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AUTHORS	Vlad Mogilevsky Zoltan Murgulov
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Vlad Mogilevsky (Australia), Zoltan Murgulov (Australia)

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Abstract

We examine underpricing of private equity (PE) backed initial public offerings (IPOs) listed on a major US stock exchange between January 2000 and December 2009. The authors identify 265 private equity backed IPOs and compare these with concurrently listed venture capital (VC) backed and non-sponsored (non-PE/non-VC backed) IPOs. Private equity backed IPO firms tend to be larger, more profitable and are underwritten by investment banks that have proportionally greater share of the underwriting market. The results indicate that, on average, private equity backed IPOs experience a significantly lower level of underpricing than venture capital backed or non-sponsored IPOs. The authors posit that the presence of a private equity firm as a client divesting through the IPO induces the investment bank to reduce expected underpricing, because private equity firms tend to be continuing and lucrative clients of investment banks. Thus, the results extend the evidence on the relative power of participants in IPO deals.

Introduction

Private equity investors are becoming increasingly important in the context of global equity markets (Levis, 2011). A private equity (PE) firm is an investment manager that invests in the private equity of operating companies by various means of loosely affiliated investment strategies that may include a leveraged buyout, venture capital and growth capital. Conversely, venture capital (VC) firms typically comprise small teams with technology backgrounds (scientists, researchers) or those with business training or deep industry experience that pool together and invest financial capital in enterprises that are too risky for the standard capital markets or bank lending. PE firms have been highly acquisitive in recent years as cheap debt has enabled them to finance an unprecedented number of deals (Klier, 2009). The availability of low-cost debt has been linked with the ability and willingness of large investors (such as pension funds, hedge funds and sovereign wealth funds) to provide large scale funding to PE firms (Klier, 2009). Because PE firms crystallize returns when exiting their investments, the exit strategy is, therefore, a critical stage of the investment process for private equity firms (Sinha et al., 2005).

Given the importance of the initial public offering (IPO) as an exit method for private equity firms (Levis, 2011) we would expect to see a significant part of the IPO literature dedicated to private equity backed IPOs, particularly in relation to the unresolved issue of underpricing. There is, however, a significant gap in the literature in this regard as underpricing in private equity backed IPOs has been largely ignored by the mainstream academic research. Instead, previous research has focused on regular and venture capital backed IPOs. For exam-

ple, Cotei and Farhat (2011) state that IPO company association with a venture capital firm signals superior information to the equity markets, compared to non-venture capital backed IPO. By analyzing an alternative scenario in which the IPO companies are backed by private equity firms we can contribute to the existing research and further explore the determinants of IPO underpricing. Thus, we examine underpricing of recent IPOs and compare private equity (PE) backed IPOs with concurrent venture capital (VC) backed IPOs and non-PE/non-VC IPOs (hereafter "non-sponsored" IPOs) in the US equity markets.

Venture capital industry has been well established in the US since at least the early 1970s (Tannon and Johnson, 2005). Unlike private equity firms, venture capital firms tend to take smaller, non-controlling stakes in their portfolio companies and take up a "monitoring" role rather than actively participating in management (Barry et al., 1990). Another difference between VC firms and PE firms is that in addition to the deep knowledge of their portfolio companies, private equity firms also possess a higher level of financial expertise (Wright and Robbie, 1998). This is because PE firms have had experience in a range of acquisitions, sales and IPOs related to their former portfolio companies. In contrast, many VC firms primarily invest in the application of new technology, new marketing concepts and new products that have yet to be proven. Therefore, any informational advantage that the investment bank would otherwise have in relation to pre-IPO owners of the firm is severely reduced or eliminated in the case of PE backed IPOs. Given these differences, it is important to analyze initial listing returns in PE backed IPOs and compare these to returns of concurrently listed VC backed IPOs and non-sponsored IPOs.

To form our sample we identify all successfully listed IPOs in the US between January 2000 and

December 2009 (inclusive). We, then, classify successful IPOs into PE backed, VC backed and non-sponsored IPOs. Our results indicate that PE backed IPOs are significantly less underpriced than VC backed or non-sponsored IPOs. This finding seems to provide evidence in support of Baron's (1982) theory that the investment bankers have the informational advantage which leads to the discounting of the issuer's stock. Private equity firms are often lucrative repeat customers of investment banks. We, therefore, conjecture that presence of private equity firms in an IPO reduces or eliminates the advantage that underwriters usually have when it comes to IPO pricing negotiations with owners of the firm. This reduced incentive of the underwriters to significantly underprice the IPO is reflected in lower initial returns on average for PE backed IPOs. This is contrary to the signaling theories by Grinblatt and Hwang (1989), Allen and Faulhaber (1989) and Welch (1989). They argue that issuers have an informational advantage and use underpricing to signal their quality to the market. If quality signaling was the prevalent pricing mechanism in IPOs then we would expect to see increasing levels of underpricing as the information advantage of the issuer increases. Using private equity firms as a proxy for more informed issuers, we see this is not the case in our sample of IPOs.

This paper is organized as follows. Section 1 provides an overview of the relevant literature and develops the research hypotheses. Section 2 describes the sample selection criteria, methods used in this research and provides a set of sample descriptive statistics. Section 3 provides the results from the regression analyses. The final section provides a discussion of the results and conclusions.

1. Relevant literature and hypotheses development

1.1. Empirical evidence and theoretical explanations of underpricing. Ibbotson (1975) documents the phenomenon of underpricing; however, he describes its existence as a mystery and fails to offer any definitive reason as to why IPO underpricing exists. Further research by Ritter (1984) confirms the underpricing phenomenon, and whilst he could not solve the underpricing puzzle he suggests that it could be related to the issuing firm's industry.

Over time, a wide range of theoretical explanations of IPO underpricing have been developed. Explanations for the underpricing phenomenon broadly fall into four categories. First, the institutional explanations which include theories on legal liability insurance (Tinic, 1998; Hensler, 1995) which suggest that issuing firms underprice to reduce the likelih-

ood of legal action for violations arising from the IPO. Second, the ownership and control explanations, such as Brennan and Franks (1997) theory that managers use the IPO allocation to strategically place shares with parties that are unlikely to call for their dismissal thereby entrenching themselves. Third, the behavioral reasons, including the prospect theory proposed by Loughran and Ritter (2002). Combining the prospect theory styled reference points and Thaler's (1980, 1985) mental accounting, Loughran and Ritter argue that issuers do not get upset at the "money left on the table" because issuers believe this loss is offset by the gains they achieve on the shares they retain[1]. Fourth category of theoretical explanations is information asymmetry; according to Ljungqvist's (2004) survey it is the information asymmetry explanations which offer the best explanations for the underpricing phenomenon. However, PE backed IPOs alter the information asymmetry balance between parties in the IPO and are, therefore, an important key to understanding the underpricing phenomenon.

Given the importance of information asymmetry and principal-agent conflicts in underpricing explanations (Baron, 1982; Grinblatt and Hwang, 1989; Rock, 1986) there have been a number of studies which suggest ways to better define this asymmetry. These include studies in which the principal and agent are the same party, thus issues are certified by prestigious underwriters or auditors, and similar certification cases where it is a venture capital investor who certifies the issue. There are two prominent cases where the principal and agent are in fact the same party. These include self-underwritten IPOs (Muscarella and Vetsuypens, 1989a) and situations in which the underwriter has a significant pre-IPO stake (Ljungqvist and Wilhelm, 2003). Muscarella and Vetsuypens (1989a) look at the self-underwritten IPOs and find similar levels of underpricing to regular IPOs. Conversely, Ljungqvist and Wilhelm (2003) look at the relationship between the underwriter's pre-IPO stake and the level of underpricing and find evidence that the equity stake provides an incentive to minimize underpricing and that underpricing levels are proportionate to the size of this stake.

Carter and Manaster (1990) and Michaely and Shaw (1994) suggest an alternative way in which information asymmetry can be reduced. The hiring of a

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[1] "Money left on the table" refers to the difference between the offer price and the IPO listing day (open or close) share price. Thus, it refers to underpricing or the difference in share price received by divesting investors in the firm and the potential maximum share price that could have been received if the IPO was priced at the maximum value the market was willing to pay for IPO shares on listing.

prestigious underwriter to manage the offering "certifies" the IPO and reduces the uncertainty over the firm's true value. Prestigious underwriters are unlikely to manage the IPOs of low quality issuers if reputational capital is important (Ljunqgvist, 2004). The empirical results on this point are, however, mixed and have varied over time. Beatty and Welch (1996) show that the relationship between reputable underwriters and underpricing has flipped since the 1970s and 1980s such that more reputable underwriters are associated with more underpriced IPOs. Loughran and Ritter (2004) suggest that this may have occurred as banks attempt to please their institutional clients by offering them shares which are certain to produce an abnormal short-run return in response for future business. This explanation seems plausible as the range of services offered by investment banks to institutional clients has increased in recent times such that the revenues generated by these activities often exceed those produced by traditional advisory and capital raising services.

In relation to venture capital backed IPOs, Barry et al. (1990) and Megginson and Weiss (1991) find a lower level of underpricing in VC backed IPOs and they attribute this to a recognition by the capital markets of the monitoring role the VC investors have. Megginson and Weiss (1991) conclude that the venture capital firm provides a third party certification of the issuing firm's value and thereby reduces the information asymmetry and underpricing. However, subsequent evidence on venture capital backed IPO underpricing is mixed (Lee and Wahal, 2004; Rossetto, 2008). Lee and Wahal (2004) find that venture backed IPOs experience larger first day returns than non-venture backed counterparts. Their explanation for this finding is in line with Gompers (1996) grandstanding hypothesis which relates venture backed underpricing to future fund-raising activity. Lee and Wahal conjecture that venture capital returns are largely dependent on the firm's ability to bring its portfolio companies public, therefore, venture capital firms are willing to bear the cost of higher levels of underpricing in order to establish their own reputation. Once established, venture capitalists can raise more funds in the future and generate higher management fees. This concern would appear to be less of an issue in private equity backed transactions as the private equity firms involved in IPO transactions tend to be larger and more established than the venture capital firms (Wright and Robbie, 1998). This, combined with their specialization in restructuring and selling companies (DeAngelo and DeAngelo, 1987) implies there is less pressure on private equity firms to establish a reputation in bringing companies public in order to raise future funds.

1.2. Hypotheses development. Despite the large number of studies examining IPO underpricing, very few studies have touched on the topic of underpricing in the IPOs of companies that have previously been controlled by a private equity firm. One such example is Muscarella and Vetsuypens (1989b) who look at companies going public for a second time after a leveraged buyout (LBO). They argue that as these firms have been public before, the information asymmetry is reduced and investors are better informed about the company's value. Our research however differs from Muscarella and Vetsuypens (1989b) in two important ways. Firstly, we examine private equity deals which are not secondary LBOs. Secondly, our research differs from previous research in that we consider the role the private equity firm itself plays in reducing underpricing, where at least a controlling stake is purchased by the PE firm.

In the case where an issuing firm has been controlled by a private equity firm it is reasonable to assume that the private equity firm would be more informed than a typical owner/issuer. Private equity investors have the benefit of a greater involvement in the issuing firm's management compared to venture capital firms and a level of financial expertise that "ordinary" non-sponsored firm owners do not have. The main reason for this is that private equity firms repeatedly invest in companies and accumulate knowledge through managing and then divesting from these investments (Rossetto, 2008).

This enables us to advance a hypothesis related to the level of underpricing in private equity backed deals. It is difficult to dispute the fact that private equity backed issuers are going to be more informed than regular issuers and venture capital backed issuers (Wright and Robbie, 1998). Thus, we present a case where the information advantage of the issuer is strengthened. The likely effect on underpricing, therefore, depends on the approach taken to the asymmetry problem. Theorists that contend underpricing is a consequence of high quality IPO firms signaling their quality to the markets would expect that the more informed the issuer becomes the more it uses underpricing to signal high quality. As a result, they would expect higher levels of underpricing in private equity backed deals (for example, Allen and Faulhaber, 1989). Those that argue underpricing results from the investment bank's informational advantage and incentives would expect to see underpricing reduced in private equity backed deals as the informational advantage is reduced (or eliminated) and incentives altered (see, for example, Baron, 1982). As we shift the informational advantage away from the investment bank and toward the client we hypothesize the following.

Hypothesis 1: Private equity backed IPOs exhibit significantly lower levels of underpricing than their venture capital backed and non-sponsored IPO counterparts.

A number of other factors could contribute to reduce information asymmetry in an IPO. Larger firms are generally subject to greater public scrutiny (including independent analysts) than smaller firms which could be susceptible to the "neglected firm effect" resulting in a relatively lower level of information asymmetry for larger firms. Thus, firm size may proxy for *ex-ante* uncertainty of an offer (Beatty and Ritter, 1986). Because private equity firms tend to buy established companies, we expect that PE backed firms are larger at IPO than their VC backed or non-sponsored IPO firm counterparts. This leads to the second hypothesis.

Hypothesis 2: Private equity backed firms that conduct IPOs are significantly larger (measured by total assets or expected market capitalization at offer price) than venture capital backed or non-sponsored IPO firms.

We infer similar reasoning for company age; we would expect to find more information on a firm that has been operating for fifty years than one operating for two years. Indeed the IPO literature indicates that older firms reduce the level of information asymmetry and ultimately lead to lower underpricing (Muscarella and Vetsuypens, 1989a; Ritter, 1984; Megginson and Weiss, 1991). This characteristic goes hand in hand with the firm's size. As a firm gets older we expect it to grow and become larger while establishing a track record. Once again, it is these larger more-established firms that private equity investors target for investment. We expect, therefore, the private equity backed firms to be older than the other firms in this sample. Consequently, we propose the following hypothesis.

Hypothesis 3: Private equity backed IPO firms are significantly older 15 venture capital backed firms or non-sponsored IPO firms in this sample.

In addition to testing our hypotheses, we construct a range of variables that have been identified in previous research to have the ability to explain initial returns; thus we control for these effects on the initial returns of our sample IPOs. The next section outlines the sample and methodology used in this research.

2. Sample and methodology

2.1. Sample construction. Our sample is constructed from a universe of IPOs in the United States listed between January 2000 and December 2009 (inclusive) obtained from SDC Platinum (Thomson Financial)[1]. Information collected included company and offer characteristics, such as offer price, offer proceeds, industry and whether the IPO company was private equity backed or venture capital backed. In order to construct the initial sample of private equity backed firms we manually check every IPO with the private equity backed flag in the SDC database to ensure that the company was subject to a full buyout by the private equity fund or at least sold a controlling stake to the investors. This results in a sample of 325 private equity backed deals. We require IPO subscription price and listing day share price to be available. Due to missing data required to compute the initial returns we are left with 265 valid observations in the private equity backed IPO sub-sample. We also identify concurrently listed venture capital backed and non-sponsored ('ordinary') IPOs, resulting in 572 VC backed IPOs and 806 non-sponsored IPOs in the remaining two sub-samples.

We manually collect missing data required on pre-IPO assets, EBIT and the proportion of shares retained by owners after the IPO from Securities Exchange Commission (SEC) firm S-1 and S-1/A filings to construct the explanatory variables for our regression models.

In the extant literature, the first day stock returns to subscribing investors are used to proxy the level of IPO underpricing. Thus, we employ equation one to calculate initial returns to subscribing investors (UP_i) in an offer:

$$UP_i = \frac{P_{i,1} - P_{i,0}}{P_{i,0}}, \tag{1}$$

where $P_{i,1}$ is the closing price on the first day of trading in the aftermarket and $P_{i,0}$ is the offer (subscription) price given by SDC[2]. The computed returns are then used to estimate the parameters of the underpricing regression equation.

2.2. Underpricing models. In order to construct a regression model that properly considers the effect of private equity backing on IPO returns it is necessary to control for a number of offer and firm characteristics. The following OLS regression equation is estimated:

$$UP_1 = \alpha_0 + \alpha_1 PE + \alpha_2 VC + \alpha_3 SEO + \alpha_4 LN\_AGE + \alpha_5 LN\_ASSETS + \alpha_6 LN\_PROCEEDS +$$
$$+ \alpha_7 MKT\_SHARE + \alpha_8 ROA + \alpha_9 RETAINED + \alpha_{10} NYSE + \alpha_{11} NASDAQ + \alpha_{12} \sum_{i=1}^{10-1} YEAR_i + e_i^b \tag{2}$$

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[1] There is no comprehensive source of information on private equity backed IPOs with most databases covering these transactions specifically not going further back than January 2000. Thus, the data restrictions dictate our sample starting date.
[2] First trading day closing share price for each deal is obtained from CRSP.

The variables are defined as the following:

PE is a dichotomous variable where unity represents the IPO was backed by a private equity firm and zero otherwise. We hypothesize that there should be a negative relationship between this variable and underpricing.

VC is a dichotomous variable where unity represents the IPO was backed by a venture capital firm and zero otherwise. Previous research by Megginson and Weiss (1991) and Barry et al. (1990) suggest that venture capital backing should have a significant and negative effect on underpricing. However, in a more recent study Lee and Wahal (2004) find a positive relationship between venture capital backing and initial returns.

SEO is a dichotomous variable is unity if the firm raised money in a seasoned equity offering (SEO) in the three years following the IPO. We use the SEO variable to examine the signaling hypothesis in Welch (1989), which suggests that firms deliberately underprice in the IPO to induce investors to subscribe to subsequent equity issues[1].

LN_AGE is the natural logarithm of 1 + age of firm in years. We use *LN_AGE* as control for the degree of information asymmetry. We expect more information to be available for older (more-established) firms, reducing the informational asymmetry and the level of underpricing. Muscarella and Vetsuypens (1989a) show that the older the firm the lower the initial return. Age has been used as a control for uncertainty in a number of other studies including Ritter (1984) and Megginson and Weiss (1991). We posit that private equity backed IPO firms tend to be older and more established and deem it necessary to control for company age in our regression models.

LN_ASSETS is the natural logarithm of the $ value of total pre-IPO assets of the firm. Beatty and Ritter (1986) find that a reduced level of information asymmetry reduces underpricing. A firm's size, measured by total assets, is a proxy for *ex-ante* uncertainty as we expect more information to be publicly available the larger the firm is, reducing uncertainty and the initial returns.

LN_PROCEEDS is the natural logarithm of the $ value of proceeds raised from the offering. Beatty and Ritter (1986) document a significant relationship between the amount offered and the initial returns. The reason for this relationship, they argue, is that smaller offerings are more speculative and therefore have higher initial returns.

MKT_SHARE is the market share of the lead underwriter in the year of the IPO. We use underwriter market share as a proxy for underwriter reputation. Higher quality underwriters provide a certification of the issue quality and hence can reduce the level of underpricing. Carter and Manaster (1990) and Booth and Smith (1986) show that higher quality underwriters are associated with lower underpricing.

ROA is the return on assets for the firm prior to listing defined as earnings before interest and taxes (EBIT) over total assets. This is a measure of firm performance pre-IPO. We would expect greater confidence in firms that have performed well pre-IPO, reducing the level of information asymmetry. We expect a negative coefficient for this variable, where better performing firms have lower levels of underpricing.

RETAINED is the percentage of shares held in the firm post-IPO by the pre-IPO owners. As the percentage of ownership retained after the IPO decreases (i.e. more shares are sold in the IPO by the existing owners) we expect to see lower underpricing. Less underpricing should occur because pre-IPO owners stand to lose more from underpricing (because they sell part of their holding in the IPO) and, therefore, should put more effort into reducing the expected level of underpricing (Habib and Ljungqvist, 2001).

NYSE is a dichotomous variable equal to one for IPO firms listed on NYSE Amex Equities[2]. This is to control for the different levels of underpricing between stock exchanges.

NASDAQ is a dichotomous variable equal to one if the firm was listed on the NASDAQ. We expect smaller, higher risk and technology companies to list on NASDAQ. We anticipate a higher level of information asymmetry for these IPOs and hence, a positive sign on the coefficient in relation to initial returns.

Ritter (1984) documented the effect of "hot" IPO issue markets, where IPO underpricing is concentrated in particular periods; therefore, to control for changing market conditions during the sample period we include $(n - 1)$ offer year dichotomous variables in our regression models.

Additionally, we construct a regression model measuring the relative effect of the above variables on the adjusted initial returns. The adjusted initial returns are calculated as in Habib and Ljungqvist (2001). The initial returns are ad-

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[1] Jegadeesh et al. (1993) and Kennedy et al. (2006) also use a three-year window after the IPO to verify whether their sample companies have a subsequent seasoned equity offer.

[2] NYSE Amex Equities, formerly known as the American Stock Exchange (AMEX) is an American stock exchange situated in New York. On January 17, 2008 NYSE Euronext announced it would acquire the American Stock Exchange for $260 million in stock. On October 1, 2008, NYSE Euronext completed acquisition of the American Stock Exchange. Before the closing of the acquisition, NYSE Euronext announced that the Exchange would be integrated with the Alternext European small-cap exchange and renamed the NYSE Alternext US. In March 2009, NYSE Alternext US was changed to NYSE Amex Equities.

justment for dilution of ownership in the IPO to better reflect the wealth loss to the issuer. The adjusted underpricing equation is given by the following:

$$UP_{ADJi} = (1 - \%RETAINED) \times \frac{P_{i,1} - P_{i,0}}{P_{i,0}}. \qquad (3)$$

$$UP_{ADJ1} = \alpha_0 + \alpha_1 PE + \alpha_2 VC + \alpha_3 SEO + \alpha_4 LN\_AGE + \alpha_5 LN\_ASSETS + \alpha_6 LN\_PROCEEDS +$$

$$\alpha_7 MKT\_SHARE + \alpha_8 ROA + \alpha_9 NYSE + \alpha_{10} NASDAQ + \alpha_{11} \sum_{i=1}^{10-1} YEAR_i + e_i^b, \qquad (4)$$

where UP_{ADJ1} is defined as the adjusted initial return. The $RETAINED$ variable is omitted from the right hand side of the equation because it is used directly to calculate the dependent variable.

3. Results

3.1. Sample firm and offering characteristics. Table 1 shows a breakdown of IPOs by year in our three sub-samples. As the results in Table 1 indicate, there is a pronounced cycle in the volume of IPOs during the sample period. In particular, most of the IPOs in this sample list during the 2004-2007 period, with a marked decrease in 2008 and 2009 due to the effects of the Global Financial Crisis. In line with the rest of the sample the majority of the PE backed IPO listings occur during the 2004-2007 period, which can be explained by increased activity in the private equity sector, coincident with the relatively low-cost and easily available debt finance. As private equity funds grew to record levels in the past decade and debt has remained relatively cheap, we have seen a boom in private equity activity (Klier et al., 2009). The consequence of this increased investment is an increase in the selling and exiting activity by private equity funds; hence it is later on in the sample period that we see an increase in the number of PE backed IPOs.

Table 1. Private equity (PE) backed, non-sponsored and venture capital (VC) backed IPOs listed between 2000 and 2009 on a major stock exchange in the US

Offer year	Private equity (PE) backed			Non-sponsored IPOs			Venture capital (VC) backed		
	N	%	PE as % of all IPOs	N	%	Non-sponsored as % of all IPOs	N	%	VC as % of all IPOs
2000	14	5.28	0.85	42	5.21	2.56	24	4.20	1.46
2001	12	4.53	0.73	38	4.71	2.31	22	3.85	1.34
2002	18	6.79	1.10	56	6.95	3.41	39	6.82	2.37
2003	11	4.15	0.67	24	2.98	1.46	17	2.97	1.03
2004	42	15.85	2.56	152	18.86	9.25	116	20.28	7.06
2005	53	20.00	3.23	144	17.87	8.76	122	21.33	7.43
2006	65	24.53	3.96	199	24.69	12.11	125	21.85	7.61
2007	42	15.85	2.56	125	15.51	7.61	94	16.43	5.72
2008	3	1.13	0.18	11	1.36	0.67	6	1.05	0.37
2009	5	1.89	0.30	15	1.86	0.91	7	1.22	0.43
Total	265	100.00	16.13	806	100.00	49.06	572	100.00	34.81

Note: Sample IPOs listed on NYSE Euronext, NYSE Amex Equities or NASDAQ between January 2000 and December 2009 (inclusive); *N* is the number of PE backed, non-sponsored or VC backed IPOs listed in a particular year; % is the number of IPOs in a particular year as a proportion of the total sample.

In a review of the IPO literature of the past three decades Ritter and Welch (2004) illustrate that the level of underpricing changes over time. Furthermore, Ritter (1984) documents that the level of first day returns tend to be clustered by industry. We partition our sample using both SIC and SDC industry classifications[1]. The SIC industry with the most IPOs in our sample is the Business Services industry (SIC code 73) with 23.1% of the companies. SDC industry classification indicates that manufacturing industry represents 35.7% of all transactions in our sample[2].

Table 2 provides an overview of the firm and offering characteristics for the three sub-samples and indicates there are differences in important firm and offer characteristics, such as company age, company size, offer proceeds and initial returns between the groups. There are also indications that firm' profitability (ROA) and the level of retained ownership by the pre-IPO investors may be different between the three sub-samples.

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[1] SIC is the US Standard Industrial Classification system while SDC is the Security Data Company.

[2] For the sake of conciseness of our paper we do not tabulate the two industry classifications for our sample.

Table 2. Firm and offering characteristics for PE backed, non-sponsored and VC backed IPOs

Variable		Private equity (PE) backed IPOs	Non-sponsored IPOs	Venture capital (VC) backed IPOs
Initial return (percent)	Mean	7.0	14.3	23.4
	Median	4.8	5.6	16.9
	Std. dev.	10.0	24.6	30.0
	Minimum	-13.6	-10.1	-13.5
	Maximum	39.6	135.3	156.3
Adj. initial return (percent)	Mean	2.3	3.3	4.4
	Median	1.2	1.7	3.6
	Std. dev.	3.6	4.9	5.4
	Minimum	-3.0	-5.0	-4.9
	Maximum	16.6	23.0	25.5
Age (years)	Mean	25.8	24.2	9.9
	Median	18.4	12.3	8.2
	Std. dev.	26.9	30.7	6.5
	Minimum	0.5	0.3	1.5
	Maximum	124.0	159.0	44.1
IPO proceeds ($ millions)	Mean	288.6	196.4	95.1
	Median	188.5	113.9	80.0
	Std. dev.	258.5	246.5	75.9
	Minimum	53.9	7.0	19.2
	Maximum	1,432.2	1,581.1	531.3
Pre-IPO assets ($ millions)	Mean	1,260.9	570.9	133.1
	Median	563.3	200.0	46.5
	Std. dev.	2,311.9	1,016.8	239.0
	Minimum	54.6	0.3	3.4
	Maximum	19,465.4	6,634.4	2,127.0
Underwriter-market share (percent)	Mean	10.1	7.5	8.9
	Median	7.8	6.0	7.6
	Std. dev.	6.6	8.0	7.4
	Minimum	0.0	0.0	0.0
	Maximum	32.5	32.5	32.5
ROA	Mean	7.0	1.8	-14.6
	Median	6.7	6.1	-3.3
	Std. dev.	11.5	64.9	44.8
	Minimum	-49.3	-304.6	-242.8
	Maximum	64.6	422.3	83.9
Retained ownership (percent)	Mean	69.3	66.2	75.0
	Median	70.0	74.8	77.6
	Std. dev.	16.1	24.1	12.6
	Minimum	15.0	0.0	14.7
	Maximum	96.5	96.7	94.2
Offer price ($)	Mean	16.9	14.8	13.7
	Median	16.0	15.0	14.0
	Std. dev.	6.3	6.1	4.4
	Minimum	7.5	4.0	6.0
	Maximum	65.0	36.0	31.0

Note: Initial return is the percent of return between the subscription price and the first trading day closing price. Adjusted initial return is calculated as [(1−% retained ownership) * initial return]. Age is the number of years between company inception and IPO listing date. IPO proceeds is the $ value raised in the offer; pre-IPO assets are measured as total assets before the IPO. Underwriter market share is the percent market share of the lead underwriter in the year of the IPO. ROA is the pre-IPO return on assets. Retained ownership is the percent of ownership retained by the pre-IPO investors. Offer price is the $ value of the subscription price per share in the IPO.

To confirm whether these differences are statistically significant, we test these differences in offer and firm characteristics between sub-samples and report the results in Table 3. Supporting our hypothesis one, headline underpricing (as measured by the initial return) is significantly different between the three sub-samples. Private equity backed deals exhibit the lowest levels of underpricing with a mean initial return of 7%, which is statistically different from both venture backed and non-sponsored IPOs at the 1% level. In contrast to Megginson and Weiss (1991), but consistent with Lee and Wahal (2004), we find that venture capital backed firms have the highest level of underpricing with a mean of 23.4% which is statistically different from the private equity IPO underpricing at the 1% level and the non-sponsored IPO underpricing at the 5% level.

Using the Habib and Ljungqvist (2001) adjusted measure for underpricing we get a somewhat different perspective on initial returns by estimating the original owner's wealth change post-IPO. By multiplying the initial return by the proportion of stock sold in the offering we get a better measure of the actual wealth loss to the issuer associated with the underpricing. The t-statistics in Table 3 indicate that

the only significant difference in wealth loss (adjusted initial return) between the sub-samples (at conventional levels) is between private equity backed IPOs and venture capital backed IPOs (the difference is significant at the 1% level). Thus, although there is a significant difference in the level of underpricing across the three sub-samples, the difference in wealth loss due to underpricing is only significant between the PE and VC backed IPOs (where VC backed IPOs suffer significantly greater loss than PE backed IPOs).

Table 3. Difference in mean tests of firm and offering characteristics for PE backed, non-sponsored and VC backed IPOs

Variable	t-statistic (PE, non-sponsored)	t-statistic (PE, VC)	t-statistic (non-sponsored, VC)
Initial return (percent)	2.773*** (0.006)	5.217*** (0.000)	2.355** (0.020)
Adj. initial return (percent)	1.560 (0.120)	3.166*** (0.002)	1.493 (0.137)
Age (years)	0.386 (0.700)	5.788*** (0.000)	4.594*** (0.000)
IPO proceeds ($ millions)	2.596** (0.010)	7.220*** (0.000)	3.948*** (0.000)
Pre-IPO assets ($ millions)	2.746*** (0.006)	4.963*** (0.000)	4.405*** (0.000)
Underwriter-market share (percent)	2.471** (0.014)	1.161 (0.247)	1.292 (0.198)
ROA	0.797 (0.426)	4.697*** (0.000)	2.088** (0.038)
Retained ownership (percent)	1.059 (0.291)	2.841*** (0.005)	3.262*** (0.001)
Offer price ($)	2.507** (0.013)	4.211*** (0.000)	1.383 (0.168)

Note: *t*-statistics and *p*-values (in parenthesis) are for the difference in means between the three groups (PE backed, VC backed and non-sponsored IPOs). *, **, *** Significant at alpha 0.10, 0.05 and 0.01 level, respectively.

Table 3 indicates there are statistically significant differences in the IPO proceeds and in the total assets prior to the IPO between three sub-samples. Private equity backed deals raise significantly more on average than both counterparts (mean proceeds of $288.6 million) and again, in contrast to Megginson and Weiss (1991), the lowest average proceeds are in venture capital backed deals (mean proceeds of $95.1 million). This same relationship can be seen for pre-IPO assets. Private equity backed deals have the largest mean total assets ($1,260.9 million) and venture capital backed deals have the smallest mean assets ($133.1 million). These findings regarding firm size are consistent with the predicted effect in our hypothesis two. Private equity funds tend to invest in mature, stable businesses which are then sold via IPO; hence, these firms and IPOs are larger than non-sponsored and venture capital backed IPO firms.

Part of the explanation for the significantly smaller size of venture capital backed firms and IPOs may be the average age of the firms in each of the sub-samples. We would expect older firms to be larger by total assets and therefore able to raise more at IPO. The results in Table 2 are consistent with this reasoning; VC backed companies have a mean age of 9.9 years compared to 25.8 years for PE backed IPOs and 24.2 years for non-sponsored IPOs. Thus, the age of VC backed firms is significantly lower compared to PE backed and non-sponsored IPOs. However there is no statistically significant difference in the age between non-sponsored and PE backed firms, indicating that age cannot explain the difference in firm and offering size for these two categories. Thus, the findings provide only partial support for hypothesis three as there is no significant difference in the firm age between PE backed and non-sponsored firms that undertook an IPO during the sample period. In other words, only VC backed IPOs are significantly younger firms. Muscarella and Vetsuypens (1989a) document a negative relationship between firm age and initial return. The results in Table 2 and Table 3 support their finding as VC backed firms (which are the youngest on average) do in fact exhibit the highest initial returns (where VC backed IPO underpricing is significantly higher compared to PE backed and non-sponsored IPOs).

Another important characteristic to examine is the percentage of ownership retained by the existing shareholders in the post-IPO company. Habib and Ljungqvist (2001) highlight the importance of this figure as they believe the larger the stake sold in the IPO by the owners the more the owner is concerned about the level of underpricing due to the amount of money that may be left on the table. On average, VC backed deals see the largest stake retained post IPO at 75% on average (see Table 2). Hence, based on Habib and Ljungqvist (2001) we would expect to see lower levels of underpricing in venture capital backed IPOs compared to the other two groups, which is however not the case in our sample. Moreover, there is no statistically significant difference in the mean percentage of ownership retained between PE backed and non-sponsored IPOs.

3.2. Regression results. *3.2.1. Standard underpricing model.* Table 4 provides bivariate Pearson correlations between the explanatory variables as well as the dependent variables. There is a high positive correlation between the two definitions of initial returns, *UP* and adjusted *UP*, which is self evident (with a correlation coefficient of 0.86). Furthermore, there is a high positive correlation between two explanatory variables, *LN_ASSETS* and *LN_PROCEEDS* (correlation coefficient of 0.76). The latter relationship is controlled for in our regression models by using alternative combinations of explanatory variables as outlined below.

Table 4. Correlation matrix (Pearson bivariate correlations)

Variable	Initial return	Adj. initial return	PE	VC	SEO	LN_AGE	LN_ASSETS	LN_PROCEEDS	MKT_SHARE	ROA	RETAINED
Initial return	1.00										
Adj. initial return	0.86	1.00									
PE	-0.33	-0.14	1.00								
VC	0.16	0.15	-0.40	1.00							
SEO	0.03	0.12	0.16	0.06	1.00						
LN_AGE	-0.13	-0.03	0.18	-0.23	0.04	1.00					
LN_ASSETS	-0.19	-0.17	0.22	-0.16	0.18	0.17	1.00				
LN_PROCEEDS	0.24	0.21	0.17	-0.11	0.16	0.08	0.76	1.00			
MKT_SHARE	0.15	0.08	0.11	0.01	0.01	0.05	0.26	0.36	1.00		
ROA	0.03	0.00	0.13	-0.14	0.01	0.12	0.24	0.26	0.10	1.00	
RETAINED	0.26	0.53	-0.03	0.19	0.04	-0.10	-0.03	0.02	0.06	0.08	1.00

We perform the underpricing regression in two steps. First, we estimate the standard underpricing model. Second, we estimate the adjusted underpricing model. In Table 5, Panel A, we report the results for the standard underpricing model. Regression model one is a standard OLS regression using all observations, model 2 uses variables adjusted to eliminate any outliers as a means of robustness and in regression model three we exclude the *LN_ASSETS* variable to avoid any collinearity with *LN_PROCEEDS* variable. Regression model three also includes the SEO dichotomous variable[1].

Table 5. Initial returns and adjusted initial returns of PE backed, non-sponsored and VC backed IPOs

Panel A	(1)	(2)	(3)
Intercept	-0.246 (3.239)***	-0.313 (2.371)**	-0.264 (2.881)***
PE	-0.096 (-4.264)***	-0.101 (-4.564)***	-0.110 (-4.610)***
VC	0.036 (1.010)	0.052 (1.123)	0.048 (1.089)
SEO			0.039 (0.924)
LN_AGE	-0.008 (-0.082)	-0.012 (-0.094)	-0.012 (-0.093)
RETAINED	0.207 (3.143)***	0.224 (3.204)***	0.202 (3.058)***
LN_ASSETS	-0.028 (-2.142)**	-0.032 (-2.205)**	
LN_PROCEEDS	0.071 (3.975)***	0.094 (4.207)***	0.046 (2.469)**
MKT_SHARE	0.338 (1.829)*	0.241 (1.805)*	0.312 (1.912)*
ROA	0.035 (0.925)	0.044 (1.052)	0.033 (0.984)
NYSE	0.032 (0.957)	0.043 (1.060)	0.062 (1.298)
NASDAQ	0.074 (2.035)**	0.055 (1.452)	0.097 (3.382)***
Year dummy	YES	YES	YES
Model F	3.728***	3.894***	3.649***
Adjusted R²	0.277	0.32	0.266
N	1643	1465	1616
Panel B	(1)	(2)	(3)
Intercept	-0.016 (0.542)	-0.022 (0.653)	-0.022 (0.679)
PE	-0.010 (-0.261)	-0.013 (-2.146)**	-0.013 (-2.204)**
VC	0.002 (0.736)	0.006 (0.948)	0.006 (0.927)

[1] In regression model three we truncate the sample for those IPOs listed in 2009 because the information on a subsequent SEO within three years was not available for all observations. Thus, the number of observations is reduced by 27 companies in regression model three.

Table 5 (cont.). Initial returns and adjusted initial returns of PE backed, non-sponsored and VC backed IPOs

Panel B	(1)	(2)	(3)
SEO			0.013 (2.205)**
LN_AGE	0.001 (0.113)	0.001 (0.113)	0.000 (0.041)
LN_ASSETS	-0.007 (-2.086)***	-0.008 (-2.105)***	
LN_PROCEEDS	0.014 (3.901)***	0.017 (4.058)***	0.007 (1.916)*
MKT_SHARE	0.060 (0.240)	0.033 (0.172)	0.053 (0.213)
ROA	0.004 (0.126)	-0.001 (-0.085)	0.004 (0.136)
NYSE	0.005 (0.121)	0.005 (0.122)	0.013 (0.420)
NASDAQ	0.017 (2.059)**	0.011 (1.320)	0.023 (3.476)***
Year dummy	YES	YES	YES
Model F	3.317***	3.428***	3.192***
Adjusted R²	0.132	0.153	0.111
N	1643	1465	1616

Note: The sample includes PE backed, VC backed and non-sponsored IPOs listed between 2000 and 2009 on a major US stock exchange. Cell values represent unstandardized regression coefficients for individual variables, with corresponding t-statistics in parenthesis. Dependent variable is the initial return measured as the percent return between the subscription price and the first trading day closing price in Panel A. Dependent variable in Panel B is the adjusted initial return. *PE* is a dichotomous variable with unity representing PE backed IPOs and zero otherwise. *VC* is a dichotomous variable, where unity indicates VC backed IPOs and zero otherwise. *SEO* is a dichotomous variable with unity representing companies that conducted a seasoned offer of equity after the IPO. *LN_AGE* is a natural logarithm of the number of years between company inception and IPO listing date; *LN_ASSETS* is a natural logarithm of the $ value of total assets before the IPO. *LN_PROCEEDS* is a natural logarithm of the $ value of IPO proceeds. *MKT_SHARE* is the percent market share of the lead underwriter in the year of the IPO. *ROA* is the pre-IPO return on assets. *RETAINED* is the percent of ownership retained by the pre-IPO investors. *NYSE* is a dichotomous variable with unity representing NYSE Euronext listed companies and zero otherwise. *NASDAQ* is a dichotomous variable with unity indicating a sample company listed on NASDAQ and zero otherwise; *Year dummy* are dichotomous variables, where unity designates IPOs listed in particular calendar year and zero otherwise. *, **, *** significant at alpha 0.10, 0.05 and 0.01 level, respectively.

The results show that the explanatory variables have a moderate ability to explain listing day returns, with adjusted R^2 of 27.7% for the full sample and 32.0% when outliers are removed (regression models 1 and 2 in Table 5, Panel A). The *PE* variable has a significant negative effect on initial returns, as hypothesized, in all three models, indicating that private equity backed IPOs have lower initial returns. Thus, the results in Table 5, Panel A support our hypothesis 1.

However, VC backed IPO dichotomous variable is not significant. This is in contrast to previous research which finds that venture capital backing does have significant explanatory power of initial returns (Megginson and Weiss, 1991; Barry et al., 1990; Robinson et al., 2004). We find no evidence of signaling by underpricing as the SEO variable is insignificant in regression model three in Table 5, Panel A. Thus, our results do not provide support for the theory put forward by Welch (1989) that firms underprice in order to raise more in follow-on-offerings. The firm age variable is also insignificant in all regression models in Table 5, Panel A.

Habib and Ljungqvist (2001) argue that the higher the level of shares retained by the issuers, the less they stand to lose from underpricing so the less effort they expend in reducing underpricing. The positive sign on the coefficient of *RETAINED* confirms this prediction. As the stake retained increases, so too does the level of underpricing as the issuer stands to lose less in this scenario than if they were to sell more shares in the IPO.

The regression models in Table 5, Panel A, confirm the relevance of some other variables used to explain underpricing in previous research. Lead underwriter market share, firm size, and offer size all prove to be significant (with underwriter market share variable significant at the 10% level). There is a positive relationship between offer proceeds and underpricing, as well as between underwriter prestige and underpricing (Booth and Smith, 1986; Carter and Manaster, 1990). These results are perhaps counter-intuitive as we would expect smaller offers and less prestigious underwriters to be associated with smaller, riskier companies where there is a greater degree of information asymmetry and hence under-

pricing (Beatty and Ritter, 1986). The *MKT_SHARE* variable provides support for the findings of Beatty and Welch (1996), and Robinson et al. (2004) who find that reputable underwriters are associated with more underpriced IPOs. Consistent with Ritter and Welch's (2002) findings, we find that IPOs listed during the technology boom of 2000 experience significantly higher level of underpricing[1]. A potential explanation for the effect of underwriter prestige variable is that many highly speculative firms, even those with no revenues, were able to float successfully during the technology boom (Ritter and Welch, 2002). This results in an increased level of uncertainty in the IPO market and hence higher levels of underpricing. Similar reasoning may also explain why firms in our sample listing on NASDAQ experience higher returns[2] (a relatively large proportion of start-up and speculative technology companies list on NASDAQ).

3.2.2. Adjusted underpricing model. The second model we estimate is the adjusted underpricing regression, with the results presented in Table 5, Panel B. Again, we estimate three different versions of the regression model. Regression model 1 is the original adjusted underpricing model, regression 2 has been adjusted for outliers as a means of robustness and regression three does not include the *LN_ASSETS* variable, while including the *SEO* variable. The adjusted underpricing model adjusts the standard underpricing formula to estimate the issuer wealth loss. This is done by multiplying the standard underpricing equation by the amount sold by the issuer $(1 - RETAINED)$. Given that we use the *RETAINED* variable in the calculation of the dependent variable, it is no longer included as an explanatory variable in regression models in Table 5, Panel B.

The adjusted underpricing model has less explanatory power than the regression model for headline underpricing, with adjusted R^2 ranging between 11.1% and 15.3% in Table 5, Panel B. These lower R^2 results can largely be explained by the fact that the explanatory variables included in the adjusted underpricing model are the same variables that are normally used to explain headline underpricing, not wealth loss measured by adjusted underpricing. There are some notable differences between the two models nonetheless.

The *PE* variable is not significant when explaining adjusted underpricing in regression model 1 in Table 5, Panel B. When we adjust for outliers and exclude the *LN_ASSETS* from the regression models the *PE* variable becomes significant at the 5% level (in regression models 2 and 3 in Table 5, Panel B). A partial explanation for the weakening of this relationship when looking at adjusted underpricing is that venture capital IPOs experience larger retention rates by existing owners in our sample. This lowers the level of adjusted underpricing closing the gap between underpricing in venture capital backed, private equity backed and non-sponsored IPOs. Moreover, the *SEO* indicator becomes significant at the 5% level in regression model three. This may indicate that issuers are willing to bear a greater loss of wealth at the IPO if they are planning on raising money in an *SEO*. Leland and Pyle (1977) and Allen and Faulhaber (1988) support this by conveying models that use ownership retention as a signal of IPO quality. Reflecting the results for headline underpricing, IPOs listed in 2000 experience significantly greater levels of adjusted underpricing then IPOs listed in other years[3]. The choice of listing exchange impacts the issuer wealth loss as the NASDAQ variable is significant and positive (in regression model 1 and in regression model 3).

Discussion and conclusions

Researchers make inferences about relative levels of information advantage of participants in the IPO process by analyzing alternative scenarios such as underwriter's own IPO (Muscarella and Vetsuypens, 1989a), venture capital backed IPOs (Megginson and Weiss, 1991; Barry et al., 1990), or private equity backed IPOs, as it is done in this research. Examining private equity backed IPOs allows us to re-examine some previously advanced explanations for underpricing. Gompers (1996) contends that venture capital issuers underprice in order to "leave a good taste in investors' mouths" in the hope that they would invest more in future funds raised by the venture capital firm. The results in this research suggest that the "grandstanding" hypothesis does not apply to private equity firms as underpricing is in fact lower in PE backed IPOs.

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[1] For brevity, we only use *Year dummy* designation in Table 5 and do not report regression coefficients for each year dichotomous variable used in regression models. Year 2000 dichotomous variable coefficient is significant at the 1% level in regression models one and two in Table 5, and at 5% level in regression model 3. The remaining year dichotomous variables coefficients are not significant at conventional levels.
[2] Regression models 1 and 3 in Table 5, Panel A.

[3] Year 2000 dichotomous variable coefficient is significant at the 1% level in all regression models in Table 5, Panel B. The remaining year dichotomous variables are not significant at conventional levels. In additional analyses, we split the sample into two sub-periods to verify the robustness of our results (where the first period is between 2000 and 2004 and the second period is between 2005 and 2009). The results for the two sub-periods are not significantly different and generally support the results of the regression analyses in Table 5 for the whole sample period. Thus, for the sake of conciseness we do not tabulate these additional results.

The results do, however, provide support for two separate, but not necessarily mutually exclusive conjectures. Previous research into VC backed IPOs suggests that the certification of these IPOs by the VC firm leads to a lower level of information asymmetry and hence less underpricing is required (Megginson and Weiss, 1991; Barry et al., 1990). Private equity firms must too rely on their reputation as astute investors in order to raise future funds, and given that PE firms are often larger and higher profile than VC firms, this certification role might be even stronger in PE backed IPOs. Furthermore, Loughran and Ritter (2003) suggest that an investment bank is usually more concerned with the buyers of the IPO stock than the sellers, because investment banks expect to earn more revenue from these institutional clients (the buyers) in the future through brokerage and research services. This situation changes dramatically when a private equity firm has an ownership stake in the IPO company. Private equity firms are frequently buying, selling and restructuring companies. This often requires the assistance of an investment bank, potentially providing substantial future fees to investment banks (Booth and Smith, 1986). Therefore, private equity firms are important clients of investment banks, giving PE firms considerable power over the IPO pricing decision. The consequence is a change in the balance of power in setting the offer price in favor of the issuer (i.e. the private equity firm).

In conclusion, supporting our hypothesis 1, we find evidence that IPOs backed by a private equity firm exhibit significantly lower level of underpricing than concurrent non-sponsored IPOs or VC backed IPOs. A comparison of PE backed IPOs with VC backed and non-sponsored IPOs indicates that the companies brought public by private equity firms raise significantly more funds at the IPO, are significantly larger by assets and are subject to significantly lower levels of underpricing compared to both VC backed and non-sponsored IPOs. The key results in our regressions are supported after controlling for outliers and potential collinearity problems. We also find support for our hypothesis 2 where PE backed IPOs are significantly larger than other IPOs (as measured by total assets or expected market capitalization). PE backed IPO firms also have significantly longer track record than VC backed IPO firms (measured by company age) but are not significantly older than non-sponsored IPO firms. Thus, we find only partial support for our hypothesis 3.

The results lead us to infer that underpricing is in part related to the potential future revenue the underwriter can earn from either the issuer or from outside investors. The implicit assumption of this proposition is that investment banks will alter the extent of underpricing to please either the issuing client or IPO investors, depending on which group they believe is capable of providing the bank with more future revenue. Obviously, this proposition requires rigorous empirical testing and, therefore, this may be an important issue to be considered in future IPO research.

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