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Underpricing of Sponsor Backed and Non-Sponsor Backed IPOs in US Market

by

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“There is no substitute for hard work.”
Thomas A. Edison

Abstract

The dissertation examines the underpricing of sponsor-backed (private equity backed and venture capital backed) and non-sponsor backed initial public offerings (IPOs) listed on all US stock exchanges between January 1997 and December 2017. The authors identify 403 PE-backed IPOs, 179 VC-backed IPOs and 1469 non-sponsor (non-PE and non-VC) backed IPOs. Evidence suggests that PE-backed firms are larger, older and more highly levered than VC counterparts. Following, the level of underpricing of PE-backed IPOs are then compared with VC-backed and non-sponsor backed counterparts. Results indicate that sponsor-backed IPOs experience lower levels of underpricing and among these three groups, on average, PE-backed IPOs experience the lowest level of underpricing. After controlling for individual firm characteristics, on average, the study finds limited support for certification effect of sponsor-backing. The relationships between certification effect and the three variables (size, age and leverage) are further analysed in both VC and PE groups. The study found statistically significant evidence which suggests that firm age has an inverse relationship with the extent of certification effect in PE-backed IPOs.

Keywords: Initial public offering, venture capital, private equity, sponsor, underpricing

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1 Introduction

Initial public offering (IPO) is the first launch of public offering where equity shares of companies are made available to the general public. An IPO is an opportunity for the company to raise equity capital and transform from a private entity to a public entity (Ritter and Welch, 2002). From the perspective of venture capital and private equity firms, IPO is an option for them to exit their investments. The first day price performance of IPOs is also one of the most widely researched phenomena (i.e. Ibbotson, 1975; Beatty and Ritter, 1986; Booth and Smith, 1986; Miller and Reilly, 1987; Ibbotson, Sindelar and Ritter, 1988; Grinblatt and Hwang, 1989; Chalk and Peavy, 1989; Barry, Muscarella, Peavy, and Vetsuypens, 1990; Ritter, 1991; Brav and Gompers, 1997).

Studies document that on average, IPOs experience significant underpricing. This is defined as the percentage difference between initial offer price and closing bid price on the first day of trading. First day closing price represents the price investors are willing to pay for the firm's shares. If the offer price is lower than first day closing price, the offering is deemed underpriced. This underpricing phenomenon, also referred as "money left on the table", has drawn large amount of attention and interest from researchers. The role of a sponsor in an IPO is likely to influence the degree of underpricing. Van der Geest and Van Frederikslust (2001) found evidence that non-sponsor backed IPOs are more underpriced than private equity backed and venture capital backed IPOs. Barry et al. (1990) and Megginson and Weiss (1991) also argue that non-sponsor backed IPOs are more underpriced than venture capital backed IPOs. They contend that this is due to the "certification effect" of the sponsor, where the backing of these specialists certifies the price of firm's IPO and thus should have a significant and negative effect on underpricing. Megginson and Weiss (1991) demonstrate the certification effect of venture capitalists on venture capital backed IPOs, indicating that venture capital backed firms are able to engage underwriters and auditors that are of higher quality and garner greater institutional awareness compared to non-venture capital backed IPOs. Sponsors exert certification effect on their issues by the reduction of informational asymmetry among investors, issuing company and financial agencies that participate in the offering, contributing to lower underpricing.

Sponsor-backed IPOs in this paper refer to IPOs of firms that are backed by venture capital firms (VC) or private equity (PE) firms. Financial sponsors are investors whose core activity is to take temporary equity stakes in firms with the goal of achieving

financial gains. Both venture capital and private equity firms provide strategic and operational expertise and financing to the target companies (Metrick and Yasuda, 2011). Private equity and venture capital firms provide an alternative form of financing available to firms as opposed to traditional means of financial intermediaries such as angel investors and banks. They ameliorate corporate governance, lessen agency costs of equity and provide certification (Jensen 1986, 1989; Baker and Wruck, 1989; Baker and Gompers, 2003; Acharya, 2009; Hochberg, 2011).

Private equity is the provision of equity capital by financial investors to buyout a private or public firm. Private equity firms invest capital in companies following due diligence, and then engage in streamlining and improving financial health of companies with the aim of exiting at a substantial profit (Baker and Gompers, 2003; Kanagaretnam, Krishnan and Lobo, 2009; Cornelli and Karakas, 2010).

Conversely, venture capital companies are made up of small teams with deep industry experience. They pool capital and invest in firms that are deemed too risky for traditional capital markets and banks. These firms are usually unprofitable or do not have a commercial product (Fraser-Sampson, 2011). The top sectors by deal activity in US are internet, healthcare, as well as mobile and telecommunication sectors (PricewaterhouseCoopers and CB Insights, 2018).

The study of private equity and venture capital companies' role in underpricing is highly relevant. After the global financial crisis in 2008, there is a growing trend in private capital market which has potential implications for investors. Venture capital investment in private US companies increased substantially from $31,2b in 2006 to $77,3b in 2015 (Ernst & Young, 2017). The value of global buyout-backed exits via initial public offerings by private equity companies has generally increased in the period from 1995 to 2017 (Bain & Company, 2018). The need for better understanding and clarity on effects of private equity and venture capital companies in initial public offerings motivate research in this area.

Previous research has focused on analysing the underpricing differential between regular and venture capital backed IPOs (i.e. Barry, Muscarella, Peavy, and Vetsuypens, 1990; Megginson and Weiss, 1991; Gompers, 1996; Habib and Ljungqvist, 2001; Lee and Wahal, 2004; Loughran and Ritter, 2004). Concurrently, private equity backed IPOs have been largely neglected by mainstream academic research. Although there are a large number of studies examining IPO underpricing, there are very few studies that have dived into the underpricing in IPOs backed by private equity firms. There are also

limited studies that compared the underpricing in PE-backed IPOs and VC-backed IPOs.

Despite an alarming number of IPOs being backed by both private equity and venture capital, there is a significant gap in the literature with regard to analysing the underpricing differential between PE-backed, VC-backed and regular IPOs and the relationships between firm characteristics and certification effect of these two groups of sponsors.

In this paper, we investigate if underpricing differential exists between private equity backed, venture capital backed and regular IPOs in United States from 1997 to 2017. We further explore if there is significant certification effect after controlling for individual firm characteristics. We also study how certification effect varies with firm characteristics (size, age and leverage) of the issuing companies through the use of interactive terms in underpricing regressions.

There are two distinguishing aspects of this paper compared to underpricing literature available. The period included for this study covers two stock market cycles, thereby providing holistic insights on the certificatory role of private equity and venture capital companies on initial returns over market cycles. This paper also takes into account of variables claimed to affect underpricing in various IPO literatures, thus the underpricing regression model can be considered to be comprehensive as we attempt to extensively cover possible explanations for underpricing of IPOs. This would allow us to better identify the key characteristics that are driving the underpricing.

In line with performance reported in prior literature, private equity and venture capital backed IPOs are less underpriced than non-sponsor backed IPOs. However, contrary to our expectation, the presence of private equity and venture capital companies analysed in the sample of IPOs does not exhibit statistical significance to its initial returns, suggesting that the certificatory role of sponsors has limited support. The study also found a statistically significant inverse relationship between firm age and the extent of certification effect in PE-backed IPOs.

This paper is organized as follows. Section 2 provides an overview of the relevant literature and develops the research hypotheses. Section 3 describes the methods used in this research. Section 4 discusses about the sample selection criteria and statistics summary based on sample data. Section 5 analyses results from the underpricing regression models. Section 6 states the conclusion of our findings and discusses the limitations and opportunities for future research.

2 Literature/Theoretical Review

2.1 Private Equity and Venture Capital

Private equity is the provision of equity capital by financial investors to buyout a private or public firm. Private equity firms invest capital in companies following due diligence, and then engage in streamlining and improving financial health of companies with the aim of exiting at a substantial profit (Baker and Gompers, 2003; Krishnan et al., 2009; Cornelli and Karakas, 2010). Private equity firms are intermediaries which raise funds and manage investments of these funds. These funds have a typical lifespan of 10 to 12 years and are usually closed-end (Stein, 2005). Investments are characterised to be in the late stage of businesses (i.e. older and larger firms). 44.16% of PE-backed IPOs in the period from 1981 to 2006 are concentrated in the manufacturing industry (Cao, 2011).

Limited partners (LPs) contribute most of the capital in a PE fund and usually include investors such as insurance firms, university endowments, pension funds and high net worth individuals (Kaplan and Strömberg, 2009). Private equity firm is known as the general partner (GP) of the fund and is in charge of the management of the fund. The GP usually injects its own equity into the fund.

Conversely, venture capital firms are made up of small teams with deep industry experience. They pool capital and invest in firms that are deemed too risky for traditional capital markets and banks. These firms are typically unprofitable or do not have a commercial product (Fraser-Sampson, 2011). The top sectors by deal activity in US are internet, healthcare, as well as mobile and telecommunication sectors (PricewaterhouseCoopers and CB Insights, 2018). Venture capital investments can be defined as professionally managed and independent pools of capital which focus on the equity investment of privately held, young, entrepreneurial and high growth firms (Gompers and Lerner, 2001). They therefore fill a gap in the market by providing financing for young startups. Venture capital firms invest their capital in aspiring companies after performing due diligence, and then engage in active monitoring and consulting activities with these companies. Venture capital firms add value by providing strategic and managerial expertise and advice, accelerating the growth of

their entrepreneurial portfolio companies. Venture capital funds have a typical life span of 8 to 12 years in which they will enter and exit all their investments.

The involved risk in venture capital investments is on average, higher than the risk of PE investment. This is due to higher variability of success of young start-up firms. Consequently, the expected returns in venture capital investments surpass its PE counterparts.

2.2 IPO as an Exit Route

Traditional exit routes for PE and VC investments are trade sales, secondary buyouts and IPOs (Povaly, 2007). They can be partial or full exit.

IPO is a possible exit route for PE and VC firms as it offers a way to exit by selling the ownership stake of a company in its portfolio. This method is likely to realise the highest return on the investment when the stock market is on its bull run (Pastor and Veronesi, 2005). In particular, the IPO offers best return from investments and enhances reputation of VC firms (Jain and Kini, 1995; Lin, 1996).

For most IPOs, PE and VC firms do not fully exit the portfolio company due to the following two reasons (Folus and Boutron, 2015). The first reason is because potential public investors will likely view this as a lack of confidence in the future prospects of the business. The second reason is because usually, PE and VC firms are subjected to a lock-up agreement with the underwriters. This agreement prevents them from divesting their shares till 6 to 12 months after IPO (Povaly, 2007).

Another common exit route includes trade sales. The financial sponsor realises gains in its investment by selling it to a strategic buyer (Prijcker and Maeseneire, 2013). The strategic acquirer is commonly a non-PE/VC firm, pursuing the acquisition with strategic motives in mind. They can involve synergies, innovative products, unique patents and market power. Acquirer can also be the portfolio company, repurchasing its shares from the PE/VC firm.

The other common exit route is secondary buyouts. The financial sponsor sells its portfolio company to another financial sponsor in a buyout transaction that may be leveraged. Motives for secondary buyout include realising a high rate of return,

reaching a minimum investment period or unsuitability of the financial sponsor to take the portfolio company through its next development stage (Achleitner and Figge, 2014; Arcot, Fluck, Gaspar and Hege, 2015).

Trade sales is the most common exit route, making up 38% of the exits in the period between 1970 and 2007 in the world. Secondary buyout makes up 24% while the least common exit route is IPOs, making up only 14% (Kaplan and Strömberg, 2009). The reason for it is due to the lengthy and expensive process of the IPOs. IPOs are subjected to regulatory restrictions (i.e. the lock up agreement which prevents the sale of all shares immediately after an IPO) (Folus and Boutron, 2015).

2.3 Empirical Evidence and Theoretical Explanation of Underpricing

Ibbotson (1975) first documents the underpricing phenomenon as a mystery with no indicative explanation behind it. The phenomenon is later further confirmed by Ritter (1984a). Over time, various theories to explain IPO underpricing have been developed. They include institutional explanations, behavioural reasons, ownership and control and informational asymmetry. The theories of IPO underpricing are generally attributed to the existence of pre-market informational asymmetry. According to Ljungqvist's (2004) survey, IPO underpricing phenomenon is best explained by information asymmetry. We expect information asymmetry to be most relevant in explaining the underpricing phenomenon and the underpricing differential between PE-backed, VC-backed and non-sponsor backed IPOs.

Information asymmetry refers to the difference in information availability to different parties involved in an offering. There are two distinct categories of information asymmetry in IPO underpricing. The first category is between the issuer and the underwriter (Baron and Holmström, 1980; Baron, 1982; Muscarella and Vetsuypens, 1989) while the other is between the underwriter and the investors or different classes of investors (Baron and Holmström, 1980; Rock, 1986; Grinblatt and Hwang, 1989; Beatty and Welch, 1996). Research by Beatty and Ritter (1986) and Benveniste and Spindt (1989) further emphasize the relation between information asymmetry and IPO underpricing.

Information asymmetry exists between underwriter and investors or different classes of investors. There are three theories supporting this assumption; (1) Signaling Theory (2) Adverse Selection (3) Information Revelation.

The first theory supporting the assumption is signaling theory. Investors are unable to determine the quality of a firm. According to Allen and Faulhaber (1989), good firms have incentive to signal their quality to raise equity on favourable terms. They are willing to incur cost of underpricing to signal their quality and the cost of signaling can be recouped via a seasoned equity offering in the future. Firms of poor quality are unable to replicate this strategy. The risk of being discovered in the post-IPO period is high and such discoveries will greatly affect the prospects of raising new capital. Poor quality firms instead find it most economically viable to price fully an IPO. However, these information asymmetries can also be reduced by financial intermediaries. Leland and Pyle (1977) suggest signaling theory, where financial intermediaries serve as a signal of firm's quality on the basis of their specialized information, hence reducing informational asymmetries. PE-backed and VC-backed firms are regarded as high quality firms with the support of industry experience, professional management expertise and capital from their sponsors. Due to the continual presence of fundraising and exits via IPOs, both PE and VC firms are unlikely to back a low-quality firm. Given the high visibility and degree of publicity of an IPO, the sponsors are likely to be reluctant to put their reputation at stake. PE and VC firms in this respect certify the quality of the firms going public.

The second theory is adverse selection. Rock (1986) argues that some investors are better informed than other parties, implying that there is information asymmetry between classes of investors. Informed investors are assumed to be able to differentiate profitable/underpriced and unprofitable IPOs. In accordance with Winner's Curse Hypothesis (Rock, 1986), due to information asymmetry, uninformed investors subscribe to IPOs indiscriminately while informed investors only subscribe to profitable IPOs. Due to excess demand, allocation of underpriced IPOs will be rationed. This results in uninformed investors getting rationed allocation of underpriced IPOs and full allocation of overpriced IPOs. Uninformed investors thus suffer from adverse selection and may experience negative returns. In order to entice uninformed investors to participate in the IPOs, on average, underpricing is necessary. It makes average rationing-adjusted returns positive and compensates uninformed investors for the risk of trading against informed investors. Studies by Johnson and Miller (1988), Thaler (1988), Koh and Walter (1989) Chowdhry and Sherman (1996) and Lee, Taylor and Walter (1996) further support the hypothesis. However, PE and VC backing are expected to lessen the adverse selection problem as the transmission of information is more uniform with greater transparency and public attention. The

increase in information spread reduces the informational gap between informed investors and uninformed investors. The strict due diligence conducted by PE and VC firms during the investment period will also increase the availability of public information of the firms. This decreases the information asymmetry between investors and reduce the uncertainty surrounding the true value of the firm. Ex-ante uncertainty about the underlying value of the firm is lessened which leads to decreased adverse selection.

The third theory is information revelation. During the book building process, underpricing is necessary to entice informed investors for information revelation as informed investors have an incentive to withhold information (Rock, 1986). Informed investors have more knowledge than the underwriter about the offer price and their own demand. During price discovery, informed investors have the incentive to withhold any information which leads to a positive price impact, in order to maximise their returns. Since price and size of issue are revised based on investors' indications of interest, investors are incentivized to understate their interest in the issue, reducing the investment price. Underwriters therefore use a discriminatory allocation system to favour informed investors who honestly reveal their information and indication of interests during the bookbuilding process. For the mechanism to function, underpricing is necessary. IPOs have to be underpriced to entice investors to seek inclusion and induce information revelation. The more positive the information, the greater incentive for informed investors to withhold it and the greater extent of underpricing is required to encourage information revelation. Carter and Manaster (1990) also produced a model similar to Rock and argue that investors have to be compensated through underpricing for the costs incurred during the process of information gathering. Benveniste and Spindt (1989) show underpricing as compensation to investors for truthful revelation of their private information to underwriters during bookbuilding process. This suggests that underpricing is necessary for information revelation. Further studies and literature also support the hypothesis of information revelation (Beatty and Welch, 1996; Habib and Ljungqvist, 1998; Rahman and Yung, 1999; Dunbar, 2000; Benveniste, Ljungqvist, Wilhelm and Yu, 2003). Similarly, as PE and VC firms are subjected to high public attention and media scrutiny, we expect them to be able to contribute higher informational homogeneity among different classes of investors. This will lessen ex-ante uncertainty about the true value of the firm, reducing information asymmetry and the need for underpricing. In this respect, the PE/VC firm will thus exert certification effect on the issuing firm.

Information asymmetry exists between issuers and underwriters. Baron and Holmström (1980) argue underwriters are better informed than issuers about market demand and market conditions. Underwriters then capitalise on this superior

information by inducing underpricing, minimising distribution efforts. The underwriter may employ the use of underpricing to oversubscribe an IPO to allocate shares to its recurrent investors, offering a positive initial return. The underwriter therefore entices them to continually participate in future offerings. Due to information disadvantage, issuers are compelled to accept this price. This reflects the agency costs between underwriters and issuers. Baron (1982) explains IPO underpricing as a way for issuing firms to compensate underwriters for employing their superior information on capital markets. Beatty and Ritter (1986) and Benveniste and Spindt (1989) established a significant relationship between the intermediation of underwriters and the degree of underpricing. By studying 1028 US IPOs from 1977 to 1982, Beatty and Ritter (1986) suggested that the underwriter is responsible for inducing the extent of underpricing.

Venture capital returns are largely dependent on its ability to list their portfolio companies publicly. Venture capital firms may favour underpricing to build their reputation, accelerate fund raising and generate higher returns for their investors (Lee and Wahal, 2004). With strong reputation, VC firms are thus more likely to raise their next round of funding and capable of earning higher management fees. This is known as the grandstanding hypothesis which explains the relation between underpricing and future fund-raising activity (Gompers, 1996; Francis and Hasan, 2001; Lee and Wahal, 2004; Rossetto, 2008). PE companies are specialised in restructuring, buying, managing and divesting firms (DeAngelo and DeAngelo, 1987). Similarly to VC firms, they may have strong interests to favour underpricing to create success stories by allocating shares to investors to generate repeated businesses. The notion of underpricing as an option to build strong reputation and generate higher returns may in this respect create an alignment of interests between underwriters and PE/VC. Both the underwriter and the PE/VC thus have the most information about market demand and market conditions, indicating that they may induce higher underpricing for their self-interests. Under these assumptions, certification effect of PE/VC is less relevant as information asymmetry between underwriter and investors may not be reduced.

We believe that sponsor-backed IPOs change the information asymmetry between different parties in an IPO. Megginson and Weiss (1991) claim that there are three essential criteria for certification to be credible. First, sponsors should have reputational capital at risk of being forfeited in the event of certifying falsely. Second, the single gain in wealth by certifying falsely must be essentially inferior to the value of the sponsors' reputational capital. Third, the cost of certification for the issuing firm must be an increasing function of opacity of the firm. In this respect, both PE and VC firms fulfil the above criteria and thus, displaying the capability of certifying the quality of their portfolio firms.

Megginson and Weiss (1991) justify that the certification effect of VC is due to the following three reasons; reputation, network and strong commitment to stay invested. VC firms naturally use IPOs as an exit strategy. VC firms with successful IPOs track records increase the credibility of future IPOs. VC firms therefore are unlikely to put their reputation at stake by backing a low quality firm. VC firms also possess strong ability to form and maintain robust relationships with parties of the IPOs. VC firms are also committed to stay invested in their portfolio companies after the IPOs. The strong network and commitment of the VC firms greatly increase the confidence of investors and reduce the information asymmetry surrounding IPOs. VC also has a monitoring role which reduces information asymmetry between investors and insiders of the firms (Barry, Muscarella, Peavy, and Vetsuypens, 1990; Megginson and Weiss, 1991). We concomitantly believe that the above reasons also apply to PE. Through active participation in the boards of firm operations, both PE and VC companies minimise problems characterised by agency problems and information asymmetry (Lerner, Hardyman and Leaman, 2009). They serve as a signal of issuing firm's quality on the basis of their specialized information and professional management expertise. In this respect, PE and VC certify the quality of the firms going public.

We believe that both PE and VC firms are subjected to more information disclosure needs, public attention and scrutiny. This will increase transparency, informational homogeneity and information flow among investors, underwriters and other parties of the IPOs. This will therefore reduce the necessity for underpricing due to a reduction of ex-ante uncertainty about the true value of the firm going public. We envisage that PE and VC will exert certification effect on the portfolio companies. We further expect that the need for underpricing due to adverse selection and information revelation, will be reduced with the presence of a sponsor.

Further studies have also supported the certification effect (Beatty and Ritter, 1986; Carter and Manaster, 1990; Del Colle, Russo and Generale, 2006; Hyytinen and Pajarinen, 2007). Van Frederikslust et al. (2001) also found evidence supporting that VC-backed and PE-backed IPOs show less underpricing than non-PE backed counterparts on the Amsterdam Stock Exchange. Chahine, Filatotchev and Wright (2007) also emphasized the significance of the certification effect by illustrating that sponsor-backed IPOs in UK are less underpriced than non-sponsor backed IPOs. Minardi, Ferrari and AraújoTavares (2013) also observed that on average, sponsor-backed IPOs are less underpriced than non-sponsor backed companies in the Brazilian market, between 2004 and 2008. They observed that sponsor-backed companies are less underpriced due to alignment of interests between administrators and investors,

better professional management, stronger governance practices and greater existence of independence of administrators.

As such, we postulate that PE-backed and VC-backed issuers have an informational advantage over non-sponsor backed counterparts. Those who argue that underpricing is largely explained by information asymmetry will likely see lower underpricing in sponsor-backed deals due to informational advantage. This allows us to advance the following hypotheses.

2.4 Hypotheses Development

There are a large number of studies examining general IPO underpricing, venture capital and VC-backed IPOs. However, few studies have dived into the underpricing in IPOs backed by private equity firms. There are also very limited studies that have compared the underpricing differential and analysed the certification effect in PE-backed IPOs and VC-backed IPOs in US for the extended time period of 20 years. Past studies also have not dived into how certification effects vary with firm characteristics. We concur that our research will be complementary to the existing research on underpricing.

In this study, we expect that there is lesser information asymmetry for issuing firms backed by VC and PE firms. This is because both PE and VC firms have greater access to information and involvement in issuing firms' management as compared to non-sponsor backed issuing firms. We also believe that both PE and VC firms will increase transparency, informational homogeneity and information flow among investors, underwriters and other parties of the IPOs. This will therefore reduce the necessity for underpricing due to a reduction of ex-ante uncertainty about the true value of the firm going public.

Therefore, we expect PE-backed and VC-backed IPOs to have lower level of underpricing as compared to non-sponsor backed IPOs.

In comparison of PE and VC issuing firms, it is intuitive to assume that PE investors have much greater financial expertise and participation in management than VC firms. The iterative process of investing, managing and divesting rendered PE firms very highly specialised and adroit investors (Rossetto, 2008). Wright and Robbie (1998) also argue that PE firms are more informed and experienced than VC firms and ordinary

issuing firms. Therefore, we expect PE-backed IPOs to have the lowest level of underpricing among these three groups.

After controlling for individual firm characteristics, we examine conditional underpricing levels for these three groups by isolating the certification effect. By controlling for individual firm characteristics, we can investigate the direct relationship between underpricing and the presence of a sponsor. We hypothesise that this informational advantage will lead to a lower conditional underpricing level due to the certification effect. In this case, both PE-backed IPOs and VC-backed IPOs should have lower level of conditional underpricing as compared to non-sponsor backed counterparts. Since PE-backed issuing firms are likely to have higher informational advantage than VC-backed issuing firms, there should be lower level of conditional underpricing for PE-backed IPOs in comparison to VC-backed IPOs. This leads to our first hypothesis.

Hypothesis 1: PE-backed IPOs exhibit the lowest level of conditional underpricing as compared to VC-backed IPOs and non-sponsor backed IPOs. VC-backed IPOs exhibit a lower level of conditional underpricing as compared to non-sponsor backed counterparts.

$UP(PE) < UP(VC) < UP(\text{Non-sponsor backed})$

PE firms usually invest in large firms in their mature stage (Levis, 2011). VC firms usually invest in small and promising startups with great growth potential (Carleton, 1986). At listing, the VC-backed firms will be smaller with limited tangible assets (Schöber, 2008). A number of other factors could reduce information asymmetry. Larger firms tend to be subjected to greater regulation and public scrutiny than smaller firms, leading to a lower level of information asymmetry. We use firm size as a proxy for ex-ante uncertainty of an offer (Beatty and Ritter, 1986). Smaller firms are expected to be riskier and more uncertain. As the size of the firm decreases, we expect higher information asymmetries since smaller firms are also subjected to lower levels of public scrutiny and regulation. Therefore, we expect that the certification effect of both sponsors to increase as firm size decreases. This leads to our second hypothesis.

Hypothesis 2: Certification effect of PE-backed and VC-backed firms increases as size of firms decreases (measured by total assets).

PE firms also tend to invest in older and more established firms. VC-backed firms tend to be immature with limited history prior to listing (Schöber, 2008). Megginson and Weiss (1991) show that VC-backed firms are significantly younger than non-VC counterparts. Younger firms tend to have limited financial information and have higher levels of information asymmetry. Older firms tend to have more established track records and financial information, reducing information asymmetry. This is supported by previous studies (Ritter, 1984a; Megginson and Weiss, 1991). As the age of firms decrease, we expect higher information asymmetries which increase the extent of certification effect. Therefore, we expect certification effect of both sponsors to increase as age of firms decreases. This leads to our third hypothesis.

Hypothesis 3: Certification effect of PE-backed and VC-backed firms increases as age of firms decreases (measured by age).

PE-backed firms are characteristically of higher leverage. Typical of buyouts, PE firms tend to finance their investments with large amounts of debt. Motivated by tax and financing incentives, PE-backed firms typically use higher leverage than non-sponsor backed firms (Jensen, 1989; Barber and Goold, 2007). Due to their repeated process of investing, managing and divesting, PE firms have strong relationships with credit providers, making it easier for their portfolio firms to obtain debt financing (Ivashina and Kovner, 2011). VC-backed firms usually lack tangible assets, resulting in higher difficulty to obtain loans from traditional banks (Zider, 1998). Firms with debt claims before flotation sends signal to the market that firm is of high quality since only these firms are able to secure debt (James and Wier, 1990; Habib and Ljungqvist, 2001; Schenone, 2004). As the leverage of firms decrease, we expect the greater requirement for sponsors to serve as a signal of firm quality. Therefore, we expect certification effect of both sponsors to increase as leverage of firms decrease. This leads to our fourth hypothesis.

Hypothesis 4: Certification effect of PE-backed and VC-backed firms increases as leverage decreases (measured by leverage).

To test our hypotheses, we identified a number of variables which may be explanatory for the initial returns and control for these effects in our sample of IPOs.

3 Methodology

3.1 Underpricing

Ritter and Welch (2002) highlight that academics measure IPO underpricing as the percentage increment from offer price to first day closing price and this is also known as the initial return. Initial studies demonstrate IPO underpricing with systematic increase from offer price to first day closing price (Stoll and Curley, 1970; Logue, 1973; Reilly, 1973; Ibbotson, 1975; Beatty and Ritter, 1986). This paper proxy the level of underpricing with first day stock returns in line with usual practice of academics.

The formula for underpricing is as followed;

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

Underpricing for firm i is calculated as percentage change from offer price $P_{i,0}$ to the closing price $P_{i,1}$ on first trading day. The IPO is considered underpriced if the first day closing price is higher than offer price and it is considered overpriced if the first day closing price is lower than offer price.

3.2 Welch's t-test

The differences in mean underpricing between sub-samples are examined in more detail with 2-sample t-test. Zimmerman (2004) cautions against using preliminary test for homogeneity of variances of the samples to determine the test for comparison of equality, with the argument that difference in population variances may exist though it is not reflected in sample variances. The paper suggests that the most efficient approach is to conduct Welch's t-test when the sample sizes are unequal. According to Ruxton (2006), Welch's t-test is always preferred compared to Student's t-test or

Mann-Whitney U test for comparison of central tendency between 2 unrelated samples.

To determine if the differences between underpricing of private equity backed, venture capital backed and non-sponsor backed IPOs are statistically significant, we employ Welch's t-test, a 2-sample t-test assuming unequal variances. Welch's t-test assumes that data follows normal distribution. This assumption is satisfied given the sufficiently large sample size of sub-samples in this study consisting of 403 PE-backed IPOs, 179 VC-backed IPOs and 1469 non-sponsor backed IPOs.

3.3 Underpricing Regression Models

An underpricing regression model is constructed to determine the degree of underpricing associated with PE-backed, VC-backed and non-sponsor backed IPOs. This theoretical model is a baseline model in our study and is estimated with OLS regression using EViews. In order to construct a regression model that effectively considers the effects of sponsor backing on IPO returns, we control for a number of firm and offer characteristics that are often mentioned in studies on IPO underpricing.

The baseline underpricing regression model is as followed;

$$UP_i = \alpha_0 + \alpha_1 PE_i + \alpha_2 VC_i + \alpha_3 Lnassets_i + \alpha_4 EBITDA_i + \alpha_5 Leverage_i + \alpha_6 Lnage_i + \alpha_7 UW_i + \alpha_8 Consta_i + \alpha_9 Energy_i + \alpha_{10} Healthc_i + \alpha_{11} Indust_i + \alpha_{12} Infotech_i + \alpha_{13} Material_i + \alpha_{14} Telecom_i + \alpha_{15} Utilities_i + \alpha_{16} \sum_{t=1}^{21-1} Year + \varepsilon_i$$

The variables are defined as followed;

VC is a dichotomous variable that takes the value of 1 if the IPO is VC-backed, otherwise it takes the value of 0. Following discussion on theories in our literature review, we expect certification effect to be present for VC-backed IPOs, indicated by a negative relationship between venture capital backing and IPO underpricing. Intuitively, presence of venture capitalists in issuing firms would act as a form of certification on the quality of the IPO given their investment in the underlying firm and reputation.

PE is a dichotomous variable that takes the value of 1 if the IPO is PE-backed, otherwise it takes the value of 0. Based on our discussion on theories in literature

review, we expect certification effect to be present for PE-backed IPOs, indicated by a negative relationship between PE backing and IPO underpricing. The intuition is that the presence of PE in issuing firms would act as a form of certification on quality of the IPO given their investment in underlying firm and reputation.

Lnassets is the natural logarithm of firm's total asset value in USD at IPO announcement. We use this as a measure of firm size, a proxy for ex-ante uncertainty. Empirical studies have indicated inverse relationship between firm size and short run underpricing (Ibbotson, Sindelar and Ritter, 1994; Carter, Dark and Singh, 1998; Brau, Brown and Osteryoung, 2004). Beatty and Ritter (1986) find that underpricing has a positive relationship with the level of information asymmetry. We expect a negative relationship between the size of the firm and the level of underpricing. Intuitively, larger firms are deemed to have more publicly available information, thus reducing uncertainty and initial returns. We also posit that PE-backed firms tend to be larger and VC-backed firms to be smaller and we deem it necessary to control for firm size in our regression model.

Lnage is the natural logarithm of 1+age of firm at flotation, used as a proxy for ex-ante uncertainty which is the degree of information asymmetry. An increase in the age of the firms lowers the initial returns (Muscarella and Vetsuypens, 1989). Loughran and Ritter (2004) indicate negative relation between age and initial returns across sub periods from 1980 to 2003. Prior studies suggest that firms operating for several years are likely to have better availability of information and this contributes to reduced information asymmetry in an IPO (Ritter, 1984a; Hensler, Rutherford and Springer, 1997). The effect of age on underpricing is further discussed in literature by Ritter (1991), Megginson and Weiss (1991) and Ljungqvist and Wilhelm (2003). We expect a negative relationship between **Lnage** and level of underpricing. Our intuition, in line with Ritter (1984a) and Hensler et al. (1997), is that the more established the firm, the greater the availability of information. We also posit that PE-backed firms tend to be more mature and older and we deem it mandatory to control for firm age in our regression models.

EBITDA refers to EBITDA margin and is measured as Earnings before interest, taxes, depreciation and amortization (EBITDA) to total revenue. Purnanandam and Swaminathan (2004) argue that one of the key factors that differentiate underpriced and overpriced IPO firms is their profitability before IPO. Higher profitability signals better quality of an IPO firm. We use operating margin (EBITDA margin) as the proxy for the profitability of the firm. Operating margin is not skewed by non-operating items and is a better measure of profitability and intrinsic value of the firm. We expect a negative relationship between profitability and level of underpricing.

The degree of **leverage**, measured as total debt to total assets, conveys the financial quality of an offering to the market. Firms with debt claims before flotation sends signal to the market that firm is of high quality since only these firms are able to secure debt (James and Wier, 1990; Habib and Ljungqvist, 2001; Schenone, 2004). According to James and Wier (1990), the presence of borrowing relationship prior to flotation can scale down uncertainty investors have about issuing company's market value which in turn increase IPO proceeds. This is intuitive given this form of signal would reduce ex-ante uncertainty which results in lower levels of underpricing. We posit that private equity backed firms tend to be more highly levered than venture capital backed and non-sponsor backed counterparts and we deem it mandatory to control for leverage in our regression models. Therefore, leverage is included as a control variable to account for the possible effect that leverage of a firm would have on its level of underpricing.

UW is a dichotomous variable where unity represents that the underwriter is reputable and zero otherwise. We use market share measured by deal volume as a proxy for underwriter reputation, with the assumption that underwriters with higher market share are more reputable. Based on our sample, we determine the market share of each individual underwriter which underwrites offerings for every individual year from 1997 to 2017. Following, we rank the underwriters by the proportion of market share. The top 20% of the underwriters with the highest market share are deemed reputable for the year and the rest otherwise. Firms that engage any of the underwriters deemed reputable for the year of IPO would take the value of 1, while firms that do not engage these underwriters would take the value of 0. Prestigious underwriters provide assurance of the quality of the offering and hence, reduce the level of underpricing (Booth and Smith, 1986; Carter and Manaster, 1990; Michaely and Shaw, 1994). Carter and Manaster (1990) determine that there is a significant inverse relationship between level of IPO underpricing and underwriter reputation. Michaely and Shaw (1994) and Megginson and Weiss (1991) also found evidence that initial return of new issues is negatively related to underwriter reputation. By associating themselves with an offering, prestigious intermediaries “certify” the quality of the issue and are associated with lower levels of underpricing. In view of the possible certification effect of underwriter reputation on level of underpricing, we include **UW** as a control variable in the underpricing regression model.

In this study, we incorporate period and industry fixed effects in view that the extent of underpricing for the sample of IPOs across period of 1997 to 2017 would be affected by outlook of market across time and across industries.

Since studies have often relate IPO underpricing with ex-ante uncertainty, the riskiness of individual industry will determine the level of uncertainty. Ritter (1991) investigated 1526 IPOs from 14 industries over the time period of 1975 to 1984. Ritter uncovered underpricing discrepancy with the highest level of initial return of 128.21% for financial services industry and lowest level of initial return of 1.42% for wholesale industry. Arosio, Guidici and Paleari (2000) and Daily, Certo and Dalton (2005) also found a significant relationship between underpricing and firms in the technology industry. In view of the potential relation between industries and underpricing, we include dummies for industries as a control in the underpricing regression model.

For **industries dummies**, consumer discretionary is positioned as the reference entity. The remaining industries (consumer staples, energy, healthcare, industrials, information technology, materials, telecommunication services and utilities) are included as dummy variables that would take the value of 1 if the firm falls under the industry classification and 0 otherwise.

For **period dummies**, the year 1997 is positioned as the reference entity. Previous studies show that underpricing varies across time. Ritter (1984b) indicates higher average initial returns for IPOs during "hot" issue period, determined by observation of ex post stock market returns. Loughran, Ritter and Rydqvist (1994) document that issuers time IPOs to coincide with periods where inflation-adjusted stock market return is high. Therefore, 20 offer year dichotomous variables are included in the underpricing model to serve as a control for varying market conditions during sample period.

3.3.1 Underpricing Regression Model with Sponsor-Backed Dummy

This regression is a direct test for **Hypothesis 1**. In this regression, **SB**, a variable indicating presence of sponsor backing is used in replacement of **VC**. **SB** is a dichotomous variable that takes the value of 1 if the IPO is either VC-backed or PE-backed and 0 otherwise. In this study, we hypothesise that certification effect is present in IPOs backed by PE and VC and thus a negative coefficient for sponsor backed variable, **SB**.

This regression is structured to determine if on average, certification effect is present by comparing the conditional underpricing differential between PE-backed, VC-backed and non-sponsor backed IPOs. The coefficient of **SB** indicates the relation of sponsor

backing on initial returns, while the coefficient of **PE** indicates the additional effect of backing by a PE firm. In this regression, the total effect of PE backing is represented by the sum of **SB** and **PE**. The additional effect of PE backing compared to VC backing, is represented by **PE**.

We surmise that sponsors have certificatory roles in IPOs, and the presence of PE backing would exhibit greater certification effect as compared to presence of VC backing. Based on hypothesis 1 which we hypothesise that PE-backed IPOs exhibit the lowest level of conditional underpricing as compared to VC-backed IPOs and non-sponsor backed IPOs, we expect a negative coefficient for **PE** variable in this regression model. In line with the hypothesis that VC-backed IPOs exhibit a lower level of conditional underpricing as compared to non-sponsor backed IPOs, we expect the coefficient **SB** to be negative.

The model is as followed;

$$\boldsymbol{UP_i = \alpha_0 + \alpha_1 PE_i + \beta_0 SB_i + \alpha_3 Lnassets_i + \alpha_4 EBITDA_i + \alpha_5 Leverage_i + \alpha_6 Lnage_i + \alpha_7 UW_i + \alpha_8 Consta_i + \alpha_9 Energy_i + \alpha_{10} Healthc_i + \alpha_{11} Indust_i + \alpha_{12} Infotech_i + \alpha_{13} Material_i + \alpha_{14} Telecom_i + \alpha_{15} Utilities_i + \alpha_{16} \sum_{t=1}^{21-1} Year + \varepsilon_i}$$

3.3.2 Underpricing Regression Models with Interaction Effects

These regressions are a formal test for Hypothesis 2, 3 and 4. Three regression models are formulated to determine how firm characteristics (size, age and leverage) are associated with the level of underpricing under the condition that IPO is PE-backed or VC-backed, but not when PE backing or VC backing are absent. These regressions address the conditional hypotheses on the relationship between firm characteristics and initial returns dependent on PE and VC backing. Brambor, Clark, and Golder (2006) suggest the addition of interaction terms to test for conditional hypotheses. In order to examine how certification effect varies with firm characteristics, we employ a multiplicative interaction model in line with the approach outlined by Brambor, Clark, and Golder (2006).

The baseline underpricing regression model is structured with interaction effects to determine if firm characteristics have different impact on the extent of certification effect for both VC-backed and PE-backed firms. The firm characteristics are represented by three individual variables; size, age and leverage. In this study, the natural logarithm of assets, **lnassets**, is used as a proxy for firm size. **Lnage**, the natural logarithm of 1+age for firm at flotation, is a measure of age. **Leverage**,

computed as total debt to total assets, is indicative of the leverage of the firm at flotation. The constitutive terms are **PE** and **VC** respectively. An interaction variable is a variable that combines individual **PE** and **VC** dummies with each of the independent variables. The interaction variable and constitutive term **PE/VC** then explains the certification effect for both individual groups; PE-backed firms and VC-backed firms.

Model 1: Regression model with interaction terms for size

$$UP_i = \alpha_0 + \alpha_1 PE_i + \alpha_2 VC_i + \alpha_3 Lnassets_i + \beta_1 Lnassets_i PE_i + \beta_2 Lnassets_i VC_i + \alpha_4 EBITDA_i + \alpha_5 Leverage_i + \alpha_6 Lnage_i + \alpha_7 UW_i + \alpha_8 Consta_i + \alpha_9 Energy_i + \alpha_{10} Healthc_i + \alpha_{11} Indust_i + \alpha_{12} Infotech_i + \alpha_{13} Material_i + \alpha_{14} Telecom_i + \alpha_{15} Utilities_i + \alpha_{16} \sum_{t=1}^{21-1} Year + \varepsilon_i$$

Model 2: Regression model with interaction terms for age

$$UP_i = \alpha_0 + \alpha_1 PE_i + \alpha_2 VC_i + \alpha_3 Lnassets_i + \alpha_4 EBITDA_i + \alpha_5 Leverage_i + \alpha_6 Lnage_i + \beta_3 Lnage_i PE_i + \beta_4 Lnage_i VC_i + \alpha_7 UW_i + \alpha_8 Consta_i + \alpha_9 Energy_i + \alpha_{10} Healthc_i + \alpha_{11} Indust_i + \alpha_{12} Infotech_i + \alpha_{13} Material_i + \alpha_{14} Telecom_i + \alpha_{15} Utilities_i + \alpha_{16} \sum_{t=1}^{21-1} Year + \varepsilon_i$$

Model 3: Regression model with interaction terms for leverage

$$UP_i = \alpha_0 + \alpha_1 PE_i + \alpha_2 VC_i + \alpha_3 Lnassets_i + \alpha_4 EBITDA_i + \alpha_5 Leverage_i + \beta_5 Leverage_i PE_i + \beta_6 Leverage_i VC_i + \alpha_6 Lnage_i + \alpha_7 UW_i + \alpha_8 Consta_i + \alpha_9 Energy_i + \alpha_{10} Healthc_i + \alpha_{11} Indust_i + \alpha_{12} Infotech_i + \alpha_{13} Material_i + \alpha_{14} Telecom_i + \alpha_{15} Utilities_i + \alpha_{16} \sum_{t=1}^{21-1} Year + \varepsilon_i$$

When the interaction terms are excluded, the coefficient on **PE** ($\boldsymbol{\alpha_1}$) measures the average effect of PE backing on underpricing while the coefficient on **VC** ($\boldsymbol{\alpha_2}$) measures the average effect of VC backing on underpricing. When the interaction terms; (**PE***size/age/leverage) and (**VC***size/age/leverage) are introduced, $\boldsymbol{\alpha_1}$ and $\boldsymbol{\alpha_2}$ measure the implied effect of PE backing and VC backing respectively when the value of size/age/leverage is equal to 0.

For the regression model with interaction terms for size (Model 1), the derivative with respect to PE is $\boldsymbol{\alpha_1 + \beta_1 Lnassets_i}$. We expect $\boldsymbol{\alpha_1}$ to be negative and $\boldsymbol{\beta_1}$ to be positive.

As the size increases, the derivative should tend to 0, demonstrating smaller certification effect. Similar interpretation applies with respect to VC.

For the regression model with interaction terms for age (Model 2), the derivative with respect to PE is $\boldsymbol{\alpha_1 + \beta_3 Lnage_i}$. We expect $\boldsymbol{\alpha_1}$ to be negative and $\boldsymbol{\beta_3}$ to be positive. As the age increases, the derivative should tend to 0, demonstrating smaller certification effect. Similar interpretation applies with respect to VC.

For the regression model with interaction terms for leverage (Model 3), the derivative with respect to PE is $\boldsymbol{\alpha_1 + \beta_5 Leverage_i}$. We expect $\boldsymbol{\alpha_1}$ to be negative and $\boldsymbol{\beta_5}$ to be positive. As the leverage increases, the derivative should tend to 0, demonstrating smaller certification effect. Similar interpretation applies with respect to VC.

3.4 Diagnostic and Specification Testing

Heteroscedasticity test is performed on the underpricing regression models to align models for regression with OLS method. Autocorrelation is not an issue given the cross-sectional nature of data. Jarque-Bera test on normality of residuals is also not needed since central limit theorem applies given large sample size in this study. There is no indication of any treatment of endogeneity in previous studies (Megginson and Weiss, 1991; Bergström, Nilsson and Wahlberg, 2006). In this paper, we assume all regressors are exogenous.

The underpricing regressions are checked for heteroscedasticity with Breusch-Pagan-Godfrey test using EViews. The chi-square test is used to test for the hypothesis of homoscedasticity. Null hypothesis of homoscedasticity has been rejected at 10% significance level for baseline underpricing regression model and regression model with sponsor-backed dummy, implying that residual variance is not constant for both regressions. White-Huber adjusted standard errors are used to correct standard errors for heteroscedasticity. With this adjustment, heteroscedasticity-robust t-statistics would be generated. In this paper, White-Huber adjusted standard errors is applied across all regressions for uniformity in computation of standard errors.

Beyond the diagnostic testing of OLS assumptions, the underpricing regression model is tested for multicollinearity and non-linearity so that the regression is appropriate for reliable inferences to be deduced from suggested underpricing regression model.

A correlation matrix between the independent variables is used to detect multicollinearity. The yardsticks for near multicollinearity are corr(x_i,x_j)≥0,8 and variance inflation factor≥10.

Table IX shows the pairwise correlation matrix among variables that are used in underpricing regressions for this study. With the pairwise correlation between independent variables for baseline underpricing regression model within the interval of [-0,153; 0,371] lesser than 0,8, it can be determined that near multicollinearity is not present between independent variables.

For the underpricing regression model with sponsor-backed dummy, variable **SB** has a correlation of 0,786 with **PE**. This correlation coefficient stems from the definition of both variables in this study. **SB** is a dichotomous variable that takes value of 1 for IPOs that are backed by venture capital or private equity firms and **PE** is a dichotomous variable indicating presence of private equity backing. This concurrent presence of private equity backing in **SB** would render the correlation coefficient prominent. However, this value is still lower than the yardstick of 0,8. The remaining pairwise correlation between independent variables for the regression model with sponsor-backed dummy is within the interval of [-0,153; 0,371].

Variance inflation factor (VIF) is employed to check for multicollinearity between several independent variables (i.e. x_1 and $(x_2 + x_3)$). In baseline underpricing regression, **Lnassets** has the highest VIF of 4,054. In underpricing regression model with sponsor-backed dummy, **SB** has the highest VIF of 5,673. A high VIF for the variable would imply that the variable is highly correlated with at least one of the other independent variables in the model. However, both values are lower than the yardstick of 10, thus absolving these models of multicollinearity.

For regression model with interaction terms for size, **Lnassets*PE** has a high correlation of 0,954 with **PE**, and **Lnassets*VC** has a high correlation of 0,969 with **VC**. Regression model with interaction terms for age also show similar high correlation between interaction terms and constitutive terms. The interaction term **Lnage*PE** has a high correlation of 0,922 with **PE**, and **Lnage*VC** has a high correlation of 0,975 with **VC**. For regression model with interaction terms for leverage, **Leverage*PE** has a high correlation of 0,758 with **PE** albeit lower than the yardstick of 0,8. The general high pairwise correlation observed between interaction terms and **PE**/**VC** dummy is a result of the interaction variable's computation where the firm characteristics have been multiplied with the dichotomous variable **PE**/**VC**. Brambor, Clark, and Golder (2006) claim that the ramification of inferential error from excluding constitutive term due to

high multicollinearity concern outweighs any possible advantages. The main application of interaction models in this study is to find out the marginal effect of certificatory role on underpricing of IPOs, thus we proceeded with the inclusion of constitutive terms in interaction models.

4 Data

4.1 Sample Collection

The sample is constructed from a universe of IPOs listed across all exchanges in the United States between January 1997 to December 2017 obtained from Capital IQ and Bloomberg. The IPO should issue ordinary common shares and should not be a unit offering, or an American Depositary Receipt (ADR). IPOs with offer price below $5 are excluded. REITs and financial institutions are also excluded from the sample. Global Industry Classification Standard (GICS), which is jointly developed by Standard & Poor's and Morgan Stanley Capital International (MSCI), is used for industry classification in this study. Bhojraj, Lee and Oler (2003) evaluated four classification methods; North American Industry Classification System (NAICS), Standardized Industry Classification (SIC), Global Industry Classification Standard (GICS) and Fama and French industry groupings (FF). They argue that GICS significantly explains key financial indicators and is the best choice for capital market research. They suggest that GICS is superior to other classification methods given that this system is established to meet the financial oriented nature of the industry categories, and that GICS code assignment to companies is centralized from specialists at S&P and MSCI. The restriction is thus based on this classification and companies in financials and real estate are excluded from the sample.

The classification of the sample of IPOs into PE-backed, VC-backed and non-sponsor backed is obtained from Bloomberg. PE-backed IPOs are issuing companies backed by at least one PE firm. Similarly, VC-backed IPOs are issuing companies backed by at least one VC firm. Classification of sponsors into PE or VC is based on a set of criteria; overall investment strategy, sectors/particulars of investments, method of investment and overall operations of the firm.

Information collected from Capital IQ include underpricing, company assets, EBITDA margin, leverage, age of company, industry classifications and underwriter reputation from offering. IPOs with missing data were removed from the sample.

This results in total sample size of 2051, consisting sub-sample size of 403 for PE-backed IPOs, sub-sample size of 179 for VC-backed IPOs and sub-sample size of 1469 for non-sponsor backed IPOs.

4.2 Statistics Summary

Figure 1 shows the average initial returns and the number of initial public offerings for the period of 1997 to 2017. This period includes two pronounced market cycles. There is considerable decrease in number of initial public offerings in 2001, as well as 2008 due to the effects of dot-com crash and global financial crisis respectively. In 1997, average initial returns on IPOs averaged 15,22% before reaching astronomical levels during 1999 and 2000. In 1999, average initial returns on IPOs peaked at 75,07%. This coincided with the internet bubble period. One reason for this high level of underpricing could be possibly due to the skyrocketing uncertainty during the internet bubble period. In 2001, average initial returns on IPOs reverted to 13,29%. Across 2002 to 2017, there was a sharp increase in initial returns during 2011 to 2013 period but on average, yearly average initial returns remained well below late 1990s level.

Figure I
Average initial returns and number of IPOs for the period of 1997 to 2017

The sample consists of 2051 IPOs across all US exchanges for the period of 1997 to 2017 with an offer price of at least $5,00. IPOs of firms from the financials and real estate sectors have been excluded. Information is obtained from Capital IQ and Bloomberg. The years are set along the horizontal axis. The number of IPOs (bars) and the average levels of underpricing (lines) are set along the vertical axis.

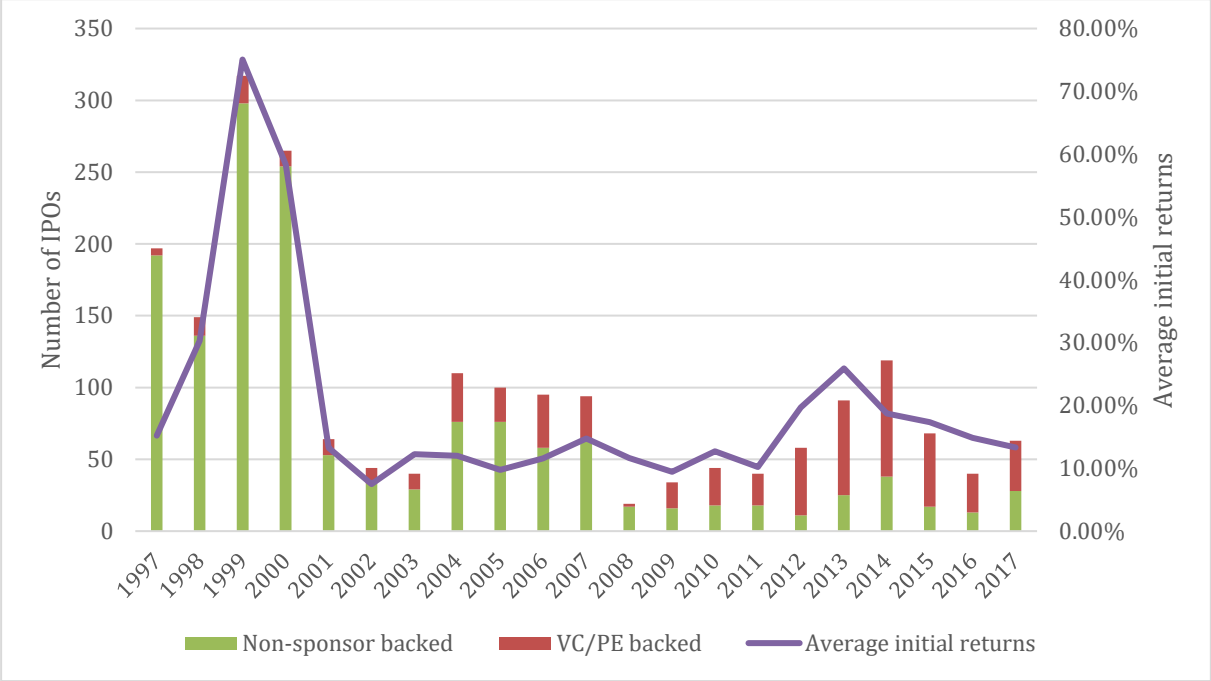

Table 1 shows the breakdown of IPOs by year in sub-samples of data collected; private equity backed IPOs, venture capital backed IPOs and non-sponsor backed IPOs. In 1997, sponsor-backed IPOs were underrepresented on the IPO market, accounting for only approximately 3% of the total IPOs in 1997. Total volume of IPOs peaked in 1999, following the economic upturn in 1999. Total volume of IPOs dropped in 2000 and remained fairly low levels for several years while the proportion of sponsor-backed IPOs started increasing from around 4% in 2000 to around 31% of total IPOs volume in 2004. Total IPO activity picked up in the period of 2004 to 2007 but remained well below late 1990s levels. In 2008, total IPO volume reached historical low with the proportion of sponsor-backed IPO to total IPO volume at 11%. During this year, the volume of sponsor-backed IPOs is also at the lowest level from 1997 to 2017. IPO activity increased after the 2008 recession but again, remained well below late 1990s levels.

The average proportion of sponsor backed IPOs to total IPO volume in the 2000s are significantly higher than the 1990s. In 2013, venture capital and private equity firms

started to capitalise on the more robust equity market and attractive valuations to exit their pre-recession investments through IPOs. Trend continued till 2014 which the US IPO market displayed a very strong year. The total number of IPOs soared to 119, the highest level since year 2000. In year 2014, PE-backed IPOs accounted for around 35% of offerings and venture capital firms accounted for around 33% of offerings. 2015 and 2016 were down years for IPOs while IPO volume picked up again in 2017.

Table I

PE-backed, VC-backed and non-sponsor backed IPOs from 1997 to 2017

This table shows the private equity (PE) backed, venture capital (VC) backed and non-sponsor backed IPOs listed across all US exchanges from 1997 to 2017. The sample consists of 2051 IPOs, where the offer price is at least $5,00. IPOs of firms from the financials and real estate sectors have been excluded. Information is obtained from Capital IQ and Bloomberg.

Year	PE-backed	Proportion of PE-backed IPOs over total IPO offerings	VC-backed	Proportion of VC-backed IPOs over total IPO offerings	Non-Sponsor backed	Proportion of Non-Sponsor backed IPOs over total IPO offerings	Total
1997	5	2,5%	0	0,0%	192	97,5%	197
1998	10	6,7%	3	2,0%	136	91,3%	149
1999	14	4,4%	5	1,6%	298	94,0%	317
2000	7	2,6%	4	1,5%	254	95,8%	265
2001	11	17,2%	0	0,0%	53	82,8%	64
2002	9	20,5%	2	4,5%	33	75,0%	44
2003	9	22,5%	2	5,0%	29	72,5%	40
2004	25	22,7%	9	8,2%	76	69,1%	110
2005	21	21,0%	3	3,0%	76	76,0%	100
2006	33	34,7%	4	4,2%	58	61,1%	95
2007	23	24,5%	8	8,5%	63	67,0%	94
2008	2	10,5%	0	0,0%	17	89,5%	19
2009	17	50,0%	1	2,9%	16	47,1%	34
2010	25	56,8%	1	2,3%	18	40,9%	44
2011	18	45,0%	4	10,0%	18	45,0%	40
2012	29	50,0%	18	31,0%	11	19,0%	58
2013	34	37,4%	32	35,2%	25	27,5%	91
2014	42	35,3%	39	32,8%	38	31,9%	119
2015	26	38,2%	25	36,8%	17	25,0%	68
2016	18	45,0%	9	22,5%	13	32,5%	40
2017	25	39,7%	10	15,9%	28	44,4%	63
Total	403		179		1469		2051

Table II provides an overview of the firm and offering characteristics for the three sub-samples. It displays the differences for important firm and offer characteristics such as initial returns, firm size, EBITDA margins, leverage, age and reputation of underwriters. **EBITDA** and **leverage** data have been winsorized at 1% level in view of some extreme values present in the sample data. The variation in **EBITDA** is large and the minimum EBITDA margins are markedly negative especially for VC-backed IPOs and non-sponsor backed IPOs. This implies that some issuing firms reported negative profitability at the time of initial public offering announcement.

The normality assumption for Welch's t-test is satisfied given that the sample size is sufficiently large for the sub-samples of PE-backed IPOs, VC-backed IPOs and non-sponsor backed IPOs. Therefore, the 2-sample t-tests assuming unequal variances are conducted to confirm whether these differences are statistically significant.

The preliminary inference drawn from Table II is that the PE-backed IPOs have the lowest mean underpricing, followed by VC-backed IPOs. Non-sponsor backed IPOs have the highest mean underpricing. PE-backed IPOs have the largest mean firm size, which is proxied by **lnassets**, followed by non-sponsor backed IPOs. VC-backed IPOs have the smallest mean firm size. PE-backed IPOs have the highest EBITDA margin, followed by non-sponsor backed IPOs. VC-backed IPOs have the lowest EBITDA margin. However, as these values are negative, comparison between these figures may not be meaningful. PE-backed IPOs have the highest **leverage**, followed by non-sponsor backed IPOs. VC-backed IPOs have the lowest leverage. PE-backed firms that conducted IPOs are generally the oldest, and this is reflected by the largest mean **lnage** value. This is followed by VC-backed firms that conducted IPOs. Non-sponsor backed firms have the smallest mean **lnage** value. Underwriter reputation, **UW**, is a dichotomous variable that takes either the value of 1 or 0. PE-backed IPOs have highest **UW** value, followed by non-sponsor backed IPOs. VC-backed IPOs have the lowest **UW** value.

To confirm whether these differences are statistically significant, we test for statistical significance in differences for offer and firm characteristics between sub-samples as shown in Table III.

Table II
Summary statistics of sample data

The table below provides an overview of the descriptive statistics for private equity (PE) backed IPOs, venture capital (VC) backed IPOs and non-sponsor backed IPOs. EBITDA margin (EBITDA) and leverage (Leverage) have been winsorized at 1% level as there are some extreme values found for these variables in the sample.

		Private Equity (PE) backed IPOs	**Venture Capital (VC) backed IPOs**	**Non-sponsor backed IPOs**
UP	Mean	0,1507	0,2677	0,3364
	Median	0,0785	0,1667	0,1220
	Maximum	2,7188	2,0375	9,8333
	Minimum	-0,4108	-0,2307	-0,5512
	Std. Dev.	0,2578	0,3634	0,6980
Lnassets	Mean	5,9751	4,1373	4,2592
	Median	6,0711	4,0765	3,9503
	Maximum	10,4175	8,5291	11,8295
	Minimum	0,8838	1,6639	-0,9039
	Std. Dev.	1,6817	1,0101	1,7986
EBITDA*	Mean	-0,2343	-5,2858	-3,8288
	Median	0,1396	-0,1186	0,0567
	Maximum	0,7810	0,4746	0,7810
	Minimum	-87,6316	-213,2086	-213,2086
	Std. Dev.	4,5569	26,3650	20,6448
Leverage*	Mean	0,4980	0,2222	0,3666
	Median	0,4738	0,0609	0,2515
	Maximum	3,1149	2,4081	3,1667
	Minimum	0,0000	0,0000	0,0000
	Std. Dev.	0,3846	0,3783	0,4470
Lnage	Mean	2,7334	2,3108	2,2072
	Median	2,8332	2,3026	2,0794
	Maximum	5,2040	4,9836	5,2149
	Minimum	0,0000	1,0986	0,0000
	Std. Dev.	1,0289	0,5052	0,9990
UW	Mean	0,8089	0,6369	0,7386
	Median	1,0000	1,0000	1,0000
	Maximum	1,0000	1,0000	1,0000
	Minimum	0,0000	0,0000	0,0000
	Std. Dev.	0,3936	0,4823	0,4395
Number of observations		403	179	1469

*0,5% of data at both extreme data points have been winsorized for these variables

5 Results and Analysis

5.1 Underpricing Between Sub-Samples

Table III shows the results of the 2-sample t-tests assuming unequal variances between the sub-samples of private equity backed IPOs, venture capital backed IPOs and non-sponsor backed IPOs.

We expect private equity backed and venture capital backed IPOs to have lower levels of underpricing as compared to non-sponsor backed counterparts. VC and PE firms contribute to lower adverse selection through their certification role and increased information disclosure. We expect PE-backed IPOs to have the lowest level of underpricing among these three groups as PE firms are expected to reduce greater extent of information asymmetries as compared to VC firms. PE investors are regarded as more informed and experienced than VC firms and ordinary issuing firms (Wright and Robbie, 1998).

Consistent with our expectations, the mean initial return of PE-backed IPOs of 0,151 is the lowest among the three groups which is statistically different from both VC-backed and non-sponsor backed IPOs at 1% significance level. The lower underpricing of PE-backed IPOs as compared to non-sponsor backed IPOs is supported by the following studies; Muscarella and Vetsuypens (1989), Hogan, Olson and Kish (2001), Ang and Brau (2002), Schöber (2008), Cao and Lerner (2009) and Ferretti and Meles (2011).

The mean initial return of VC-backed IPOs of 0,268 is also lower than non-sponsor backed counterparts of 0,336 at 5% significance level. This finding is supported by Barry, Muscarella, Peavy, and Vetsuypens (1990) and Megginson and Weiss (1991) who similarly documented that there is a lower level of underpricing in VC-backed IPOs.

Table III indicates that there are statistically significant differences in total assets, EBITDA margin, leverage, age and underwriter reputation between PE-backed IPOs group and VC-backed IPOs group.

Between PE-backed IPOs group and non-sponsor backed IPO group, there are statistically significant differences in total assets, EBITDA margin, leverage, age and underwriter reputation. Between VC-backed IPOs group and non-sponsor backed IPOs group, there are only statistically significant differences in leverage, age and underwriter reputation.

PE-backed firms have a larger mean **Lnassets** of 5,975 as compared to VC-backed firms with a mean **Lnassets** of 4,137. This is supported by Levis (2011) and Schöber (2008). Levis argues that private equity firms usually invest in large and mature firms while Schöber argues that venture capital backed firms are smaller with limited tangible assets. The characteristics of having the lowest level of underpricing and the largest size exhibited by private equity firms are supported by Bergström, Nilsson and Wahlberg (2006). They suggested that there is a higher tendency for private equity firms to invest in larger firms, contributing to lower level of underpricing in private equity backed IPOs.

The same relationship is also observed for leverage and age. Private equity backed firms have a higher mean **leverage** of 0,498 and higher **lnage** of 2,733 as compared to venture capital backed firms with a mean **leverage** of 0,222 and **lnage** of 2,311. This is in line with our expectations as private equity backed firms tend to finance their investments with large amount of debt while venture capital firms are high growth firms which do not have excessive cash flow to service debt. For age, the current finding is also supported by study from Schöber (2008) which claims that venture capital backed firms tend to be immature with limited history prior to listing.

Private equity backed firms also have a larger mean assets, higher mean leverage and higher age as compared to non-sponsor backed firms which have mean **lnassets** of 4,259, mean **leverage** of 0,367 and mean **lnage** of 2,207. This is supported by Levis (2011) which argues that private equity firms usually invest in large firms in their mature stage. This is also supported by Jensen (1989) which claims that private equity backed firms typically use higher leverage than non-sponsor backed firms.

Venture capital backed firms have lower leverage and higher age as compared to non-sponsor backed firms. This is in line with our expectations, suggesting that venture capital backed firms usually do not hold significant debt. For age, this finding is contrary to Megginson and Weiss (1991) which claims that VC-backed firms are significantly younger than non-VC counterparts.

Consistent with prior expectations, private equity backed firms are larger in size, more mature and have higher leverage than venture capital backed firms while the characteristics of non-sponsor backed firms are more heterogeneous in nature. This may be possibly due to the different investment styles and interests of PE and VC. PE firms tend to invest in large, mature and highly levered firms which are then exited via IPOs. VC firms, contrariwise invest in small and young start-ups with low leverage. Therefore, we have observed that private equity backed firms are larger, older and of higher leverage than venture capital backed and non-sponsor backed firms.

Table III
Difference in mean test for PE, VC and non-sponsor backed IPOs

This table shows the t-statistics and p-values (in parenthesis) based on Welch's t-test for PE-backed, VC-backed and non-sponsor backed IPOs. EBITDA margin (EBITDA) and leverage (Leverage) have been winsorized at 1% level as there are some extreme values found for these variables in the sample.

	t-statistic		
	PE vs VC	**PE vs non-sponsor**	**VC vs non-sponsor**
UP	3,8931***	-8,3332***	-2,1021**
	(0,0001)	(0,0000)	(0,0362)
Lnassets	16,2964***	17,8697***	-1,3714
	(0,0000)	(0,0000)	(0,1712)
EBITDA	2,5466**	6,1495***	-0,7132
	(0,0117)	(0,0000)	(0,4765)
Leverage	8,0773***	5,8608***	-4,7218***
	(0,0000)	(0,0000)	(0,0000)
Lnage	6,6396***	9,1526***	2,2574**
	(0,0000)	(0,0000)	(0,0246)
UW	2,8674***	3,0963***	-2,6894***
	(0,0045)	(0,0020)	(0,0077)

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

5.2 Regression Results

Table IV shows the baseline underpricing regression model from 1997 to 2017. The regression includes period fixed effects and industry effects. **PE** and **VC** variables reflect statistical insignificance in the relation to initial returns. The firm characteristics, on the other hand, largely reflect statistical significance in their relation to IPO underpricing. The adjusted R-squared of the model is relatively low, around 18%, similar to R-squared levels found in prior studies of underpricing (see e.g. Flagg, 2007; Levis, 2011).

Table IV
Baseline underpricing regression model from 1997 to 2017

The initial returns of IPOs (UP) is regressed against private equity dummy (PE), venture capital dummy (VC), natural logarithm of firm's total asset value (Lnassets), EBITDA margin (EBITDA), total debt to total assets (Leverage), natural logarithm of 1+age of firm at flotation (Lnage) and underwriter reputation (UW). This regression is based on sample with winsorized EBITDA margin and leverage data. Period fixed effects and industry fixed effects are included in this regression through the inclusion of year and period dummies. The t-statistics are adjusted with White-Huber standard errors.

	Baseline regression model		
	Coefficient	**Standard Error**	**t- Statistic**
Constant	0,3253***	0,0519	6,2625
PE	0,0022	0,0194	0,1117
VC	-0,0187	0,0333	-0,5616
Lnassets	-0,0142*	0,0077	-1,8497
EBITDA	0,0003	0,0005	0,6249
Leverage	-0,1446***	0,0245	-5,9120
Lnage	-0,0371***	0,0103	-3,5928
UW	0,0460	0,0359	1,2813
Adjusted R^2	0,1751		
Log-likelihood	-1699,0720		
Prob(F-stats)	0,0000		
Observations	2051		
Period fixed effects	Yes		
Industry fixed effects	Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

The results of the underpricing regression model which uses sponsor backed dummy are presented in Table V. The regression includes period fixed effects and industry effects, and has been structured this way to do a formal direct test on Hypothesis 1 which is the comparison of conditional underpricing between PE-backed, VC-backed and non-sponsor backed IPOs.

The idea behind inclusion of firm characteristics as control variables is to capture the effect of these characteristics on underpricing and more effectively single out the effect

of **PE** and **SB** dummy on underpricing. The underpricing would therefore be considered to be conditional on the notion that firm characteristics have been accounted for. Wald test is conducted for year dummies and industry dummies to determine if these variables are significant in the regression. The rejection of null in both tests that year dummies are jointly zero and industry dummies are jointly zero, allow us to conclude that both industries and year dummies are significant and should be included in the regression. While most of the independent variables indicate statistical significance, both **PE** and **SB** coefficients show statistical insignificance.

Table V

Underpricing regression model with sponsor backed dummy from 1997 to 2017

The initial returns of IPOs (UP) is regressed against private equity dummy (PE), sponsor backing dummy (SB), natural logarithm of firm's total asset value (Lnassets), EBITDA margin (EBITDA), total debt to total assets (Leverage), natural logarithm of 1+age of firm at flotation (Lnage) and underwriter reputation (UW). This regression is based on sample with winsorized EBITDA margin and Leverage data. Period fixed effects and industry fixed effects are included in this regression through the inclusion of year and period dummies. The t-statistics are adjusted with White-Huber standard errors.

	Regression model with sponsor-backed dummy		
	Coefficient	**Standard Error**	**t- Statistic**
Constant	0,3253***	0,0519	6,2625
PE	0,0209	0,0337	0,6195
SB	-0,0187	0,0333	-0,5616
Lnassets	-0,0142*	0,0077	-1,8497
EBITDA	0,0003	0,0005	0,6249
Leverage	-0,1446***	0,0245	-5,9120
Lnage	-0,0371***	0,0103	-3,5928
UW	0,0460	0,0359	1,2813
Adjusted R^2	0,1751		
Log-likelihood	-1699,0720		
Prob(F-stats)	0,0000		
Observations	2051		
Period fixed effects	Yes		
Industry fixed effects	Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

SB's coefficient takes on expected negative sign but is statistically insignificant in the regression, suggesting that the presence of venture capital or private equity companies do not affect a firm's initial return. Contrary to expectations, the coefficient of PE is positive. However, coefficient of **PE** is also statistically insignificant in the regression. Based on the structure of this regression, the coefficient of **PE** indicates the additional effect of backing by private equity companies, and **SB** captures the effect of sponsor backing that includes the presence of private equity and venture capital companies. Results from earlier regression in Table IV has indicated statistical insignificance in the relation of **PE** and **VC** on underpricing. It is therefore intuitive that **PE** also reflects statistical insignificance along with **SB** variable in this set of results. Contrary to our conjecture formulated during discussion of theories, we find limited support for

hypothesis 1. Study conducted by Bergström, Nilsson and Wahlberg (2006) on London Stock Exchange and Paris Stock Exchange has similarly indicated that certification effect by private equity firms is not significant in explaining the underpricing of IPOs.

SB is statistically significant otherwise when above regression is conducted with exclusion of period fixed effects and industry fixed effects. However, years dummies and industries variables are significant in the regression. The change in result following the addition of these dummies suggests that the effect of certification role of private equity and venture capital companies on underpricing of IPOs has limited support.

Most of the firm variables indicate statistical significance in the regression. **Lnassets** shows statistical significance in its negative relation with underpricing of IPOs. This is in line with our intuition that larger firms are likely to have reduced levels of informational asymmetry and thus lower levels of underpricing.

Leverage, in line with our intuition, shows statistical significance and has a negative significant relation with underpricing of IPOs. It can be suggested that debt claims signal that firm is of high quality since only these firms are able to secure debt. This form of signal would reduce ex-ante uncertainty which results in lower levels of underpricing.

Lnage shows statistical significance in its negative relation with underpricing of IPOs. This suggests that established firms have more information available and thus lower levels of underpricing. This result is in line with prior studies on underpricing of IPOs (Muscarella and Vetsuypens, 1989; Loughran and Ritter, 2004) and our expectation. The negative relation to underpricing suggests that increased availability of publicly information for firms that are in operations for a longer period of time prior to flotation reduces informational asymmetry and thus lowers levels of underpricing.

EBITDA, a control variable in the model, displays statistical insignificance in its relation to underpricing of IPOs. Moreover, the coefficient for this variable is very small and this could be attributed to the negative mean EBITDA margin values.

UW exhibits statistically insignificance in this regression. This could be due to the difference in measurement for underwriter reputation used in this study compared to those in other IPO literature (see Carter et al., 1998).

Main results observed here are largely congruent to the results of the regression model based on sample data without winsorization found in Table X and Table XI (see Appendix). Although coefficient of **PE** has changed sign after winsorization, both PE and VC remain statistically insignificant. **Lnassets** continues to show statistical significance in its negative relation with underpricing of IPOs, albeit a weaker relationship. Previously, for regression without winsorization, **EBITDA** exhibits

statistical significance in its relation to underpricing of IPOs, but the relation is not economically meaningful. Based on discussion of findings, this study provides limited support for hypothesis 1 where we posit that private equity backed IPOs exhibit lowest level of conditional underpricing as compared to venture capital backed IPOs and non-sponsor backed IPOs.

Initial Welch t-tests show that private equity backed IPOs are least underpriced compared to venture capital backed IPOs and non-sponsor backed IPOs. However, based on results from the regressions run where control variables are included, the effect of **PE** and **SB** is statistical insignificant in relation to underpricing. The results from baseline regression similarly show that the effect of **PE** and **VC** is statistically insignificant in relation to underpricing. It can be established that after controlling for firm characteristics, there is limited support for certification role by sponsors on underpricing. The presence of venture capital and private equity firms is therefore not sufficient for explaining the lower underpricing levels of IPOs. Findings show unexpected sign of coefficient estimate of **PE** variable and too much variability to establish statistical significance. There may be the possibility of other unaccounted factors that determine whether or not certification effect is present. It can also be observed that there is fairly strong statistical significance between certain firm characteristics and initial returns of IPOs. This warrants analysis into the relationships between firm characteristics and certification effect.

Table VI indicates the results from the underpricing regressions with interactions effects. These regression models address the hypotheses on the relationships between firm characteristics and extent of certification effect by sponsors.

Model 1: Regression model with size interaction terms

With the introduction of size interactions terms; **Lnassets*PE** and **Lnassets*VC**, coinciding with our expectations, the coefficients on both **PE** and **VC** have become much more negative while the coefficient of the interactions terms are positive.

For interactions terms; **Lnassets*PE** and **Lnassets*VC**, we found no statistical significance in the coefficients. There is no statistically significant evidence that certification effect of private equity backed and venture capital backed IPOs increases as size of firm decreases. We are unable to accept hypothesis 2. The effect of size on the extent of certification effect for both private equity backed and venture capital backed IPOs has limited support. There is lack of a statistically significant relationship between size and certification effect for PE-backed and VC-backed IPOs. One cogent reason may be due to the removal of IPOs with offer price below $5 from our sample. A statistically significant relationship between size and certification effect may only be seen in very small firms, i.e. penny stocks which may have very high information asymmetries. Bradley, Cooney, Dolvin and Jordan (2006) find that penny stock IPOs are more information problematic than ordinary IPOs. Another possible reason is that

investors do not perceive that the presence of sponsorship by PE/VC will lead to lower information asymmetry in small firms backed by PE/VC.

Model 2: Regression model with age interaction terms

With the introduction of age interactions terms; **Lnage*PE** and **Lnage*VC**, coinciding with expectations, the coefficients on both **PE** and **VC** have become much more negative while the coefficient of the interactions terms are positive.

The coefficient of the interaction term; **Lnage*PE** is statistically significant at 1% level. This is indicative of a strong relationship between firm age and the extent of certification effect. The positive coefficient of the interaction term supports that as age decreases, the extent of certification effect increases. When the age of the firms is lower, there is also lower availability of information. This leads to greater uncertainty and information asymmetries which can possibly increase the extent of certification effect. The presence of a private equity firm backing a young issuing firm creates a greater reduction of information asymmetries as compared to a private equity firm backing a much older issuing firm. Therefore, for private equity backed firms, the hypothesis that lower age leads to higher certification effect, is accepted. In toto, for private equity backed IPOs, certification effect has a statistically significant inverse relationship with age.

However, for interactions term; **Lnage*VC**, we found no statistical significance in the coefficients. There is no statistically significant evidence that certification effect of venture capital backed IPOs increases as age of firm decreases. The effect of age on the extent of certification effect for VC-backed IPOs has limited support. As observed, the age of the VC-backed issuing companies has a standard deviation of 0,505 which is almost half of the standard deviation of PE-backed issuing companies. One plausible explanation may be the lack of variation for the age variable for VC-backed IPOs and therefore, the subsequent lack of a statistically significant relationship between age and certification effect of VC-backed firms.

Model 3: Regression model with leverage interaction terms

With the introduction of leverage interactions terms; **Leverage*PE** and **Leverage*VC**, coinciding with expectations, the coefficients on both **PE** and **VC** have become much more negative while the coefficient of the interactions terms are positive.

For interactions terms; **Leverage*PE** and **Leverage*VC**, we found no statistical significance in the coefficients. There is no statistically significant evidence that certification effect of private equity backed and venture capital backed IPOs increases as leverage of firm decreases. We are unable to accept hypothesis 4. The effect of leverage on the extent of certification effect for both private equity backed and venture

capital backed IPOs has limited support. A plausible reason is that the presence of sponsors may not serve as an effective signal of high firm quality to investors in less levered PE/VC-backed firms.

Main results observed here are largely consistent with the results of the regressions based on sample data without winsorization found in Table XII (see Appendix). Compendiously, a statistically significant inverse relationship between firm age and extent of certification effect in PE-backed IPOs was found in the regression model with age interaction terms.

Table VI

Underpricing regression models with interaction terms from 1997 to 2017

There are 3 regressions; one with size interaction terms, one with age interaction terms and one with leverage interaction terms. The interaction variables are Leverage*PE, Leverage*VC, Lnage*PE, Lnage*VC, Lnassets*PE and Lnassets*VC. Size interaction terms are Lnassets*PE and Lnassets*VC. Age interaction terms are Lnage*PE and Lnage*VC. Leverage interaction terms are Leverage*PE and Leverage*VC. The t-statistics for are adjusted with White-Huber standard errors.

	Regression model with size interaction terms (Model 1)			Regression model with age interaction terms (Model 2)			Regression model with leverage interaction terms (Model 3)		
	Coefficient	Standard Error	t- Statistic	Coefficient	Standard Error	t- Statistic	Coefficient	Standard Error	t- Statistic
Constant	0,3327***	0,0563	5,9124	0,3541***	0,0554	6,3953	0,3317***	0,0530	6,2632
PE	-0,0219	0,0736	-0,2981	-0,1444***	0,0483	-2,9897	-0,0228	0,0312	-0,7302
VC	-0,1353	0,1132	-1,1953	-0,0614	0,1619	-0,3792	-0,0388	0,0401	-0,9659
Lnassets	-0,0159*	0,0084	-1,8952	-0,0148*	0,0077	-1,9324	-0,0145*	0,0077	-1,8952
EBITDA	0,0003	0,0005	0,6115	0,0004	0,0005	0,6904	0,0003	0,0005	0,6679
Leverage	-0,1441***	0,0247	-5,8362	-0,1446***	0,0246	-5,8892	-0,1583***	0,0300	-5,2853
Lnage	-0,0371***	0,0104	-3,5570	-0,0498***	0,0130	-3,8412	-0,0373***	0,0103	-3,6133
UW	0,0451	0,0360	1,2501	0,0466	0,0358	1,3013	0,0469	0,0364	1,2884
Leverage*PE							0,0538	0,0470	1,1435
Leverage*VC							0,0818	0,0627	1,3052
Lnage*PE				0,0566***	0,0163	3,4777			
Lnage*VC				0,0204	0,0636	0,3208			
Lnassets*PE	0,0046	0,0116	0,3975						
Lnassets*VC	0,0285	0,0254	1,1224						
Adjusted R^2	0,1745			0,1756			0,1746		
Log-likelihood	-1698,8320			-1697,4160			-1698,6490		
Prob(F-stats)	0,0000			0,0000			0,0000		
Observations	2051			2051			2051		
Period fixed effects	Yes			Yes			Yes		
Industry fixed effects	Yes			Yes			Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

5.3 Robustness

One approach to test for robustness is to conduct earlier tests based on a different sample, which involves removing a specific year data from the original sample. The robustness of this study is verified by omitting crisis periods from the sample data. The volume of IPOs and magnitude of underpricing have been shown to be highly cyclical and subjected to variation. Ibbotson and Jaffe (1975) discern hot issue market from cold issue market depending on the extent of IPOs underpricing. They argue that underpricing is highly cyclical. Cold IPO issues are characterized by reduced underpricing, low issue volume and a reduced tendency of oversubscription (Helwege and Liang, 2004). Crisis period is therefore considered an extreme cold period. Our sample data covers 2 crisis periods; the dot-com crash spanned across the period of 2000 to 2002 and the financial crisis spanned across the period of 2007 to 2009.

Regressions are run based on sample data with these 2 crisis periods removed. The results from this robustness test would allow us to draw insights and determine if exclusion of crisis periods would affect our results.

Table VII shows the results of the underpricing regression model with sponsor backed dummy based on sample data with 2 crisis periods removed. **PE** and **SB** demonstrate statistical insignificance in relation to IPO underpricing, similar to main empirical findings earlier. This finding coincides with earlier analysis that on average, there is limited support for the presence of certification effect by sponsors on IPOs. Control variable **Lnassets** is no longer statistical significant in relation to underpricing with the removal of 2 crisis periods. One plausible reason may be that during crisis periods, uncertainty skyrocketed and firm size became an even better proxy of ex ante uncertainty.

Table VII

Underpricing regression with 2 crisis periods removed

The initial returns of IPOs (UP) is regressed against private equity dummy (PE), sponsor backing dummy (SB), natural logarithm of firm's total asset value (Lnassets), EBITDA margin (EBITDA), total debt to total assets (Leverage), natural logarithm of 1+age of firm at flotation (Lnage) and underwriter reputation (UW). This regression is based on sample with winsorized EBITDA margin and leverage data. Period fixed effects and industry fixed effects are included in this regression through the inclusion of year and period dummies. This regression is based on sample data with 2 crisis periods removed. The t-statistics are adjusted with White-Huber standard errors.

	Regression with 2000 to 2002 and 2007 to 2009 data removed		
	Coefficient	**Standard Error**	**t- Statistic**
Constant	0,3444***	0,0620	5,5507
PE	0,0169	0,0367	0,4607
SB	-0,0055	0,0358	-0,1547
Lnassets	-0,0120	0,0095	-1,2544
EBITDA	0,0008	0,0005	1,4028
Leverage	-0,1269***	0,0276	-4,6005
Lnage	-0,0425***	0,0126	-3,3786
UW	0,0280	0,0438	0,6396
Adjusted R^2	0,1731		
Log-likelihood	-1273,5910		
Prob(F-stats)	0,0000		
Observations	1531		
Period fixed effects	Yes		
Industry fixed effects	Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

Table VIII shows the results for the regression with interaction terms based on sample with 2 crisis periods removed.

For regression model with size interaction terms (Model 1), there is no statistical significance for the constitutive terms **PE** and **VC** as well as the interaction terms **Lnassets*PE** and **Lnassets*VC**. Similar to the main empirical findings earlier, there is no statistically significant evidence that certification effect of PE-backed and VC-backed IPOs increases as size of firm decreases.

For regression model with age interaction terms (Model 2), there is statistical significance for the constitutive term **PE** and no statistical significance for **VC** as well as the interaction term **Lnage*VC**. The coefficient of **Lnage*PE** is statistically significant in relation to initial returns at 1% significance level which is concordant to the main results. The positive coefficient of the interaction term supports that as age decreases, the extent of certification effect increases. The relation between interaction term **Lnage*PE** and constitutive term **PE** on underpricing is similar to our main results. Therefore, the hypothesis that lower age leads to higher certification effect for firms backed by private equity companies is accepted.

For regression model with leverage interaction terms (Model 3), there is no statistical significance for the constitutive terms **PE** and **VC** as well as the interaction terms **Leverage*VC** and **Leverage*PE**. Similar to the main empirical findings earlier, there is no statistically significant evidence that certification effect of PE-backed and VC-backed IPOs increases as leverage of firm decreases.

Overall, the results from the robustness test generate findings that are generally consistent with earlier findings. The results from exclusion of crisis periods demonstrate that the main findings are not affected by cold periods. Both **PE** and **SB** are not statistically significant in relation to underpricing, coinciding with earlier finding that there is limited support for hypothesis 1. For hypothesis 3, it can be established that age has a statistically significant inverse relationship with certification effect for PE-backed IPOs. There is limited support for effect of age on extent of certification effect for VC-backed IPOs. There is limited support for hypotheses 2 and 4 given that there is no statistical significance for relationships between size/leverage and certification effect by PE/VC. The conclusions made from earlier main findings generally hold as illustrated by congruence of general outcome with results from robustness test.

Table VIII

Underpricing regression models including interaction variables with 2 crisis periods removed

There are 3 regression models; one with size interaction terms, one with age interaction terms and one with leverage interaction terms. Size interaction terms are Lnassets*PE and Lnassets*VC. Age interaction terms are Lnage*PE and Lnage*VC. Leverage interaction terms are Leverage*PE and Leverage*VC. The results shown in this table is based on sample data that excludes IPOs during the period of 2000 to 2002 and 2007 to 2009. The t-statistics are adjusted with White-Huber standard errors.

	Regression model with size interaction terms (Model 1)			**Regression model with age interaction terms (Model 2)**			**Regression model with leverage interaction terms (Model 3)**		
	Coefficient	**Standard Error**	**t- Statistic**	**Coefficient**	**Standard Error**	**t- Statistic**	**Coefficient**	**Standard Error**	**t- Statistic**
Constant	0,3546***	0,0690	5,1398	0,3820***	0,0673	5,6733	0,3493***	0,0635	5,4973
PE	-0,0092	0,0864	-0,1061	-0,1512***	0,0573	-2,6363	-0,0057	0,0356	-0,1604
VC	-0,1902	0,1265	-1,5033	-0,0999	0,1792	-0,5573	-0,0193	0,0432	-0,4471
Lnassets	-0,0145	0,0103	-1,4111	-0,0125	0,0095	-1,3137	-0,0123	0,0095	-1,2870
EBITDA	0,0008	0,0006	1,3551	0,0008	0,0006	1,4067	0,0008	0,0005	1,4481
Leverage	-0,1257***	0,0280	-4,4897	-0,1280***	0,0277	-4,6203	-0,1363***	0,0340	-4,0082
Lnage	-0,0423***	0,0127	-3,3149	-0,0584***	0,0163	-3,5916	-0,0427***	0,0126	-3,3981
UW	0,0260	0,0442	0,5886	0,0277	0,0438	0,6325	0,0286	0,0446	0,6402
Leverage*PE							0,0357	0,0532	0,6703
Leverage*VC							0,0512	0,0661	0,7751
Lnage*PE				0,0625***	0,0194	3,2217			
Lnage*VC				0,0427	0,0718	0,5949			
Lnassets*PE	0,0042	0,0136	0,3094						
Lnassets*VC	0,0449	0,0288	1,5592						
Adjusted R^2	0,1725			0,1738			0,1722		
Log-likelihood	-1273,0920			-1271,8930			-1273,4350		
Prob(F-stats)	0,0000			0,0000			0,0000		
Observations	1531			1531			1531		
Period fixed effects	Yes			Yes			Yes		
Industry fixed effects	Yes			Yes			Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

6 Conclusion

Using a sample of US IPOs consisting of PE-backed, VC-backed and non-sponsor backed issues from January 1997 to December 2017, this study demonstrates that PE-backed IPOs are on average, larger, older and more highly levered than VC-backed firms while the characteristics of non-sponsor backed firms are more heterogeneous in nature. This coincides with the investment philosophy of PE firms which usually invest in large, mature and highly levered firms.

Concurrently, on average, both PE-backed and VC-backed IPOs exhibit lower levels of underpricing as compared to their non-sponsor backed counterparts. PE-backed IPOs have the lowest level of underpricing among these three groups. After controlling for firm characteristics, on average, this study finds limited support for certification effect of PE-backing or VC-backing. This implies that there may be other factors unaccounted which will determine whether certification effect is present. This calls for greater research into other sources of certification effect beyond the presence of a sponsor. Other variables including quality of sponsorship and proportion of sponsor ownership can be explored to test if sponsors are able to provide certification effect in general.

While Megginson and Weiss (1991) found support for certification role of VC from 1983 to 1987, this difference in results may be attributed to greater information availability from 1997 to 2017. One plausible explanation is that underpricing could have structurally changed with greater information availability brought by rapid technological advancements. The importance of information asymmetry may have decreased over the past decades, resulting in diminishing presence and importance of the certification role of a sponsor. Robustness tests also suggest that the lower underpricing of PE-backed and VC-backed IPOs may possibly stem from the differences in firm characteristics of their portfolio companies which may not be fully taken into account in previous studies.

We have also investigated the relationships between firm characteristics (size/age/leverage) and extent of certification effect. We have raised the following three questions: Does certification effect of PE-backed and VC-backed firms increases as size of firm decreases? Does certification effect of PE-backed and VC-backed firms increases as age of firm decreases? Does certification effect of PE-backed and VC-backed firms increases as leverage of firm decreases?

The study finds a strong statistically significant relationship between firm age and the extent of certification effect for PE-backed firms. As firm age decreases, the extent of

certification effect increases. As the age of a firm decreases, the availability of information decreases due to shorter business and financial track records. This leads to greater uncertainty, risk and information asymmetries, which can possibly increase the extent of certification effect. The presence of PE-backing thus reduces information asymmetries that accompanies a younger firm, exerting greater extent of certification effect. However, the study finds no statistically significant evidence that this relationship applies to VC-backed IPOs.

As observed from the descriptive statistics of our sample, VC-backed firms as a whole are much younger than PE-backed firms. There is also much lesser variation in age for VC-backed firms as compared to PE-backed firm. One plausible explanation may be the lack of variation and therefore, the lack of a statistically significant relationship between age and certification effect of VC-backed firms. Another possible explanation may be due to the investment style of VC companies. VC companies usually invest in highly risky firms which have high uncertainty, risk and information asymmetries. As the age of a VC-backed firm changes, there may not be significant alteration in the availability of information. This may result in the lack of a statistically significant relationship between age and the extent of certification effect for VC-backed firms.

For both PE-backed and VC-backed IPOs, the study also finds no statistically significant evidence that certification effect of PE-backed and VC-backed IPOs increases as size of firm decreases. There is also no statistically significant relationship between certification effect and leverage of firm for PE-backed and VC-backed IPOs. This signifies that there is limited support for the inverse relationships between firm characteristics (size and leverage) and certification effect in PE-backed and VC-backed IPOs.

In relation to existing IPO research, we have dived into the underpricing phenomenon in PE-backed IPOs which was not extensively covered previously. We have also analysed the underpricing differential between PE-backed, VC-backed and regular IPOs. We have particularly studied how certification effect varies with firm characteristics of issuing firms, bridging the gap in existing literature. This paper has increased the knowledge of underpricing in general and created a deeper comprehension of the underpricing phenomenon, particularly in sponsor-backed and non-sponsor backed IPOs.

6.1 Limitations and Future Research

This study has formed comprehensive analysis based on potential characteristics that drive underpricing in US. One general limitation includes the lack of complete information available for this study from accessible databases. We worked around this limitation to form the sample data by matching identifiers and company names to merge the information from different databases. While it would have been ideal to

perform the study based on a complete set of IPOs conducted from 1997 to 2017 across all US exchanges, it is more meaningful to conduct study based on IPOs that have all information available and necessary for this study. Therefore, IPOs that do not have all required information, are removed from the sample.

Moving forward, there are three potential areas for future research. First, it would be interesting to include quality of sponsor and proportion of sponsor ownership as variables in this thesis. Past studies concentrate on the presence or absence of the sponsor backing and conceal any possible dependence that certification value may have with regards to the sponsor's quality and proportion of sponsor ownership.

Second, it would be beneficial to determine if issuing firms are able to benefit from sponsor-backing in the long term. Buy and Hold Abnormal Returns (BHAR) and Cumulated Abnormal Returns (CAR) between these three individual groups (PE-backed IPOs, VC-backed IPOs and non-sponsor backed IPOs) over the first few years, could be used as performance measures. Potential underlying drivers for long run performance of IPOs could also be investigated.

Third, similar study could be extended to other geographical markets to determine if certificatory role of sponsors is present for other markets. The relationships between the firm characteristics (age, size and leverage) and certification effect could also be studied in other geographical markets.

To sum up, these are the three research areas that could contribute and build on this study. From a global perspective, these insights would complement our current study for investors, academic researchers and professionals, deepen the understanding of the implications on investments undertaken by private equity and venture capital firms.

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Appendix

Table IX
Correlation matrix

This table shows pairwise correlations between the independent variables that are used in regression models. The sample consists of 2051 IPOs across all US exchanges for the period of 1997 to 2017 with an offer price of at least $5,00. IPOs of firms from the financial and real estate sectors have been excluded. **PE**, **VC**, **UW** and **SB** are binary numbers taking the value of either 1 or 0.

Correlation	PE	VC	Lnassets	EBITDA	Leverage	Lnage	UW
PE	1						
VC	-0,1529	1					
Lnassets	0,37089	-0,0749	1				
EBITDA	0,07733	-0,0327	0,13172	1			
Leverage	0,13432	-0,112	0,09478	-0,0342	1		
Lnage	0,20602	-0,0028	0,27158	0,1036	0,09565	1	
UW	0,07405	-0,0755	0,20409	0,08802	-0,0605	0,03272	1
SB	0,78564	0,49127	0,28003	0,04771	0,04827	0,17985	0,01798
Leverage*PE	0,75805	-0,1159	0,34866	0,06528	0,35695	0,18391	0,09931
Leverage*VC	-0,075	0,49044	-0,0726	-0,1041	0,16819	0,01025	-0,1206
Lnage*PE	0,92219	-0,141	0,38613	0,07569	0,13789	0,36734	0,0757
Lnage*VC	-0,1491	0,97494	-0,0697	-0,0204	-0,1041	0,03065	-0,0783
Lnassets*PE	0,95418	-0,1459	0,47416	0,07753	0,15831	0,23551	0,09357
Lnassets*VC	-0,1482	0,96903	-0,0329	-0,0164	-0,1247	0,00076	-0,0537

Table IX (continued)
Correlation matrix

Correlation	SB	Leverage*PE	Leverage*VC	Lnage*PE	Lnage*VC	Lnassets*PE	Lnassets*VC
PE							
VC							
Lnassets							
EBITDA							
Leverage							
Lnage							
UW							
SB	1						
Leverage*PE	0,59555	1					
Leverage*VC	0,24094	-0,0568	1				
Lnage*PE	0,72451	0,72245	-0,0692	1			
Lnage*VC	0,47896	-0,113	0,49538	-0,1375	1		
Lnassets*PE	0,74964	0,77358	-0,0716	0,91276	-0,1423	1	
Lnassets*VC	0,47606	-0,1123	0,42012	-0,1366	0,94985	-0,1414	1

Table X
Baseline underpricing regression model without winsorization

The initial returns of IPOs (UP) is regressed against private equity dummy (PE), venture capital dummy (VC), natural logarithm of firm's total asset value (Lnassets), EBITDA margin (EBITDA), total debt to total assets (Leverage), natural logarithm of 1+age of firm at flotation (Lnage) and underwriter reputation (UW). Period fixed effects and industry fixed effects are included in this regression through the inclusion of year and period dummies. The t-statistics are adjusted with White-Huber standard errors.

	Baseline regression model		
	Coefficient	**Standard Error**	**t- Statistic**
Constant	0,3141***	0,0514	6,1130
PE	-0,0027	0,0195	-0,1368
VC	-0,0173	0,0333	-0,5197
Lnassets	-0,0155**	0,0077	-2,0088
EBITDA	0,0001**	0,0000	2,1510
Leverage	-0,1071***	0,0221	-4,8550
Lnage	-0,0378***	0,0103	-3,6701
UW	0,0484	0,0358	1,3499
Adjusted R^2	0,1731		
Log-likelihood	-1701,5480		
Prob(F-stats)	0,0000		
Observations	2051		
Period fixed effects	Yes		
Industry fixed effects	Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

Table XI
Regression model with sponsor backed dummy without winsorization

The initial returns of IPOs (UP) is regressed against private equity dummy (PE), sponsor backing dummy (SB), natural logarithm of firm's total asset value (Lnassets), EBITDA margin (EBITDA), total debt to total assets (Leverage), natural logarithm of 1+age of firm at flotation (Lnage) and underwriter reputation (UW). Period fixed effects and industry fixed effects are included in this regression through the inclusion of year and period dummies. The t-statistics are adjusted with White-Huber standard errors.

	Regression model with sponsor-backed dummy		
	Coefficient	**Standard Error**	**t- Statistic**
Constant	0,3141***	0,0514	6,1130
PE	0,0146	0,0338	0,4331
SB	-0,0173	0,0333	-0,5197
Lnassets	-0,0155**	0,0077	-2,0088
EBITDA	0,0001**	0,0000	2,1510
Leverage	-0,1071***	0,0221	-4,8550
Lnage	-0,0378***	0,0103	-3,6701
UW	0,0484	0,0358	1,3499
Adjusted R^2	0,1731		
Log-likelihood	-1701,5480		
Prob(F-stats)	0,0000		
Observations	2051		
Period fixed effects	Yes		
Industry fixed effects	Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

Table XII

Underpricing regression models with interaction terms without winsorization

There are 3 regressions; one with size interaction terms, one with age interaction terms and one with leverage interaction terms. The interaction variables are Leverage*PE, Leverage*VC, Lnage*PE, Lnage*VC, Lnassets*PE and Lnassets*VC. Size interaction terms are Lnassets*PE and Lnassets*VC. Age interaction terms are Lnage*PE and Lnage*VC. Leverage interaction terms are Leverage*PE and Leverage*VC. The t-statistics for are adjusted with White-Huber standard errors.

	Regression model with size interaction terms (Model 1)			Regression model with age interaction terms (Model 2)			Regression model with leverage interaction terms (Model 3)		
	Coefficient	Standard Error	t- Statistic	Coefficient	Standard Error	t- Statistic	Coefficient	Standard Error	t- Statistic
Constant	0,3215***	0,0557	5,7672	0,3426***	0,0548	6,2502	0,3146***	0,0521	6,0402
PE	-0,0215	0,0738	-0,2919	-0,1497***	0,0480	-3,1190	-0,0056	0,0305	-0,1842
VC	-0,1565	0,1126	-1,3902	-0,0514	0,1621	-0,3170	-0,0238	0,0398	-0,5966
Lnassets	-0,0172**	0,0084	-2,0417	-0,0161**	0,0077	-2,0896	-0,0155**	0,0077	-2,0124
EBITDA	0,0001**	0,0000	2,1537	0,0001**	0,0000	2,2151	0,0001**	0,0000	2,1199
Leverage	-0,1067***	0,0221	-4,8298	-0,1072***	0,0221	-4,8545	-0,1089***	0,0255	-4,2686
Lnage	-0,0376***	0,0104	-3,6270	-0,0504***	0,0129	-3,9032	-0,0378***	0,0103	-3,6788
UW	0,0472	0,0360	1,3111	0,0491	0,0358	1,3714	0,0490	0,0364	1,3470
Leverage*PE							0,0061	0,0452	0,1354
Leverage*VC							0,0276	0,0602	0,4593
Lnage*PE				0,0568***	0,0162	3,5074			
Lnage*VC				0,0167	0,0637	0,2624			
Lnassets*PE	0,0037	0,0116	0,3208						
Lnassets*VC	0,0339	0,0253	1,3398						
Adjusted R^2	0,1726			0,1737			0,1723		
Log-likelihood	-1701,2250			-1699,8880			-1701,5170		
Prob(F-stats)	0,0000			0,0000			0,0000		
Observations	2051			2051			2051		
Period fixed effects	Yes			Yes			Yes		
Industry fixed effects	Yes			Yes			Yes		

(***) Significant at the 0.01 level, (**) Significant at the 0.05 level, (*) Significant at the 0.10 level

The End