
Financial Market Efficiency (1/0)	-0.07	-0.10	-0.25	-0.35*
	(-0.70)	(-1.06)	(-1.01)	(-1.78)
Observations	1744	1672	1744	1672

prudent to examine the extent to which they affect our regression results and the reliability of our findings. We use robust regression provided by Stata version 13.0 to investigate the effect of outliers on the linear regression and examine the robustness of our results for both the original and the log-transformed data. Robust regression does not completely eliminate the outliers from the analysis but treats them differently based on how well they behave compared to the other data points. For example, data points with high absolute residuals are given a small weight (close to 0), while observations which small residuals get a weight of 1.

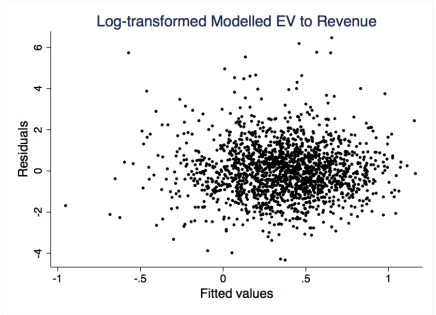
Overall, the results in Table 11 are consistent with the results reported in Table 9 in Section VIII. We find that the coefficients of *Log Assets*, *Profitability* and *VIX index* keep their significance, indicating that the size and profitability of a private target, as well as volatility of the market in which the target operates, impact the private company discount. Additionally, the *Financial market efficiency* and the *Method of payment* do not change the sign of their coefficients but become insignificant. Thus, we assume that the data is contaminated with some influential observations, which change the estimates of the regression coefficients (Verardi and Croux, 2009). We also apply robust regression instead of OLS regression to the log-transformed data. However, we do not observe substantial



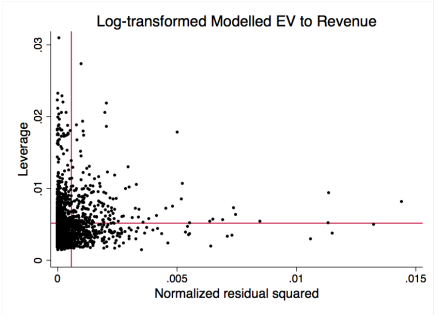
(a) Residuals vs. Fitted



(b) Residuals vs. Leverage



(c) Residuals vs. Fitted



(d) Residuals vs. Leverage

Figure 3: Diagnostic Plots

differences in the coefficients. Overall, we notice that using robust regression allows us to increase the degree of significance of those coefficients that are already significant in our main model. We further look at some diagnostics, examining residuals, fitted values and leverage, to see whether there are observations that can be problematic to our model. It appears that the predicted values of the percentage differences overestimate the measured ones, which leads to negative residuals. While the log-transformed discounts behave normally, i.e. they are relatively symmetrically distributed, tend to cluster around 0 of the y-axis and do not show clear patterns. The diagnostic plots are presented in Figure 3.

To address the problem of errors that are not dependent or identically distributed, we further compute the robust standard errors. The ordinary OLS assumes that the variance of the errors is constant (homoscedasticity), therefore the OLS estimates are not optimal when heteroscedasticity is present. Heteroscedasticity causes the standard errors to be biased. In Table 12 we present our results when we employ robust standard errors.

As expected, the coefficient estimates do not change when we compare the results with the earlier regression, however we can notice a small change in the standard errors and significance tests[15]. Using robust standard errors does not alter our conclusions substantially, only the *Method of payment* appears to lose its significance. If there was more heteroscedasticity in our data, we would probably see bigger variations in the output results.

[15]Please refer to Appendix G for the OLS regression with robust standard errors for the log-transformed data. We observe only minor changes in the standard error estimates.

Table 12: OLS Regression with Robust Standard Errors - Modelled EV to Revenue

Table below reports results of the OLS regression with robust standard errors with private company discount as a dependanat variable. PCD is calculated as a percentage difference between the Modelled EV to Revenue multiple of private and public companies. Log Assets represents log transformed book values of target assets expressed in USD and extracted from Zephyr. Profitability is a dummy variable that takes the value of 1 if the target company has positive profits and 0 if it is a loss-making firm. Acquirer type is an indicator variable that takes the value of 1 if the acquirer is a financial sponsor and 0 if it is a strategic buyer. Method of payment is also an indicator variable that takes the value of 1 if the transaction is a cash deal and 0 if the acquirer has performed a stock swap. Business cycle is a variable based on CEPR Recession Indicator that takes the value of 1 if the transaction accnoncement date belongs to the recession period and the value of 0 for expansionary periods. IPO volume is measured as the number of IPOs in each year scaled by the total number of listed firms in the year before. VIX Index is a measure of the implied volatility of S&P 500 index options traded at CBOE. Financial market efficiency is an indicator variable that takes the value of 1 for observations above the sample median and the value of 0 for the values below the median. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

				Regression with robust standard errors		
	Coefficient	**Std. Error**	**T-statistics**	**Coefficient**	**Std. Error**	**T-statistics**
Intercept	1.79***	0.4782	3.74	1.79***	0.5266	3.39
Log Assets	-0.33***	0.0430	-7.71	-0.33***	0.0702	-4.72
Positive Income (Profitability) (1/0)	-0.22*	0.1300	-1.70	-0.22*	0.1351	-1.64
Financial Sponsor (Acquiror Type) (1/0)	-0.20	0.1496	-1.34	-0.20	0.1382	-1.45
Cash (Method of Payment) (1/0)	0.27*	0.1509	1.81	0.27	0.1817	1.51
Recession (Business Cycle) (1/0)	0.47**	0.1994	2.34	0.47***	0.1636	2.85
IPO Volume	4.22	3.7111	1.14	4.22	4.5774	0.92
VIX Index	-0.03***	0.0086	-3.77	-0.03***	0.0091	-3.55
Financial Market Efficiency (1/0)	-0.59	0.4894	-1.20	-0.59	0.4984	-1.17
Observations			1744			1744
Adjusted R2			4.3%			4.8%

X Conclusion

In our paper we attempt to address the limitations of the existing academic research on private company discount. Our results are relevant to practitioners as we provide estimates of PCD for European unlisted companies. When investment bankers and analysts value privately-held companies, they first compute the acquisition multiples of comparable public companies and then apply a discount for the lack of liquidity. In contrast to earlier studies, which focus on the U.S. and estimate the discounts on pre-crisis data, we concentrate on European Union countries and examine most recent transactions. Our set-up allows us to investigate the impact of institutional factors on PCD, not covered in the existing literature.

Our results provide evidence for the existence of PCD in Europe, with the size of the discount ranging from 23% to 32% for the mean revenue multiples, and from 13% to 47% for the earnings multiples. Results based on log-transformed data indicate acquisition discounts in a similar range between 24% and 36%. We show, however, that applying the same acquisition discount for all the private firms would generate estimation errors. Our findings suggest that company and transaction characteristics, industry membership, as well as market conditions, influence the size of the discount.

Large and profitable firms are deemed less risky, and thus acquirers are willing to pay more for them than for loss-making and small companies. We also show that sellers of private firms are more likely to accept large discounts if they are offered immediate access to liquidity, i.e. when they are offered cash rather than shares. These results support the broader notion that lack of marketability is an important source of private company discount. We find only partial support for our hypothesis that the acquisition discount increases when the cost of liquidity increases, or alternatively, when alternative sources of liquidity are not available. Private firms experience larger discounts in recessions relative to expansionary periods, however we do not find relationship between the IPO volume and acquisition discount. Our results further show that the private company discount decreases when the market volatility increases, suggesting that valuation of private firms lags behind the more volatile public prices. We additionally consider cross-country differences and find evidence that institutional factors of each country influence the size of the private company discount. Companies based in countries with more efficient financial markets face fewer obstacles financing their investment plans, allowing them to achieve higher valuations.

The main limitation of our study is that private companies in our sample are relatively smaller than public companies. A more careful construction of public portfolio, i.e. controlling for size and narrowing the time-window, would generate a more precise estimate of PCD. Furthermore, the relationship between the private firm owners and management could help explain the size of acquisition discount. Given that owners of private companies often participate in management of their firms, part of their compensation may not be included in the reported target price. Hence, the

reported acquisition multiples of unlisted firms would be biased downwards, and thus, PCD we find may overestimate the true discount once these factors are taken into consideration.

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Appendices

A Average private company discount by year

This table reports private company discount for each of the years in the period from 1997 to 2015. Discounts are estimated using six different acuiqisition multiples. Acquisition discounts are calculated as a percentage difference between the acquisition multiples of matched private and public companies. Top row reports average PCD for the year and the number in the square brackets indicates number of matched pairs in each subsample. ***, ** and * denote statistical significance at the 1%. 5% and 10% levels, respectively.

Year	Deal to Revenue	Deal to EBITDA	EV to Revenue	EV to EBITDA	Modelled EV to Revenue	Modelled EV to EBITDA
1997	43%	-5%	N/A	N/A	47%	-7%
	[22]	[22]	[0]	[0]	[20]	[20]
1998	39%	-11%	N/A	N/A	47%	-34%
	[34]	[31]	[0]	[0]	[30]	[28]
1999	68%	41%	93%	N/A	59%	31%
	[37]	[35]	[1]	[0]	[21]	[19]
2000	30%	0%	84%	74%	20%	-31%
	[75]	[70]	[2]	[2]	[58]	[53]
2001	33%	42%	-99%	39%	43%	36%
	[86]	[74]	[2]	[2]	[74]	[64]
2002	54%	28%	50%	-595%	41%	15%
	[159]	[144]	[5]	[4]	[136]	[126]
2003	61%	32%	-12%	12%	54%	36%
	[195]	[172]	[9]	[9]	[180]	[159]
2004	39%	23%	-42%	2%	46%	31%
	[298]	[272]	[19]	[18]	[261]	[237]
2005	32%	18%	12%	-1%	41%	27%
	[441]	[417]	[20]	[21]	[397]	[377]
2006	10%	8%	21%	62%	39%	33%
	[489]	[461]	[23]	[29]	[431]	[409]
2007	13%	18%	45%	61%	36%	36%
	[557]	[524]	[40]	[43]	[497]	[470]
2008	-1%	8%	35%	63%	16%	23%
	[389]	[369]	[26]	[24]	[344]	[324]
2009	12%	20%	38%	67%	24%	36%
	[153]	[146]	[11]	[11]	[142]	[136]
2010	20%	23%	7%	40%	32%	33%
	[255]	[242]	[18]	[15]	[222]	[208]
2011	12%	3%	42%	30%	21%	19%
	[308]	[281]	[25]	[21]	[270]	[249]
2012	36%	22%	-18%	33%	40%	36%
	[221]	[203]	[10]	[10]	[191]	[175]
2013	16%	9%	36%	62%	19%	31%
	[222]	[202]	[11]	[11]	[183]	[168]
2014	21%	0%	49%	20%	27%	21%
	[272]	[254]	[13]	[12]	[223]	[211]
2015	-3%	-22%	29%	2%	-4%	6%
	[260]	[249]	[12]	[12]	[218]	[208]

B Average private company discount by country

This table reports private company discount for each of the 28 EU Member States. Discounts are estimated using six different acuiqisition multiples. Acquisition discounts are calculated as a percentage difference between the acquisition multiples of matched private and public companies. Top row reports average PCD for the country and the number in the square brackets indicates number of matched pairs in the country subsample. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Country	Deal to Revenue	Deal to EBITDA	EV to Revenue	EV to EBITDA	Modelled EV to Revenue	Modelled EV to EBITDA
Austria	-14%	-50%	-24%	38%	49%	-18%
	[32]	[30]	[4]	[4]	[23]	[22]
Belgium	-10%	-21%	-107%	-11%	19%	6%
	[116]	[107]	[8]	[10]	[101]	[96]
Bulgaria	12%	10%	-87%	3%	26%	35%
	[17]	[17]	[3]	[3]	[16]	[16]
Croatia	25%	-4%	40%	0%	30%	23%
	[12]	[11]	[2]	[1]	[9]	[9]
Czech Republic	49%	35%	77%	78%	59%	40%
	[89]	[82]	[4]	[3]	[78]	[72]
Denmark	-1%	0%	55%	58%	29%	19%
	[35]	[35]	[4]	[4]	[29]	[29]
Estonia	24%	1%	46%	80%	18%	30%
	[13]	[10]	[1]	[1]	[12]	[9]
Finland	39%	40%	77%	86%	51%	55%
	[102]	[93]	[6]	[6]	[86]	[80]
France	16%	-2%	52%	53%	34%	24%
	[534]	[494]	[30]	[33]	[451]	[415]
Germany	19%	3%	67%	57%	27%	19%
	[318]	[308]	[21]	[23]	[272]	[263]
Great Britain	20%	15%	22%	39%	29%	27%
	[1634]	[1518]	[70]	[65]	[1463]	[1361]
Greece	52%	45%	N/A	N/A	39%	24%
	[41]	[36]	[0]	[0]	[35]	[31]
Hungary	47%	26%	53%	-4%	51%	30%
	[29]	[29]	[1]	[1]	[27]	[27]
Italy	34%	24%	31%	50%	36%	31%
	[511]	[484]	[36]	[36]	[450]	[422]
Luxembourg	-77%	-126%	N/A	N/A	-26%	-105%
	[7]	[7]	[0]	[0]	[6]	[7]
Malta	-88%	-318%	N/A	N/A	-59%	-286%
	[2]	[2]	[0]	[0]	[2]	[2]
Netherlands	44%	51%	72%	51%	60%	54%
	[77]	[74]	[10]	[9]	[61]	[57]
Poland	40%	39%	-10%	60%	42%	52%
	[115]	[101]	[5]	[4]	[107]	[95]

Country	Deal to Revenue	Deal to EBITDA	EV to Revenue	EV to EBITDA	Modelled EV to Revenue	Modelled EV to EBITDA
Portugal	9%	-3%	-24%	-48%	2%	16%
	[64]	[57]	[1]	[1]	[54]	[48]
Republic of Ireland	-13%	-5%	67%	29%	-4%	-3%
	[22]	[22]	[1]	[1]	[15]	[15]
Romania	40%	20%	43%	50%	28%	34%
	[28]	[27]	[3]	[2]	[18]	[18]
Slovakia	75%	75%	N/A	N/A	64%	75%
	[17]	[16]	[0]	[0]	[16]	[16]
Slovenia	16%	53%	N/A	N/A	58%	52%
	[16]	[14]	[0]	[0]	[13]	[12]
Spain	27%	10%	-19%	40%	31%	23%
	[458]	[432]	[28]	[28]	[402]	[385]
Sweden	9%	15%	16%	41%	41%	39%
	[184]	[162]	[9]	[9]	[152]	[134]

C Estimates of private company discount

The table below reports acquisition discounts estimates using the central half of the sample (between the 25th and 75th percentile). The acquisition discount is estimated as a percentage difference between the private and public acquisition multiples of the matched pairs. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Values in the most right-hand column represent the number of observations for each of the multiples.

	Private Targets	Public Targets	Discount	Number of matched pairs
Deal to Revenue	1.3	2.0	33%***	2235
Deal to EBITDA	10.3	14.1	27%***	2084
EV to Revenue	1.9	3.2	40%***	124
EV to EBITDA	13.5	26.0	48%***	122
Modelled EV to Revenue	1.4	2.5	45%***	1949
Modelled EV to EBITDA	11.4	19.7	42%***	1819

D IPO volume computation

The table below presents the steps in the computation of IPO volume. The IPO volume is measured as the number of IPOs in each year scaled by the total number of listed firms in the year before. The number of listed companies is based on available data from both the World Federation of Exchanges (WFE) and the Federation of European Securities Exchanges (FESE). The number of IPOs is sourced from Zephyr, a Bureau Van Dijk database.

Year	Number of listed companies	Number of IPOs	IPO Volume
2015	11,274	268	0.02
2014	11,221	337	0.03
2013	11,108	251	0.02
2012	11,167	257	0.02
2011	11,409	415	0.04
2010	11,431	371	0.03
2009	11,691	159	0.01
2008	12,169	338	0.03
2007	12,392	663	0.05
2006	11,625	783	0.07
2005	11,345	614	0.05
2004	11,553	390	0.03
2003	11,355	145	0.01
2002	11,300	187	0.02
2001	10,410	298	0.03
2000	10,280	861	0.08
1999	16,247	517	0.03
1998	13,044	495	0.04
1997	10,131	258	0.03

E Number of listed companies in the EU

The table below reports the number of listed companies for each of the 28 EU Member States between 1997 and 2015. The data is obtained from the World Federation of Exchanges (WFE) and the Federation of European Securities Exchanges (FESE). If the information is not available, the data is collected indiviually from the stock exchange of each country. (a) Borsa Italiana was acquired by the LSE in Oct 2007, thus since 2008 the London SE Group includes the number of listed companies in Italy. (b) Euronext includes Belgium, England, France, Netherlands and Portugal. (c) NASDAQ OMX Nordic Exchange includes Copenhagen, Helsinki, Iceland, Stockholm, Tallinn, Riga and Vilnius Stock Exchanges.

Exchange	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**
Athens Stock Exchange	240	244	251	265	272	280	288	292	292
BME Spanish Exchanges	3651	3452	3245	3200	3276	3345	3472	3576	3537
Borsa Italiana (a)								300	307
Bratislava Stock Exchange	69	80	86	88	98	108	133	191	225
Bucharest Stock Exchange	84	83	83	79	79	69	64	64	54
Budapest Stock Exchange	45	48	50	52	54	52	46	43	41
Bulgarian Stock Exchange	365	372	381	387	393	390	399	399	380
CEESEG - Prague	25	23	26	28	26	27	25	29	32
Cyprus Stock Exchange	84	104	105	112	118	123	129	136	143
Deutsche Boerse	619	670	720	747	746	765	783	832	866
Euronext (b)	1068	1055	1062	1073	1112	1135	1160	1002	1043
Irish Stock Exchange	53	52	50	50	55	59	64	68	73
Ljubljana Stock Exchange	46	51	55	61	66	72	76	84	87
London SE Group	2685	2752	2736	2767	2886	2966	3088	3096	3307
Luxembourg Stock Exchange	192	220	274	293	298	289	266	261	261
Malta Stock Exchange	23	24	24	22	21	21	20	19	16
NASDAQ OMX Nordic Exchange (c)	832	787	755	751	773	778	797	824	851
Warsaw Stock Exchange	905	902	895	867	777	585	486	458	375
Wiener Borse	92	99	102	99	105	110	115	118	119
Zagreb SE	196	203	208	226	254	257	280	377	383
Total region	**11 274**	**11 221**	**11 108**	**11 167**	**11 409**	**11 431**	**11 691**	**12 169**	**12 392**

Exchange	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
Athens Stock Exchange	290	304	321	340	338	332	310	262	246	220
BME Spanish Exchanges	3378	3337	3315	3223	3015	1482	1036	727	486	388
Borsa Italiana (a)	290	282	278	279	295	294	297	270	243	239
Bratislava Stock Exchange	256	306	389	448	510	888	866	830	833	0
Bucharest Stock Exchange	53	59	60	62	65	65	114	127	126	76
Budapest Stock Exchange	41	44	48	51	48	56	60	66	55	49
Bulgarian Stock Exchange	357	341	332	354	353	394	503	828	998	15
CEESEG - Prague	32	39	55	65	79	102	151	195	304	320
Cyprus Stock Exchange	144	147	153	156	159	149	124	66	57	53
Deutsche Boerse	760	764	819	866	934	984	989	6546	3525	2711
Euronext (b)	954	966	1333	1392	1114	1194	1286	1934	1732	1623
Irish Stock Exchange	68	66	65	66	77	87	96	103	101	87
Ljubljana Stock Exchange	100	116	140	134	135	151	149	125	90	79
London SE Group	3256	3091	2837	2692	2824	2891	2929	2791	2920	2991
Luxembourg Stock Exchange	260	245	234	242	244	257	270	274	277	284
Malta Stock Exchange	15	14	13	14	13	12	10	10	10	10
NASDAQ OMX Nordic Exchange (c)	791	678	641	482	693	677	704	693	661	636
Warsaw Stock Exchange	265	241	216	189	202	216	211	221	198	143
Wiener Borse	113	111	121	125	129	113	111	114	128	137
Zagreb SE	202	194	183	175	73	66	64	65	54	70
Total region	**11 625**	**11 345**	**11 553**	**11 355**	**11 300**	**10 410**	**10 280**	**16 247**	**13 044**	**10 131**

F Financial market efficiency index

The table below presents the standardised scores and rankings for each of the 27 EU (excl. Cyprus due to missing data) Member States in the financial market efficiency index. The financial market efficiency index is composed of three distinct components. The interest margin to gross income measures the share of the net interest earnings within the gross income. Data for the interest margin to gross income is available from the IMF database. The interest rate spread, sourced from the World Banks World Development Indicators catalogue, is the spread between reference lending and deposit rates. Financial freedom measures banking efficiency and the bank independence of government control. Financial freedom data is from the Economic Freedom Index of the Heritage Foundation. Financial market efficiency index is an agreggation of the three components with the intention of meaningfully rescaling and condensing the different units. The numbers in the most right-hand column represent the rank assigned to each country, with 1 being the most efficient financial market and 27 being the least efficient financial market.

	Rescaled observations				
Country	**Interest Margin to Gross Income**	**Interest Rate Spread**	**Financial Freedom**	**Financial Market Efficiency Index**	**Rank**
Austria	0.43	0.86	0.67	0.65	10
Belgium	0.45	0.92	0.67	0.68	9
Bulgaria	0.32	0.00	0.33	0.22	25
Croatia	0.36	0.31	0.33	0.33	23
Czech Republic	0.40	0.53	1.00	0.65	11
Denmark	0.22	0.90	1.00	0.71	8
Estonia	0.59	0.77	1.00	0.79	4
Finland	0.65	0.96	1.00	0.87	3
France	0.78	0.79	0.67	0.75	6
Germany	0.22	0.66	0.67	0.52	19
Greece	0.11	0.11	0.00	0.07	27
Hungary	0.55	0.66	0.67	0.62	13
Republic of Ireland	0.45	0.73	0.67	0.61	15
Italy	0.61	0.69	0.33	0.55	18
Latvia	0.50	0.58	0.00	0.36	22
Lithuania	1.00	0.79	1.00	0.93	2
Luxembourg	0.86	1.00	1.00	0.95	1
Malta	0.30	0.57	0.33	0.40	21
Netherlands	0.24	0.70	1.00	0.64	12
Poland	0.46	0.73	0.67	0.62	14
Portugal	0.56	0.85	0.33	0.58	16
Romania	0.42	0.21	0.00	0.21	26
Slovakia	0.00	0.58	0.67	0.42	20
Slovenia	0.45	0.38	0.00	0.28	24
Spain	0.33	0.66	0.67	0.55	17
Sweden	0.44	0.75	1.00	0.73	7
Great Britain	0.57	0.68	1.00	0.75	5

G OLS regression with robust standard errors for log transformed data

The table below reports results of the OLS regression with robust standard errors with private company discount as a dependanat variable. PCD is calculated as a percentage difference between the Log-transformed Modelled EV to Revenue multiple of private and public companies. Log Assets represents log transformed book values of target assets expressed in USD and extracted from Zephyr. Profitability is a dummy variable that takes the value of 1 if the target company has positive profits and 0 if it is a loss-making firm. Acquirer type is an indicator variable that takes the value of 1 if the acquirer is a financial sponsor and 0 if it is a strategic buyer. Method of payment is also an indicator variable that takes the value of 1 if the transaction is a cash deal and 0 if the acquirer has performed a stock swap. Business cycle is a variable based on CEPR Recession Indicator that takes the value of 1 if the transaction accnoncement date belongs to the recession period and the value of 0 for expansionary periods. IPO volume is measured as the number of IPOs in each year scaled by the total number of listed firms in the year before. VIX Index is a measure of the implied volatility of S&P 500 index options traded at CBOE. Financial market efficiency is an indicator variable that takes the value of 1 for observations above the sample median and the value of 0 for the values below the median. ***, ** and * denote statistical significance at the 1%. 5% and 10% levels, respectively.

				Regression with robust standard errors		
	Coefficient	**Std. Error**	**T-statistics**	**Coefficient**	**Std. Error**	**T-statistics**
Intercept	1.23***	0.2520	4.88	1.23***	0.2589	4.75
Log Assets	-0.16***	0.0226	-6.93	-0.16***	0.0248	-6.33
Positive Income (Profitability) (1/0)	-0.29***	0.0685	-4.30	-0.29***	0.0701	-4.20
Financial Sponsor (Acquiror Type) (1/0)	-0.08	0.0789	-1.01	-0.08	0.0830	-0.96
Cash (Method of Payment) (1/0)	0.15*	0.0795	1.86	0.15*	0.0805	1.84
Recession (Business Cycle) (1/0)	0.10	0.1051	0.96	0.10	0.1117	0.90
IPO Volume	3.91**	1.9560	2.00	3.91*	2.0797	1.88
VIX Index	-0.01***	0.0045	-2.67	-0.01**	0.0047	-2.54
Financial Market Efficiency (1/0)	-0.23	0.2580	-0.87	-0.23	0.2453	-0.92
Observations			1744			1744
Adjusted R2			4.3%			4.8%