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Initial Returns and Long-Run Performance of Private Equity-backed IPOs in the UK: The Post-Y2K Experience

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Abstract

This paper studies a sample of 257 initial public offerings (IPO) that occurred in the period from 2001 to 2011, differentiated into sub-samples of 32 venture capital-backed (VC), 55 buyout-backed (BO), and 170 non-backed (NB) share issuances undertaken on the London Stock Exchange's (LSE) Main Market and Alternative Investment Market. We separately analyze initial first-day returns, commonly referred to as underpricing, as well as long-run after-market performance using an event study setting with a horizon of 36 months. Our research identifies significant levels of underpricing in UK IPOs. Underpricing varies considerably between different IPO cycles. Moreover, periods of increased IPO activity, so called 'hot-issue' markets, exhibit higher levels of underpricing. Evidence suggests pronounced differences in long-run stock price performance between the three IPO sub-groups independent of the benchmark used to adjust returns. Underlying the analysis is an in-depth case-by-case IPO type separation, in turn based on the collection of extensive data on private equity (PE) portfolio companies' key firm and offering characteristics. As related literature has as of yet only rarely carried out sample selection with comparable elaborateness, we highlight the importance of the distinction between VC- and BO-backing and its implications for post-IPO performance analysis.

Keywords: Initial Public Offering, Private Equity, Venture Capital, Underpricing, After-Market Performance

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1 Introduction

Within finance, only few topics garner more public attention than private equity, a phenomenon that has been met with controversial appraisal by the media since its emergence in the form of leveraged buyouts in the 1980s. Doubt was casted on the assumption that the asset class can benefit the prospects of its target companies. However, studies have shown that private equity firms do in fact contribute to the success and long-term growth in their portfolio companies. The investors are also found to benefit new business creation and to spur innovation (Popov, Roosenboom, 2009a; Popov, Roosenboom, 2009b). The last decades did not only see a considerable increase in size of private equity but also a growing diversification of the asset class, now including financing options across many different investment stages, ranging from early-stage venture capital to later-stage buyout investments. This expansion has been fueled by the burgeoning demand of pension funds, sovereign wealth funds and other investors for alternatives from traditional debt and equity investments (Klier et al., 2009). The zenith of public scrutiny and probably the single most important moment in the private equity investment process is marked by the exit from a portfolio company. Whenever a sale comes in the form of an initial public offering, it constitutes an openly accessible measure of success. When formerly private companies are floated on a stock exchange, their performance can be benchmarked against other publicly traded firms that did not receive financing by private equity investors. Thus, the comparative analysis of IPO companies has often been the subject of research trying to assess the unique effects that private equity involvement has on businesses. Historically, IPO studies have focused on the phenomenon of underpricing, referring to positive first-day returns, and on after-market performance over horizons of three to five years, which is generally found to be inferior to that of overall stock market indices. So far however, the existing literature does not allow for many decisive conclusions and has often yielded contradicting results depending on the used techniques for performance measurement. Especially in Europe there is still a paucity of studies that repeatedly apply comparable approaches in their analysis, meaning that existing work has often focused on different markets, time frames or investment stages. Moreover, we find that overlapping definitions and terms used to describe the sub-groups and investment stages within private equity add to the so far ambiguous results.

With our paper, we try to assist the process of reaching more meaningful insights and comprehensive results on the topic. In terms of geography, we focus on the United Kingdom (UK), a market widely regarded as the most important for private equity in Europe and thus the focal point of activity in the region. A hand-picked sample of IPOs undertaken in the years of 2001 to 2011 meets the objective of observing long-term developments and also allows for the inclusion of recent stock market data. In an attempt to alleviate the controversy observed in parts of the existing literature regarding

nomenclature of private equity and its sub-groups, we apply a thorough approach to the differentiation between early-stage (VC) and later-stage (BO) investments. Depending on investment stage, preferences regarding ownership and financial structure as well as selection criteria for potential portfolio companies may vary widely among the different private equity investors. The distinctive features of different sub-types within the asset class are thus expected to considerably affect portfolio companies and stock market performance. Once the private equity transactions in our sample are differentiated, we study the phenomenon of initial returns on the first day of trading, underpricing, using techniques to account for cross-sectional differences. The results show sizable significant median initial returns of 7.5% for the full sample and time period. Moreover, underpricing varies between different IPO cycles. We identify higher levels of underpricing in times of increased IPO activity, so called 'hot-issue' periods. Furthermore, first day returns vary depending on the respective IPO type. Using a matching procedure that compares initial returns of PE-backed IPOs to the median underpricing of a synthetic IPO portfolio composed of closely matched non-backed IPO firms, we find that VC-backed IPOs are 1.9 percentage points less underpriced than their non-backed control IPOs. BO-backed IPOs on the other hand are 1.5 percentage points more underpriced than their non-backed reference IPOs. The analysis however fails to confirm statistical significance of the observed differences. Long-term after-market performance is calculated using buy-and-hold returns (BHR) for a post-IPO event window of 36 months. Adjustments are made for various benchmarks to account for market movements and cross-sectional differences potentially affecting stock performance. Across all long-run analyses, results are compared to those of the IPO companies in our sample that did not receive private equity financing. Overall performance of the sample companies over the entire time period is in line with previous academic findings of underperformance by recent IPO companies. For all but one of the used benchmarks, whole sample returns turn negative after a period of 12 to 16 months and further deteriorate, reaching double digit negative returns.

Regarding IPO sub-types, we identify striking differences in after-market performance. VC-backed flotations are associated with considerable underperformance expressed by a gradual deterioration over the course of the studied event window. After a brief period of positive returns for several months immediately after an IPO, buy-and-hold abnormal returns (BHAR) drop to as low as negative 57% using stock market adjustment. BO-backed IPOs show a contrary pattern, namely considerably sized positive BHAR throughout the entire event window with the exception of a few months exhibiting negative values using size book-to-market adjustment. Values reach peaks of as high as 49% using stock market adjustment. The returns of the non-backed IPO companies show values that are in between the highs of BO-backed firms and the lows of VC-backed flotations. We observe positive BHAR for approximately the first half of the event window, followed by a gradual decline for the

remainder of the analyzed time period and a culmination in lows of -29%. Results follow a similar pattern across all used cross-sectional adjustments.

Summarizing our findings, the key questions are first of all how results compare to past research on the topic and as to how far explanations for performance differences among different IPO types can be supported. Our results confirm past evidence on the overall magnitude of underpricing but as no statistically significant sizable differences between the sub-samples are identified, we conclude that causal explanations regarding initial return disparity depending on IPO type cannot be reasonably supported by this paper. Considering after-market performance, the inferior results of VC-backed flotations are in line with the majority of literature focusing on European markets. It is reasoned that VC-backed companies are taken public at times of inflated valuations. Venture capitalists thus take advantage of overly optimistic investors and share prices subsequently decline after an IPO. The outperformance of BO-backed IPOs in comparison to other IPO types is also congruent to what past research concluded. Buyout investors are expected to be more experienced, their usually larger sized investments are reasoned to attract more prestigious underwriters and institutional investors, and their typical portfolio companies are said to be more mature than in the case of venture capital-backing. In support of this theory, median market values are highest for the BO-backed sub-group. Furthermore, compared to the other IPO types, a much larger percentage of the buyout-backed IPO group lists on the UK main market, which is characterized by larger and more established companies. While around 64% of BO-backed IPO firms list on the UK Main Market, less than 31% of the VC- and NB sub-sample chose it for their share issuance. However, the pattern of sustained positive abnormal returns throughout the event window in our analysis is somewhat distinct from past research. We stress the possibility that the used in-depth approach to the differentiation of private equity deals into sub-groups, which has as of yet only very rarely been applied by other authors, may affect aggregate performance of the resulting sub-samples.

In detail, this paper is organized as follows. A brief background section providing key definitions and characteristics of the considered market sets the stage for later analysis. Thereafter, an overview of existing literature provides a more detailed understanding of the topic. Derived from this is the section on sample selection and methodology, describing the used approaches and techniques of analysis. The following section on descriptive statistics equips the reader with a detailed understanding of the compiled sample necessary for interpreting the results section it precedes. The final conclusion section summarizes results and puts our findings in perspective. Moreover, it suggests possible fields of further study on the topic.

2 Background

Private equity refers to investments in firms that are not publicly traded on a stock exchange. Anticipating high growth, financing for the target companies is usually provided in return for equity stakes. Included in private equity are both venture capital and buyouts. VC refers to investments in early stage companies as well as investments to facilitate and profit from further growth in still relatively young companies. VCs typically focus on entrepreneurial undertakings. Buyouts refer to acquisitions of already established companies and are often financed with the help of debt instruments (Bourrat, Wolff, 2013). Buyout investors usually buy existing shares from previous owners and subsequently try to improve operating performance of the portfolio company (ICAEW, 2014). In addition to providing vitally needed financing, PE investors also support their portfolio companies with valuable industry knowledge and access to business networks. This is especially important for VC-backed companies as they tend to be in an early phase of corporate development.

Even though differences between the two subgroups of PE are clearly distinguishable, a considerable body of research, mainly in Europe, uses the term Venture Capital to refer to both early- (VC as we label it) and later-stage (BO-related) investments and thus synonymously with our definition of Private Equity. Adding to the confusion, other authors use the term PE in a narrower sense, only referring to BOs and excluding VC from the definition. When analyzing and comparing existing literature, the nomenclature used by the respective authors can lead to confusion. Exemplifying the historically loose definitions, both the European and the British trade body for companies operating in all sub-groups of PE originally bore the name ‘venture capital associations’. The factor of nomenclature and its implications for results and conclusions do not seem to have always been granted the necessary importance in prior research and we advise the reader to bear this ambiguity in mind when studying the topic. Clearly distinguishing venture capital from buyout investments is especially important for the United Kingdom as large private equity firms, investing at all the different investment stages, are a major source of non-public equity financing in the country (BVCA, 2012).

The roots of private equity in the UK date back to the late 18th century when wealthy individuals started to financially support business projects outside of the public markets. However, the incorporation of private equity companies as we know them today only started in the 1970s, when some of the companies that shape today’s market such as the 3i Group were founded. Being one of the most important private equity companies in Europe, 3i is also prominently featured in our sample, having participated in more than 15 of the identified PE transactions. Other PE firms that have invested in multiple companies in our IPO sample are for example Bridgepoint Capital Advisers, CVC Capital Partners, Alchemy Partners, Permira Advisers, and the IP Group. Presently, there are more than 250

PE firms operating in the UK according to the British Private Equity and Venture Capital Association (BVCA). Providing a common law code and highly developed stock exchanges, the UK private equity market is considered to be the most mature in Europe (Chahine et al., 2007). This is illustrated by the fact that the UK market accounts for around 50% of funds raised by PE companies in Europe (EVCA, 2013). Having participated in two major waves of PE activity, namely the boom in leveraged BOs in the 1980s and the VC-dominated Dotcom bubble period around the turn of the millennium, UK-based PE firms became more and more experienced. Subsequently, higher involvement in portfolio companies' management as well as increasing specialization on specific industries was noticeable.

The time frame analyzed in this paper, namely the years 2001 through 2011, coincides in its onset with the end of the Dotcom boom, a period in which Venture Capital funding for technology companies was available in abundance. Traditional BOs were not as important during the time and had virtually disappeared in the aftermath of the junk bond market crash at the end of the 1980s. With the burst of the Dotcom bubble, the record levels of VC fundraising and investing experienced worldwide and in the UK during the years around 2000 collapsed just as quickly as did stock prices at the time (BVCA, 2014). Fueled by an again roaring stock market during the mid-2000s, funding levels rebounded to almost the levels of the Dotcom period. In contrast to the previous waves, which had usually been dominated by one sub-group of PE investors, the occurrence of both early- and later-stage funding sharply increased. The years of 2005 to 2007 saw the emergence of so-called mega-buyouts, large debt financed transactions of unprecedented size. Even though these investments were undertaken by PE companies from all over the world, UK companies, alongside with competitors from the US, represented the major participants at the time. The financial crisis of 2008 and the subsequent credit crunch marked the end of this most recent cycle in PE activity. As the exit from portfolio companies is a vital part of the PE business model, the observed trends in VC and BO financing should over time be reflected in the number of IPOs backed by PE investors. This expectation is derived from Tykvová and Walz's (2004) finding that for VC firms, an IPO represents the exit channel of choice compared to other possible options such as a private sale back to management or to a third party via a secondary sale. Schwienbacher (2002) argues that as the exit represents the quantitative assessment of a PE firm's quality, a successful IPO, receiving considerable publicity, is highly desirable. In our sample period we see a notably higher level of IPO activity during the period from 2004 to 2007 than in the preceding and following years. The observation is in line with research suggesting that IPOs in general, as well as flotations backed by financial investors, cluster in time (Ibbotson, Jaffe, 1975; Schöber, 2008). Further analysis of IPO characteristics eventually leads to the studying of stock price performance, on which this paper shall focus in the following sections.

3 Literature Review

3.1 Underpricing

Past research on IPOs focusses on the observed long-run performance of the shares of a company over the course of several years and on the returns on the first day of trading, referred to as underpricing and predominately defined as the difference between the closing price of a stock on the first day of trading and its respective offering price as a percentage of the offering price. The reason that existing literature on the topic generally refers to initial returns as underpricing is abundantly available evidence showing that IPOs across many different markets and time periods exhibit significant positive first day returns, usually ranging between 15% and 20% (Schöber, 2008). Underpricing has been found to increase for an extended time period leading up to the Dotcom bubble around the year 2000 and reaching a historical peak with values of as high as 70% (Ritter, Welch, 2002). Explanations for the phenomenon are based on the presence of asymmetric information (Loughran, Ritter, 1994), implying that prospective investors do not possess sufficient insight into the company going public and are uncertain about the quality of the firm and its expected future share price development (Rock, 1986). They thus require a return for the risk taken when acquiring shares in an IPO. Accounting for this uncertainty, underwriters tend to offer shares at a discounted price compared to the company's underlying fair value (Tinic, 1988).

The distinction between different financial backers of IPO companies, constituting a key focus of our analysis, has been the topic of a considerable body of literature. As mentioned earlier, the differentiation between VC- and BO-backing has not been handled homogenously and varies depending on authorship, analyzed countries and studied stock markets. As it is not possible to retroactively apply our approach to past research, we shall state all findings maintaining the nomenclature used by the respective authors. The cited classifications of VC-backing, BO-backing and, more broadly, PE-backing can thus overlap and need to be handled with care. Beyond the labels assigned to each sub-group, the different kinds of financial backers have considerable impact on their portfolio companies. This can lead to altered capital structure and influence both management decision making and overall strategy, all of which can be expected to affect firm characteristics and thus, IPO performance. One strand of literature identifies a lower level of underpricing in VC-backed and BO-backed IPOs (Barry et al., 1990; Megginson, Weiss, 1991). It is argued that venture capitalists and BO investors, closely monitoring their portfolio companies, provide a certification of the issuing firm's quality. Having established a positive reputation among investors by successfully exiting past investments, PE companies are therefore in a position to lend reputation to their portfolio companies (Kraus, Burghof, 2003). This signaling role leads to reduced asymmetric information and thus lower

levels of underpricing. Megginson and Weiss (1991) suppose that VCs with a high reputation are able to attract more prestigious auditors and underwriters for an IPO, whose involvement could help to further reduce uncertainty among prospective investors. Another explanation for reduced underpricing relates to financial backers and their objective to maximize returns on investments. The ultimate goal is thus a high offering price which translates into a small as possible amount of money in the form of positive first-day returns being 'left on the table' by the selling shareholders (Schöber, 2008). Under this assumption, companies are preferably taken public when an offering price close to the assumed underlying value can be achieved in the market, linking PE investors to the ability of exit timing. Contradicting evidence on the phenomenon of underpricing comes from another stream of research that points to the conclusion that VC-backed IPOs are associated with more and not less underpricing when compared to non-backed IPO companies (Lee and Wahal, 2004; Rossetto, 2008). In an attempt to explain these findings, Gompers (1996) suggests the motive of grandstanding for VC investors, especially among relatively young and less well-known VCs. Because it is crucial for these companies to attract capital for future investments, they need to build a reputation of successful portfolio company exits. This goal is of paramount importance as VC funds have finite lives and capital has to be returned to investors. Hence, in order to complete portfolio company exits and to secure future contributions to their funds, the venture capital investors are prepared to bear the cost of higher underpricing. The increased first-day returns in this case are due to the fact that the prematurely exited portfolio companies tend to be younger and less mature when rushed to be taken public, which is associated with higher perceived risk. In a related study, Hsu (2009) analyzed the connection between the duration of VC participation and operational success of companies that receive funding. He finds that a longer period of involvement of a VC investor is associated with superior performance and increased probability of survival of a portfolio company. Heightened underpricing caused by grandstanding might also stem from the fact that VCs prioritize completion of the exit over everything that could potentially decrease underpricing. Hence, they for example forego attempts to time the market in order to achieve favorable offering prices (Flagg, 2007). In contrast to VCs, the grandstanding motive is considered to be less important in the case BO-backed IPOs as these investors tend to be more mature, having already built considerable reputation. Gompers (1996) suggests that the same can be expected for established VCs in well developed markets such as the United Kingdom. In line with this assumption, Jelic et al. (2005) provide evidence that BO-backed IPOs are associated with less underpricing than VC-backed IPOs. Mogilevsky and Murgulov (2012) however fail to identify a difference in underpricing between IPOs backed by BO-type investors and those of non-backed firms. Summing up, the evidence on the phenomenon of underpricing, albeit not yielding a completely unambiguous picture, suggests that VC- and BO-backed IPOs exhibit reduced first-day returns compared to those of non-backed companies.

3.2 After-Market Performance

Beyond first-day returns, stock prices are analyzed over a longer time period in order to assess the performance of IPOs and the differences between the identified IPO-types. This is achieved by comparing a company's share price development to that of a relevant benchmark (Van Frederickslust and van der Geest, 2000). Long-term in this context usually refers to a time horizon of three to five years. The analysis of long-run stock performance is complicated, however, as there is no generally accepted way of conducting such a study, resulting in differences concerning for example the used return metrics, benchmarks, and time regimes. These factors are of great importance when comparing results of existing literature (Schöber, 2008). Considering IPOs in general, various studies have confirmed underperformance, meaning long-run returns that are below those of the used benchmark. Aggarwal and Rivoli (1990) did so for a time span of one year, Ritter (1991) as well as Loughran et al. (1994) for a period of three years and Loughran and Ritter (1995) using share price data of five consecutive years. The findings suggest that investors systematically overestimate the prospects of IPO companies. Initial market prices after flotation thus reflect the valuations of overly optimistic investors (Chemmanur, Loutskina, 2006; Miller, 1977). This may also be the result of generally inflated valuations due to economy or industry-wide bubbles and business cycle peaks. However, as peak periods subside, earnings tend to mean revert. Moreover, as more and more information about an IPO firm becomes available, valuations at the time of flotation may prove excessively high (Fama, 1998). In combination, this can lead to fading optimism among shareholders and deteriorating long-run performance as a result of share sales (Ritter, 1991). Derived from these findings is the hypothesis that issuers deliberately exploit investor behavior by taking firms public whenever the aforementioned temporarily increased valuations can be realized. Loughran and Ritter (1995) refer to this phenomenon as 'windows of opportunity' being seized by selling shareholders. Beyond theories related to the timing of flotations, another possible explanation for long-term IPO underperformance involves agency problems meaning that as pre-IPO owners and managers reduce stakes in a company when going public, their incentives for improving operating performance are diminished (Coakley et al., 2007).

Similar to the phenomenon of underpricing, long-run stock performance of IPO companies in connection with different types of financial backing has been studied to a considerable extent. Research by Brav and Gompers (1997) has identified an outperformance of VC-backed firms relative to non-VC-backed firms when using equally weighted average returns. The used sample contains over 900 VC-backed IPOs in the US within the years of 1972 to 1992. Of major importance for the results is the especially poor performance of small non-backed IPOs, which is the reason why the observed performance difference between VC- and non-backed IPOs diminishes once average returns are value-weighted. The influence of the invested VCs in terms of knowledge transfer and monitoring

as well as their ability to attract superior management personnel is cited as an explanation for the findings. In addition, VCs may only take those portfolio companies public that they expect to have the highest probability of future success. Sørensen (2007) finds that the more experienced VCs are, the more successfully their portfolio companies tend to operate. In turn, better performing portfolio companies are more likely to be taken public. Thus, VC-backing in an IPO may be a signal for quality. Comparing the stock performance of firms that went through this pre-IPO selection process to that of companies which did not, namely non-backed IPOs, may explain the observed superior performance of VC-backed flotations (Kraus, Burghof, 2003). Moreover, VC investors might benefit the fully or partially exited portfolio company by retaining board seats or continuously providing access to valuable business networks (Barry et al., 1990). However, further studies on the subject yield mixed results. Some find that performance of the group of VC-backed companies compared to non-backed IPO firms declines after an IPO (Cumming, MacIntosh, 2000). Contrary to the reasoning in Gompers's (1997) work, the observed disparity is attributed to reduced monitoring as a result of the exit of VC investors. Beyond VC-backed flotations, van Fredericklust and van der Geest (2000) also considered BO-backed IPOs and identified an outperformance of PE-backed IPOs compared to non-backed IPOs for a sample of companies in the Netherlands. Focusing on BOs, a European analysis of flotations between 1994 and 2004 by Bergström et al. (2006) finds BO-backed IPOs to perform better than non-backed IPOs in the long term. The study argues that BO-backed IPOs are usually larger in size than other flotations and link this fact to more publicity received and the presence of knowledgeable institutional investors as post-IPO owners. Analysis by Levis (2011) finds BO-related IPOs to produce positive abnormal returns for all used benchmarks. However, as studies on BO-backed IPO performance is generally scarce, especially for markets outside the US, we also considered literature covering IPOs of reverse leveraged buyouts (RLBO). It has to be noted that these companies, as they have been previously traded on a stock exchange, are usually associated with less information asymmetry than regular BO-backed IPOs. Using a sample covering multiple countries and ranging from 1980 to 2002, Cao and Lerner (2009) find that the studied companies consistently outperform the market.

Besides the overall long-term stock performance of PE-backed companies, a strand of literature focuses on the timing of the trends in performance within the used samples. The observed patterns are often associated with the exit behavior of financial backers that did not fully dispose all their shares in an IPO but decided to stay invested in the portfolio company and sell their remaining stakes at some time after the flotation. Gompers and Lerner (1998) for example find superior performance of VC-backed IPO firms up until the complete exit of their respective investors. The effect reversed after the VCs were no longer invested in the companies. Bessler and Kurth (2005) find

comparable outperformance of VC-backed companies in Germany over a post-IPO period of six months and an underperformance over the following 18 months, linking the evidence to the expiry of lock-up commitments¹. The same conclusion is reached by Espenlaub et al. (2003) who find underperformance of VC-backed firms compared to non-backed companies as soon as the end of the lock-up period for pre-IPO owners is reached. Kraus and Burghof (2003) argue that as VCs need to timely exit portfolio companies, they are more likely than other investors, especially shareholders of non-backed IPOs, to quickly sell their shares subsequent to the end of the lock-up period. This in turn results in greater downward pressure on the underlying share price and a sharper decline in stock performance for the VC-backed subset of companies when compared to non-backed IPO companies.

Casting doubt on the studies that find notable performance differences between IPO sub-types, another stream of literature fails to identify any such disparity. Campbell and Fry (2004) find no difference in performance of VC-backed and non-backed IPO companies. Jelic et al. (2005) reach the same conclusion when studying a sample of management buyout-backed IPOs in the UK and comparing to non-backed companies. Summarizing the available research, the long-run effect of VC- and BO-backing on the stock performance of IPO companies compared to non-backed firms does only allow for few decisive conclusions. While VC-backing in the US seems to be associated with long-run outperformance of respective IPO companies compared to non-backed IPOs, European evidence fails to confirm this view. IPOs backed by BO investors are mostly found to perform better than non-backed flotations in the long-run, regardless of the analyzed time frame or stock market. Besides performance over the complete long-run samples, a heap of available literature does show outperformance for VC-backed IPOs for a limited time after an IPO, linking the finding to the end of lock-up periods. In combination with the literature covering IPO underpricing detailed above, the overall results yield an inconclusive picture. As of yet, it was only rarely possible to identify clear patterns that apply to different markets, time frames and IPO types and that can be repeatedly confirmed by subsequent studies. The question at hand is what the disparity in results is produced by. Past literature suggests varying methodologies for analysis and underlying differences between firms or stock markets and inhomogeneous time periods. Our paper will try to assist the ongoing efforts of understanding the effects of different types of financial backing on IPO underpricing and long-term stock performance.

¹ Lock-up agreements and resulting lock-up periods (also referred to as lock-in in the UK) are defined as contracts between pre-IPO shareholders of an issuing firm and the underwriters of the listing under which the original shareholders agree to abstain from selling shares of the company for an agreed upon time after the flotation, usually between six to twelve months (Espenlaub et al., 2003).

4 Sample and Methodology

4.1 Sample Selection

4.1.1 General Sample

The analysis of this paper is based on UK IPOs during a time from 2001 through 2011. The lower boundary of 2001 was set in an attempt to exclude the potentially distorting effect on findings of the preceding Dotcom bubble. Past studies repeatedly cited the significant influence this relatively short period had on results (Levis, 2011). The upper boundary of 2011 was set in order to ensure the availability of 36 months of stock price data for all IPOs including those dated shortly before the end of the sample period. We obtain a complete list of new issues on the LSE Main Market and the LSE Alternative Investments Market (AIM) from 2001 to 2011 from the 'New Issues & IPO Summary' available on the exchange's website (London Stock Exchange, 2014). The summary includes details on the date of the IPO, the listing market, market capitalization, offer size, issue price, as well as industry classification. The total sample of just over 3000 companies was reduced through following procedures proposed in previous academic contributions:

- We excluded any listings not classified as an IPO, such as secondary equity offerings. This reduces the sample to less than 2000 new issues.
- Furthermore, cross-listings of companies not incorporated in the UK were deleted from the list.
- Common procedure in the academic literature is to exclude any IPOs of companies active in the banking or insurance sector. Moreover we also excluded other IPOs related to the financial sector including a large number of specialized funds, investment trusts, as well as any real estate affiliated companies.
- Finally IPOs with an offer size below £10 million were also removed from the sample.

Through the above listed measures the size of our final sample was reduced to 292 companies, which went public on either the London Main Market or AIM from 2001 to 2011.

4.1.2 Distinguishing Private Equity-backed IPOs

As pointed out earlier, the distinction between the different IPO types is expected to be of major importance. We believe so because firm differences of both the investors and the portfolio companies can significantly affect IPO performance, may it be on the one hand as a result of a different capital structure, industry or size of a portfolio company or on the other hand as a result of a different level of experience of an investor. However, establishing whether a company belonged to the VC-, BO- or non-backed group prior to its IPO proved to be a challenge for several reasons. First of all, there is a general paucity of publicly available information on private equity deals. Furthermore, as Cao and

Lerner (2009) and Schöber (2008) note, lines between VC and BO firms have become increasingly blurry, making the distinction between these two subgroups even more demanding. On a similar note, Wright and Robbie (1998) observe a trend of VC firms, which formerly invested exclusively into early-stage transactions, expanding into a wider range of financing activities such as management buyouts and buyins. Additionally, private equity companies tend to invest through a variety of funds with the ultimate ownership often being hard to establish. Many previous studies, especially on the US market, assume a close link between the type of financial sponsor and the type of investment (Schöber, 2008). In fact, common procedure was to classify private equity-backed IPOs as either VC- or BO-backed according to the financial sponsor's listing in the directories of national VC or BO organizations, among others found in Coakley et al. (2007) and Chahine et al. (2007). This may have been applicable for studies focusing on time periods before the turn of the century, when activities of BO and VC firms were largely distinct. However, as Levis (2011) remarks, the overlap among sponsors in BO- and VC-backed IPOs has strongly increased in the United Kingdom. This may have led to the above mentioned usage of the term venture capital to refer to all kinds of private equity transactions, regardless of investment stage, in Europe and especially in the UK (Schöber, 2008). As such an approach can yield distorted results, a more refined distinction between VC-, BO- and non-backed IPOs is desirable in order to investigate differences in underpricing and long-run performance between the three subgroups. Therefore, to be as precise as possible, we individually research each IPO in order to first establish the involvement of a private equity sponsor prior to the IPO, and second to distinguish between VC- and BO- backed IPOs. To the best of our knowledge, this approach has as of yet only rarely been applied in comparable depth and thus constitutes a unique characteristic of this paper.

Similar to Schöber (2008), two conditions have to be met for an IPO to be defined as private equity-backed. First, the company has to have experienced either a type of buyout investment or received venture capital financing. Second, the private equity sponsors are required to own a significant equity stake in a portfolio company prior to the IPO. If multiple private equity investors were present in one company, their respective shares were in aggregate considered as a syndicate of sponsors. Our threshold calls for a combined ownership by the financial sponsors of at least 15% of total share capital. Therefore, determining the initial affiliation of our IPOs to either a private equity-backed or a non-backed sample demands an analysis of pre-IPO shareholders. The primary source for this sort of information was the listing prospectus, which usually contains a list of shareholders interested in 3% or more of the total share capital immediately prior to and after the IPO. Several sources were utilized in order to collect IPO prospectuses for as many listings as possible. First of all, the UK Listing Authority publishes approved prospectuses, which are available in digital form on the Morningstar Document Library. Unfortunately, a number of IPO prospectuses seems to be unavailable

electronically and can therefore only be viewed at the viewing facility of the UK Listing Authority in London. However, in some rare instances, even though the prospectus was not accessible through Morningstar, a copy could be attained through either the Bloomberg Professional Service or the company's investor relation website.

For IPO companies looking to list on the AIM, IPO prospectuses were harder to come by. The London AIM however requires applicants to the exchange to submit admission documents containing key information on the company and the offering prior to the listing. Similar to an IPO prospectus, these so-called AIM Schedules contain information on parties interested in more than 3% of total shares immediately before and after the IPO. In instances where neither a prospectus nor an AIM schedule was available, confirming the participation of a private equity sponsor was more challenging. One further source utilized in order to gather information on pre-IPO shareholders was Bureau van Dijk's Zephyr database, which contains detailed information on M&A activity as well as several public listings. In order to ensure a large enough sample size, as a last resort we attempted to establish affiliation to the private equity- or non-backed IPO group by studying news articles on the companies around the time of their listing dates. The Factiva news article database proved to be an efficient tool to obtain articles on the IPO companies from the period of interest surrounding the flotation. Additionally to Factiva, a general internet based search was used to supplement the information. Since news articles in general may not be the most reliable sources, contained information was only used if there was at least one other confirming source.

Due to the before mentioned possible overlap of VC and BO companies' activities, sorting the private equity-backed subsample further into a VC- and BO- backed group required careful case-to-case analysis. If an IPO company was involved in any type of BO transaction prior to the IPO, the company was assigned to the BO sub-sample. Types of BO transactions include leveraged buyouts, management buyouts and buyins, as well as secondary buyouts. IPO firms were classified as VC-backed if a company received start-up, development or expansion capital before its public listing. In some rare cases, companies initially received VC funding and at a later stage underwent some sort of BO. These firms were allocated to the BO sub-sample, since it can be assumed that the influence of the more recent BO transaction outweighs and the BO sponsor will most likely be more actively involved than the VC backers, whose stakes have been either diluted or entirely sold in the BO transaction. Our primary medium to gather detailed information on private equity-backed IPOs was Thomson's VentureXpert database. For several portfolio companies of private equity sponsors in our sample, VentureXpert contains details on types of previous investments, such as past funding rounds in case of VC deals or the type of buyout for BO deals. Furthermore, Unquote, a news portal specialized on the European private equity market, proved to contain additional background information on a

number of private equity transactions, allowing us to clearer distinguish between VC- and BO- backed deals. Once more, the Factiva news database as well as a general internet search using the name of the portfolio company and the private equity sponsor as keywords was used to collect additional information on the type of transaction. Finally, even though generally publishing only very limited transaction details, in some instances PE investors shared insightful information on exited portfolio companies via their corporate website.

In addition to separating VC- and BO- backed IPOs, the above mentioned resources were used to collect details on stockholdings of private equity companies immediately before and after the IPO. We only include an IPO into our VC or BO sample when it can be assumed that the private equity sponsors were able to exercise significant influence. Thus, as mentioned before, IPOs are assigned to the VC or BO group if the involved private equity firms collectively owned at least 15% of the total share capital before the listing. In cases where private equity shareholdings did not exceed the threshold, the IPO was classified as non-backed. If despite our best efforts, we were either not able to clearly assign an IPO to one of our three sub-groups or clearly establish stockholdings of the involved private equity companies, the IPO was excluded from our analysis. This leaves us with a final sample of 257 companies, of which 32 are VC-backed, 55 are BO-backed and 170 firms fall into the non-backed sample. We concede that a justified critique to our paper may be the limited sample size. However, making a precise distinction between VC, BO and NB IPOs, as well as collecting information on the private equity sponsors' pre- and post-IPO shareholdings requires thorough and time-consuming research on each individual IPO. Hence, we faced a trade-off between sample size and accurateness of our data. In light of the fact that many private equity houses nowadays partake in both venture capital deals and buyouts, we argue that simply assigning private equity-backed IPOs to sub-groups according to the private equity sponsors' listing in national VC or BO directories can lead to erroneous segmentation. Therefore, we prioritized quality over quantity in the assemblance of our data and strived to create a unique sample in which every single IPO is categorized based on extensive research regarding its pre-IPO financial sponsors.

4.2 Underpricing Methodology

We follow the standard procedure in the academic literature to analyze initial returns of IPOs in our sample (Ritter, 1984; Loughran and Ritter 2004). Moreover, we continue with the synonymous use of the terms initial return and underpricing, which is calculated as the percentage change from the offer price ($P_{o,i}$) to the closing price on the first day of trading ($P_{c,i}$), hence:

$$Underpricing_i = \frac{P_{c,i} - P_{o,i}}{P_{o,i}}$$

The offer prices are provided by the London Stock Exchange. The first day closing prices on the other hand were individually collected for each IPO, with the assumption that the first day of trading corresponds to the official listing date stated by the London Stock Exchange. In order to be as precise as possible, closing prices were cross-checked using several databases. First of all, we collected unadjusted price data from Datastream. We use unadjusted price data to exclude corporate actions such as stock splits, which can significantly distort underpricing results. As a first sanity check and to fill out any blanks, where Datastream price data was not available, we also obtained closing prices on the same day from the Compustat database. Finally, historical prices on the Yahoo Finance portal were used to further improve the robustness of our closing prices.

We describe the magnitude of underpricing for our total sample, as well as across the VC, BO and NB IPOs sub-samples. However, simply comparing initial returns of the three different groups neglects cross-sectional differences between IPO types. For instance, Loughran and Ritter (2004) and Ljungqvist and Wilhelm (2003) find differences in underpricing depending on the IPO cycle. Furthermore, firm characteristics such as market value, offer size and industry may significantly affect the level of underpricing (Hogan et al., 2001; Schöber, 2008). In a perfect setting, in order to draw conclusions about the effect of private equity involvement on an IPO's underpricing, one would like to observe the first day return of a private equity-backed IPO and compare it to the same IPO had it not received any private equity financing. Since this is not possible in practice, a next best approach used in various academic papers matches VC- and BO-backed IPOs to a single, as similar as possible, NB IPO firm with regard to several firm specific metrics such as market value, offer size or industry, as well as external factors like the IPO cycle (Hogan et al., 2001; Ang, Brau, 2002).

However, in our analysis we chose to utilize a slightly different approach to matching firms proposed by Schöber (2008).² He argues that by using a matching procedure which assigns only a single control firm, the analysis is prone to distortion caused by firm- or offering-specific factors that can affect the underpricing of the control firm. Therefore, for every BO-backed IPO firm, he creates a synthetic control IPO, derived from a portfolio of NB IPO companies that possess similar characteristics along various dimensions. More specifically, to be included by Schöber as a part of the synthetic control IPO portfolio for a certain BO-backed listing, companies must:

- Go public in a time window of 12 months around the BO-backed IPO.
- Operate in the same industry as the BO-backed firm.

² Schöber (2008) focuses his analysis on BO-backed IPOs and does not include VC-backed IPOs.

- Possess pre-IPO book value of assets and offer size that are at most 500% and minimum 20% of the respective values of the BO-backed IPO company.

By aggregating first day returns of these closely matched NB IPO companies using medians, firm- or offering-specific factors that may affect underpricing are cancelled out. Thereby, Schöber creates a reference transaction for every BO-backed IPO firm, which resembles the respective company along several key dimensions. The median of the differences in underpricing between BO-backed IPO companies and their synthetic control IPOs are then analyzed in order to make inferences about the effect of private equity involvement on the magnitude of underpricing. With the data available to us, we attempted to follow Schöber's matching approach as closely as possible. In detail, we created synthetic control IPO portfolios for every firm in our BO and VC sample as follows:

- Non-backed control firms have to go public during the same IPO cycle as the private equity-backed IPO company. We identify three distinct IPO cycles within our sample period. The first cycle reaches from 2001 to 2003 and is characterized by only moderate IPO activity as a result of the Dotcom crisis at the turn of the century. The next cycle from 2004 to 2007 can be characterized as a 'hot-issue' period with a booming IPO market. In fact, around 70% of the listings in our sample occur in these four years. The subsequent international financial crisis led to a considerable decline in the frequency of IPOs in our third cycle from 2008 to 2011. The main reason for extending Schöber's allowed time window of 12 months around the PE-backed listing date, in which non-backed IPOs can fall, was to ensure a sufficient amount of control firms in each synthetic reference IPO portfolio. Nevertheless, we believe that using our segmentation of IPO cycles, we achieve a sufficient distinction between inhomogeneous periods in our sample with regard to IPO frequency and market environment.
- Reference firms are required to operate in the same general industry as the VC- or BO-backed firm. Broad industry classification was determined by collecting the first digit of each IPO firm's Standard Industrial Classification (SIC) code.
- The control firm's market value and offer size have to fall within a range of 500% and 20% of the respective values of the VC- or BO-backed IPO firm. We chose to use market values at the close of the first trading day, rather than book values of assets as a proxy for firm size, because book values of assets prior to the listing are only sporadically available.

For three companies within both the VC and BO sample, no control IPO could be identified using the above matching criteria. Obviously there exists a trade-off between the accuracy of our match and the number of identifiable control IPOs. In order to ensure a minimum amount of IPOs in each synthetic control IPO, we neglect the identical industry requirement for the six private

equity backed listings where no match was initially found. As a result, we succeed in creating synthetic control IPOs with closely matched criteria that are assumed to affect initial first-day returns for every single BO- and VC-backed listing in our sample.

In a next step we determine the underpricing of the synthetic IPO portfolios as the median of the first-day returns of the non-backed reference transactions assigned to the respective portfolio. Analogous to Schöber, we use medians rather than averages, because averages may be distorted due to extreme outliers. Thereafter, we calculate the median difference between the underpricing of the synthetic IPO portfolios and their assigned private equity-backed IPOs, in order to determine differences in initial first-day returns. To check whether median differences are significantly different from zero, we use a Wilcoxon signed rank test.³

The additional data required in the matching procedure was collected from two main sources. The London Stock Exchange's new issues list provides information on the listing date, the offer size, as well as the market value implied by the first trading day closing price. In order to double check market values and fill any blanks, market values were also collected from Datastream. Market values as well as offer sizes have to be adjusted for inflation to ensure comparability between IPOs that occurred in different years. With yearly Consumer Price Index data from the UK Office for National Statistics, all values are expressed in 2001 Great British Pound Sterling (GBP). Furthermore, Datastream also presents us with SIC codes for the IPO companies contained in our sample required for the industry classification.

4.3 After-Market Performance Methodology

In the analysis of long-run post-IPO performance, no best practice methodology has so far clearly distinguished itself in the academic literature. In fact, prior research has shown that results may depend on a variety of parameters such as the return metric (buy-and-hold abnormal returns versus cumulative abnormal returns), the time regime (event time versus calendar time), as well as the method of aggregating returns (equal-weighted averages, value-weighted averages or medians). The main reasoning behind the choice of our parameters in the long-run performance analysis was ensuring comparability with the existing literature.

We choose to implement an event study time regime since most long-run performance studies contain an analysis carried out in an event setting (Brav, Gompers, 1997; Levis 2011). In an event time study, returns of IPO firms are calculated for a given number of months following the event, which in our case is the IPO. Abnormal returns with the same relative distance to the IPO, i.e. in the

³ The Wilcoxon signed rank test is a non-parametric alternative to the student's t-test that does not assume normality in the data and can thus be used when this assumption is violated.

same event month, are then averaged across IPO type sub-groups with the chosen method of aggregating returns.

We analyze a post-IPO holding period of three years, which is on the lower end of the time frames commonly considered in prior research, mostly ranging between three and five years (Bergström et al., 2006). Hence, we were able to include more recent IPOs into our sample. In particular, we compound daily returns for the partial IPO month, starting with the second day of trading in order to exclude the effect of underpricing and avoid potential distortion of the results. This is necessary in order to clearly distinguish between the separately measured initial returns and the long-term performance of IPO companies. Thereafter, we compound 36 monthly returns. If a firm delisted prior to its three year anniversary, the returns of the company were set equal to the market return. Thus, the implicit portfolio strategy assumes that any proceeds from the sale or liquidation of the company are reinvested into the market. However, a delisting prior to the 36th month of trading is quite uncommon with only two firms in the VC sample, eight in the BO sample and 16 in the NB sample not reaching this milestone.

As our abnormal return metric, we opted to use buy-and-hold abnormal returns (BHAR), which are calculated as follows:

$$BHAR_{1,T}^i = \prod_{t=1}^T (1 + R_t^i) - \prod_{t=1}^T (1 + R_t^{i,BM})$$

Here, R_t^i refers to the simple return of company i in period t , $R_t^{i,BM}$ is the benchmark simple return in the same period and T is the analyzed holding period.

The main advantage of using BHARs, rather than CARs, is that they incorporate compounding and therefore more accurately reflect the return an investor could have generated with a multi-period investment. However, the periodical compounding may also lead to more extreme results. In fact, BHARs often possess fat right hand tails and can be heavily positively skewed (Schöber, 2008). Therefore, averages, both equal-weighted and value-weighted, can be driven by a small amount of companies with exceptional performance. Within our sample, the non-backed IPO sub-sample seems to be especially susceptible to this drawback, as can be illustrated by the non-backed sample's equal-weighted average BHAR versus the FTSE All Share index. When one excludes the ten firms in the non-backed sample with returns of above 300%, the three year BHAR drops dramatically from 38% to -1%. Moreover, even though the averages suggest an outperformance versus the FTSE benchmark, the median BHAR is actually negative at -26%. As a consequence of these findings, similar to Schöber

(2008), we choose to focus our analysis on median BHARs, since they are less affected by extreme outliers. The significance of the computed medians is again tested using the Wilcoxon signed rank test.

We compute both unadjusted raw buy-and-hold returns, as well as abnormal buy-and-hold returns versus a variety of carefully picked benchmarks. Raw buy-and-hold returns are interesting, since they accurately reflect the return an investor around the time of the IPO would have achieved over different holding periods. However, unadjusted returns neglect the influence that general stock market movements as well as unique firm characteristics can have on returns. Therefore, as is standard practice in many academic papers, we adjust raw buy-and-hold returns using a variety of benchmarks. As a first adjustment to correct for general stock market movements, we use the FTSE All Share index, which represents all companies listed on the London Stock Exchange's Main Market and captures over 98% of UK market capitalization (LSE Main Market Factsheet; 2015). Since around two thirds of IPO firms in our sample list on the London Stock Exchange's AIM, we also present abnormal returns versus the FTSE AIM index.⁴ To control for industry-specific effects on returns, we further separate IPO firms into broad industries, as implied by the first digit of their SIC code, and compare firms' raw buy-and-hold returns to those of their corresponding industry portfolio.⁵ Finally, Fama and French (1992) show that size and book-to-market characteristics can explain cross-sectional variation in stock returns. Therefore, we also compare our IPO firms to closely matched size and book-to-market portfolios.⁶ IPO companies are assigned to one of six size and book-to-market portfolios, resulting from two different size categories and three different book-to-market categories, dependent on a firm's market value at the first closing price and its respective book-to-market ratio. Book values are calculated by multiplying the number of shares with the first available post-IPO book value per share. Size and book-to-market portfolios are rebalanced annually.

Stock price data is collected from Datastream. More specifically, we use total return indices, since these include gross dividends and thus more precisely reflect the return to an investor. Due to missing data, the non-backed IPO sample is reduced by ten firms to 160. Datastream is also the source for information on the number of shares and book values per share, as well as returns for the various benchmarks.

⁴ The AIM was established by the London Stock Exchange in 1995 in order to help smaller and growing companies raise the capital they need for expansion. Today the AIM is one of the most successful growth markets worldwide, with over 3100 companies having joined the market since its launch, thereby raising over £67bn (London Stock Exchange, 2010).

⁵ In particular the industry portfolios used are: FTSE UK Oil & Gas, FTSE UK Basic Materials, FTSE UK Industrials, FTSE UK Consumer Goods, FTSE UK Health Care, FTSE UK Consumer Services, FTSE UK Telecommunications, FTSE UK Utilities, FTSE UK Financials and FTSE UK Technology.

⁶ Kenneth French does not report UK specific portfolios. However, we were able to obtain size and book-to-market portfolios composed for the UK market by Gregory et al. (2013) from the Xfi Centre for Finance and Investment.

5 Summary Statistics

To facilitate a profound understanding of the data underlying our analysis we shall provide several key characteristics of the analyzed data. The sample contains 257 IPOs that occurred during the years of 2001 through 2011 in the United Kingdom. As shown in Table 1, considering the different IPO types, we find that 32 (12%) companies received VC financing, 55 (21%) were backed by BO investors, and 170 (66%) were non-backed IPOs. Regarding stock exchange distribution, 87 (34%) of the companies listed on the UK Main Market while the remainder, 170 firms (66%), floated on the Alternative Investment Market. Moreover, depending on IPO sub-type there exist marked differences regarding listing market. While almost two thirds of BO-backed firms pursue a listing on the London Main Market, only 31% of VC-backed and 25% NB companies list on this market for larger and more mature companies. A reason for the higher overall observed percentage of firms floating on the AIM might be less strict listing requirements and thus lower cost of going public when compared to the Main Market.

Table 1 – Annual IPO Distribution and Stock Market Distribution

Year	Total Number of IPOs	Number per IPO Type			Number per Stock Market	
		VC-backed	BO-backed	Non-backed	UK Main Market	UK AIM
2001	12	4	2	6	5	7
2002	14	1	7	6	10	4
2003	10	0	1	9	3	7
2004	51	4	19	28	13	38
2005	50	11	8	31	11	39
2006	41	5	10	26	15	26
2007	36	4	7	25	14	22
2008	9	1	0	8	2	7
2009	1	0	0	1	1	0
2010	18	0	1	17	8	10
2011	15	2	0	13	5	10
Total	257	32	55	170	87	170

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. 170 of the firms listed on the Alternative Investment Market (AIM) while the remaining 87 went public on the UK Main Market.

Analyzing IPO timing throughout the sample, we find strong cyclicity in the yearly activity levels. Three distinct cycles emerge, namely a ‘hot-issue’ market from 2004 to 2007, set

between two periods of relatively few flotations from 2001 through 2003 and 2008 through 2011. The phase of high activity contains almost 70% of the IPOs in the entire sample. Both the UK Main Market and the Alternative Investment Market exhibit the same degree of clustering. Considering IPO types, cyclicity is even more pronounced in PE-backed IPOs than in non-backed flotations. More than 80% of the VC- and BO-backed offerings occurred during the identified 'hot-issue' market.

Applying broad industry classification, detailed in Table 2 below, we find that healthcare and technology are the most common sectors among VC-backed companies as they account for almost half of the IPOs in the sub-sample. These industry preferences are in line with findings of past research, for example by Gompers and Lerner (2001). More surprisingly, a quarter of the VC portfolio firms is found in the oil and gas industry. A more thorough analysis shows that the respective companies are mostly young technology-oriented firms with a focus on next-generation energy research. Considering the group of BO-backed IPOs, almost 60% of firms operate in the sectors of industrials and consumer services. As these industries are generally not associated with research-intensive high-growth businesses, the finding confirms the before mentioned focus of BO-investors on more mature companies. As do PE-backed companies, non-backed IPO firms in our sample also exhibit considerable industry clustering. The most prominent sectors are industrials, oil and gas, basic materials and consumer services. In aggregate, these industries account for over 70% of all IPOs in the sub-group.

Table 2 – Industry Classification

Industry Class	Number of Companies per IPO Type		
	VC-backed	BO-backed	Non-backed
Oil & Gas	8	1	33
Basic Materials	1	3	30
Industrials	3	17	35
Consumer Goods	0	1	9
Healthcare	9	2	7
Consumer Services	3	15	25
Telecommunications	1	3	3
Utilities	1	1	7
Financials	0	2	4
Technology	6	10	17
Total	32	55	170

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. Industry Class is defined by the first digit of an IPO company's Standard Industrial Classification (SIC) code. The occurrence of companies in the financial sector can be explained by disparity between the industry classification by the LSE and the SIC codes provided by Datastream. Since the LSE classifies the respective companies as non-financials, we chose to include them in our analysis.

Another important characteristic to consider is a company's market capitalization for which results are summarized in Table 3, along with data on offer sizes and book-to-market ratios. Unsurprisingly, firms in the VC-backed group have the lowest average market value with £135.6m. This seems intuitive as VCs mostly invest in relatively small companies with high growth potential. BO investors on the other hand prefer investments in more mature and thus bigger companies, aiming for value creation through efficiency gains. The average market value of an IPO company for the BO-backed group of £262.8m is almost twice as big as that found in the VC sub-sample. Eclipsing both groups of PE-backed firms, non-backed IPO companies exhibit average market values of £581.2m. However, this is mainly due to a few very large firms such as Glencore, which was valued at £36bn on IPO in 2011. These outliers drive up standard deviation, which is why an analysis of the median values can yield more insightful results. Median IPO company market values are the greatest for the BO-backed sample with £105.7m, followed by the NB and VC sample with values of £86.9m and £70.2m, respectively.

Table 3 – Market Value, Offer Size and Book-to-Market Ratio

IPO Type	Market Value (£m)		Offer Size (£m)		Book-to-Market Ratio	
	Average	Median	Average	Median	Average	Median
VC-backed	135.8	70.2	51.9	23.4	1.57	0.33
BO-backed	262.8	105.7	140.2	75.0	0.97	0.36
Non-backed	581.2	86.9	144.6	30.0	2.15	0.44
Full Sample	457.6	88.0	132.1	32.5	1.82	0.40

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. Firm market value and offer size are given in million GBP. Market value is measured using the closing price on the first day of trading. Offer size refers to the amount of money raised in an IPO. Book values are calculated by multiplying the first available book value per share with the number of shares. Dividing by the market value yields the book-to-market ratio.

Studying the amounts of capital raised, we find similar proportions among the different IPO types. Median offer size is the lowest for the VC-backed group at £23.4m, followed by non-backed IPOs with £30m, and finally BO-backed companies at £75m. The few large IPOs that affected standard deviation earlier also distort the average offer size data. Thus, non-backed flotations are on average accompanied by the greatest amount of money raised with £144.6m, followed by £140.2m for BO-backed IPOs, and £51.9m given the presence of VC investors. Examining yet another measure, book-to-market ratios are lowest for the VC group at 0.33 when using medians, potentially reflecting the fact that VC portfolio companies are typically small companies with low past earnings. Values for the other sub-groups are only slightly higher at 0.36 for the BO-backed IPOs and 0.44 for non-backed companies. Once again, a small number of outliers in the data increases averages of the book-to-

market ratio, adding to the finding that median values are the preferred measure when studying the offering-specific characteristics.

To further differentiate companies that received funding by PE firms, we analyzed ownership stakes pertaining to the respective investors before and immediately after an IPO. The results are detailed in Table 4 below.

Table 4 – Private Equity Ownership Statistics

IPO Type	Pre-IPO Stake (%)		Post-IPO Stake (%)		Stake Sold (%)	
	Average	Median	Average	Median	Average	Median
VC-backed	42.1	40.7	21.5	20.8	49.2	39.4
BO-backed	65.5	70.0	19.8	17.0	69.8	69.8
All PE-backed	56.9	55.5	20.4	18.0	62.2	61.4

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. Underlying pre- and post-IPO stakes represent aggregate values for all involved VC- or BO-investors that held stakes of more than 3% in the respective company. Values for stake sold refer to the size of the sold stake as a percentage of the respective pre-IPO stake.

The aggregate pre-IPO share VCs hold in a portfolio company amounts to 42% (41%) compared to 66% (70%) for BO-investors using average (median) values. The observation that VCs typically hold a smaller stake than BO investors is in line with the expectation that early-stage VC investors see their share diluted by subsequent funding rounds whereas BO investments are usually not followed by further funding and sales of equity. Moreover, BOs are mostly associated with the acquisition of majority stakes. Post-IPO, the average (median) stake held decreases to 22% (21%) for VC investors and 20% (17%) for BO investors. As the size of the stakes following an IPO is similar for both types of PE investors, it follows that BOs sell a greater part of their share in an IPO, on average (median) 70% (70%) compared to only 49% (39%) for VCs.

6 Results & Analysis

6.1 Underpricing

6.1.1 Full Sample Underpricing Analysis

In order to get a first impression of the magnitude of underpricing, we analyzed initial returns of the full sample for both the entire time period and the individual years. The obtained results are displayed in Table 5 below.

Table 5 – Full Sample Underpricing per Year

Year	Underpricing (%)	
	Average	Median
2001	9.5	5.9**
2002	4.8*	6.9**
2003	2.3	1.8
2004	9.5***	5.9***
2005	9.4***	8.8***
2006	9.3***	7.8***
2007	7.2**	10.5**
2008	5.3	7.8
2009	2.9	2.9
2010	6.6***	6.0***
2011	7.3	2.7**
Total	8.1***	7.5***

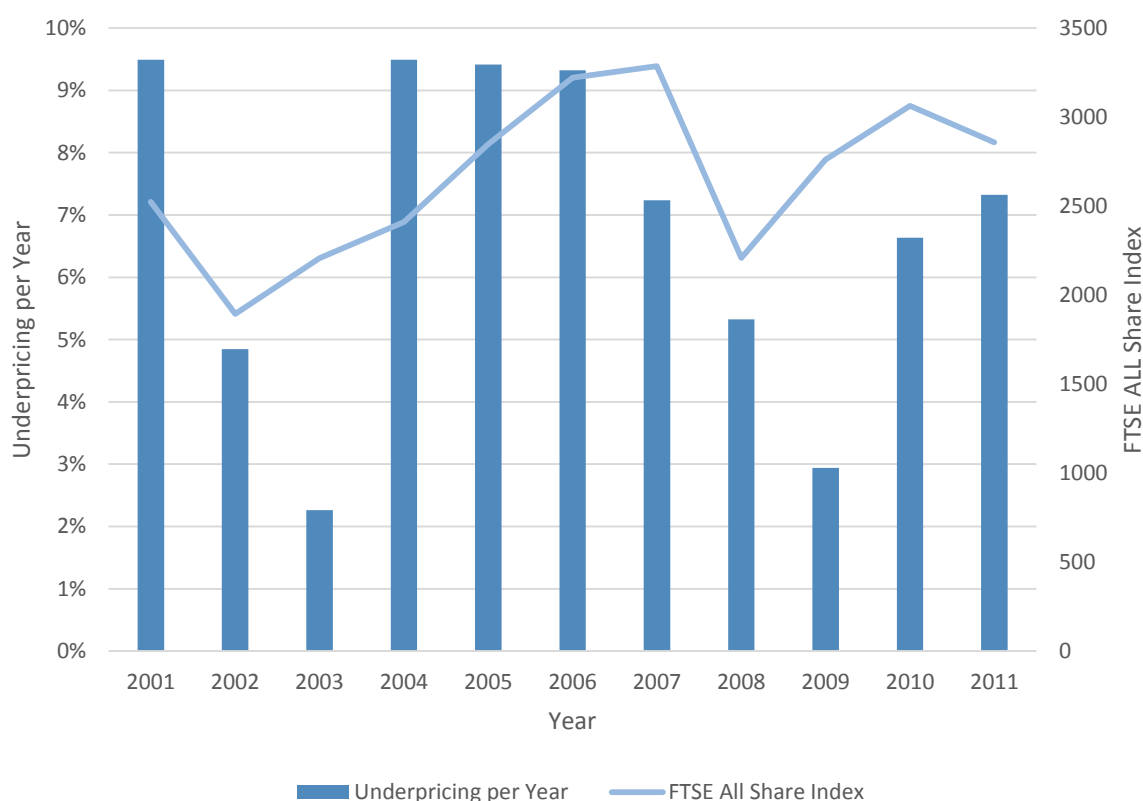
The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Underpricing refers to returns on the first of trading and is measured for each firm as the difference between the closing price on the first of trading and the initial offering price expressed as a percentage of that offer price. Significance levels, referring to Wilcoxon signed rank tests for median values and t-tests for average values, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Confirming past research, we find positive average and median first-day returns throughout the entire sample and time period. The average (median) underpricing for the time frame amounts to 8.1% (7.5%) and is statistically significant different from zero. This is lower than findings by Levis (2011), who investigates the UK market from 1992 to 2005 and finds an average underpricing of 18.6%. As is reasoned in the study, a possible explanation for the relatively higher underpricing might be the inclusion of the ‘hot-issue’ period in the years of the Dotcom bubble, when market valuations soared and led to substantial underpricing. However, the median of Levis’ (2011) first-day returns is only 7.3%, which is almost identical to the median of our total sample of 7.5%. Coakley et al. (2009)

confirm the general magnitude of underpricing in our sample as they find initial returns of 10.5% for UK IPOs between 1985 and 2003.

However, as mentioned earlier, our sample period also exhibits a pronounced cycle in the volume of IPO activity, which is why we chose to study differences in underpricing between the identified three distinct IPO cycles: The ‘hot issue’ period from 2004 to 2007, as well as two cycles with only moderate IPO activity from 2001 to 2003 and from 2008 to 2011. To exemplify the existing cyclicalities, Figure 1 plots the underpricing of our total sample over time as well as the development of the FTSE All Share index as a proxy for developments in the overall stock market.

Figure 1 – Full Sample Underpricing versus FTSE All Share Index



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. Yearly underpricing reflects aggregated median values across all IPO types and corresponding firms. Yearly FTSE All Share index results are year-end closing values.

We can see that the clustering in IPO activity, analyzed earlier and displayed in Table 1, coincides with both a positive market development, as well as higher underpricing. Average IPO underpricing reaches its highest levels above 9% from 2004 to 2006 before dropping to values of 7.2% in 2007, all of which are statistically significant. The only other year in which the first day returns exceed 9% is 2001, when market valuations were still relatively high as a result of the Dotcom boom. However, the 2001 value is not statistically significant different from zero at common significance levels. Splitting the timeframe into two separate sub-samples, namely the ‘hot-period’ of 2004 to 2007 and the

combination of the remaining years, and looking at aggregate values, we find average underpricing of 9% for the 'hot-market' period and 6.1% for the other years. Median values amount to 8.2% and 5%, respectively. In addition to Levis (2011), further literature confirms the observed cyclicity in underpricing, which is found to be most pronounced during the 1990s with peak periods in initial returns of as high as around 70% during the zenith of the Dotcom bubble in 1999-2000 (Loughran, Ritter, 2004). Bessler and Seim (2011b), using a similar observation period as our study, analyze underpricing in IPOs across Europe and come to comparable conclusions. In particular, they confirm the lower magnitude of underpricing in the IPO wave of 2004 to 2007 compared to the 'hot-issue' period during the Dotcom boom.

6.1.2 Underpricing Across IPO Types

Going beyond underpricing across all IPOs regardless of financial backing, a heap of academic papers compares initial first day returns of private equity- and non-backed IPO companies. Muscarella and Vetsuypens (1989), Ainina and Mohan (1991), Hogan et al. (2001), Ang and Brau (2002) and Cao and Lerner (2009) all find lower underpricing in BO-backed IPOs compared to non-backed IPOs, while, among others, Megginson and Weiss (1991) and Muscarella et al. (1990) find lower underpricing in VC-backed IPOs compared to their non-backed counterparts. Despite the number of papers supporting lower underpricing of IPOs backed by a PE company, the causal explanations of the differences in first-day returns are still the subject of debate and no general consensus has yet been reached. Thus, we aim to identify differences in the magnitude of underpricing between PE-backed and non-backed IPOs and try to refrain from drawing insufficiently grounded causal inferences. Separating the data sample into the sub-groups of VC-, BO- and non-backed IPOs, underpricing is found to be the lowest for the group of VC-backed IPOs with an average (median) of 6.6% (7.1%). Results are detailed in Table 6. Rather surprisingly, at first glance, BO backed IPOs are the group with the highest first-day returns. The mean (median) underpricing for the BO-backed group is 9% (8%). These values are relatively similar to results of comparable studies by Bergström et al. (2006) and Levis (2011) for the UK market and Schöber (2008) for the US, who reach similar average results of around 9%. In contrast however, the non-backed IPOs in our sample exhibit average (median) initial returns of 8.1% (7.4%) respectively. The mentioned studies found BO-backed IPOs to be less underpriced than flotations that did not receive financial backing.

Table 6 – Underpricing, IPO Type and Market Activity

Time Frame	Underpricing (%) by IPO Type					
	VC-backed		BO-backed		Non-backed	
	Average	Median	Average	Median	Average	Median
Entire Sample	6.6***	7.1***	9.0***	8.0***	8.1***	7.4***
High-Activity Period	8.9***	7.6***	10.1***	8.5***	8.5***	8.3***
Low-Activity Period	-0.2	4.1	4.3	7.2*	7.3***	4.9***

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. Initial returns are aggregated for the separate sub-groups of financial backing for the entire sample period, the period of increased IPO activity from 2004 to 2007, and the two combined periods of relatively low IPO activity from 2001 to 2003 and from 2008 to 2011. Significance levels, referring to Wilcoxon signed rank tests for median values and t-tests for average values, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Adding the distinction between the identified period of high IPO activity and the remaining years to the analysis, we observe rather interesting dispersion in average and median values. We combined the two identified IPO cycle periods before and after the ‘hot-issue’ period into one phase of little IPO activity. For VC-backed IPOs, average (median) underpricing during the ‘hot-market’ of 2004-2007 is found to be 8.9% (7.6%) as compared to -0.2% (4.1%) for the years with little IPO activity. Only the values for the period of increased activity in IPOs satisfy common significance levels. BO-backed flotations exhibit average (median) initial returns of 10.1% (8.5%) during the ‘hot-market’ period as opposed to 4.3% (7.2%) for the remaining years. Medians are significant for both periods. Non-backed IPOs show average (median) underpricing of 8.5% (8.3%) from 2004 through 2007 and 7.3% (4.9%) for the adjacent years, results which are significant at the 1% level. Thus, differentiating time periods with regard to varying market activity, both groups of PE-backed IPOs show similar patterns. During times when many share issuances are undertaken, VC- and BO-backed IPOs are on average more underpriced than non-backed IPOs whereas during periods with fewer IPOs, PE-backed flotations show a lower degree of initial returns. This is the result of a relatively large difference in underpricing between the two periods for the PE-backed companies and only little variation in the initial returns for the non-backed sample. Average values differ by 9.1 percentage points for VC-backed IPOs and 5.8 for BO-backed IPOs whereas the variation for non-backed IPOs only amounts to 1.2 percentage points.

The observations seem to confirm Rossetto (2008), Cao and Lerner (2009), and other studies that find underpricing of VC-backed IPOs to increase in ‘hot-issue’ markets. A lack of consideration for the level of market activity in a data sample might explain a part of the dispersion in the existing research studying the phenomenon of underpricing in different IPO types. Focusing on the analysis of a highly active IPO market might lead to the conclusion that PE-backed flotations are more

underpriced than non-backed IPOs while limiting a sample period to years with few IPOs could result in the observation of smaller initial returns for PE-backed companies. Even though the reasoning seems intuitive, median values obtained from our sample do not confirm the view. Using this measure, underpricing of BO-backed IPOs is greater than that of both VC- and non-backed IPOs in all periods. Moreover, median initial returns are always the lowest when floated companies were backed by VCs.

Overall, the differences in first day returns between the three sub-samples and also between the different time periods are rather small, especially when considering median values, which are less affected by extreme outliers as opposed to averages. However, an approach that simply compares the initial returns of the three groups may not be appropriate due to cross-sectional differences of IPO firms (Schöber, 2008). Thus, as detailed earlier in the methodology section, we apply a matching approach using synthetic control IPOs for every PE-backed IPO firm. Using this more sophisticated technique, we find VC-backed IPO companies to be 1.9 percentage points less underpriced than their synthetic control portfolio using median values. This helps to confirm the results drawn from the more naive approach used before, namely that the presence of VC investors is associated with less IPO underpricing compared to non-backed flotations. Compared to the fairly small median differences between the two groups of 0.3 percentage points obtained by simple median calculations, the more sophisticated matching procedure shows more notable differences. However, the results fail to satisfy common statistical significance levels. Considering BO-backed IPOs, we find median underpricing to be 1.5 percentage points higher for the BO-backed sub-group when compared to non-backed control portfolios. The results are in line with those drawn from a more simplistic approach neglecting cross-sectional differences that identified 0.6 percentage points more underpricing for BO-backed IPO companies compared to non-backed flotations. Again, the obtained values are not statically significant.

In general, the used matching approach confirms the results obtained by the comparison with simple median values of underpricing for the sub-groups in the sample. Moreover, it provides us with more noticeable variation between the values of the different IPO type sub-groups. Whereas simple medians of underpricing for VC-backed and BO-backed IPOs only vary from the non-backed group by 0.3 percentage points and 0.6 percentage points, respectively, the matching procedure identifies greater differences between the three groups. A low level of underpricing in the sample of VC-backed IPOs in comparison to non-backed flotations confirms the majority of past research. As mentioned, existing literature points to the conclusion that the signaling role of VC investors helps to reduce asymmetric information and therefore to realize a fair initial market price in an IPO company. The mature VC companies in the UK market that are involved with the IPOs in the sample help to explain the results as they are expected to be able to attract the most prestigious

underwriters and auditors in a flotation and aid in reducing asymmetric information. As the success of all PE investors crucially depends on successful exits and thus on value maximization during the holding period of any firm they are invested in, BO investors should in theory have similar incentives and, as a result of the large stakes they usually own, similar positive impact on their portfolio companies regarding monitoring, quality signaling and information asymmetry alleviation. Furthermore, given that the size of stake sold is found to on average be larger in BO-backed IPOs than in VC-backed flotations, the effect of underpricing in terms of money 'left on the table' when taking a portfolio company public is expected to be more pronounced in the presence of a BO investor. In absolute terms, the degree to which pre-IPO shareholders can benefit from reduced underpricing thus increases with the size of the stake that is sold in a flotation (Ljungqvist, Habib, 2001). Because of this, it is rather surprising to find BO-backed flotations to be more underpriced than non-backed IPOs. Past research, using varying time frames and different approaches of identifying financial backing, mostly came to the conclusion that the involvement of BO investors is associated with reduced underpricing when compared to the absence of financial backing prior to an IPO. In a separate attempt to explain reduced underpricing in the PE sub-group, Schöber (2008) cites the fact that BO-backed IPO companies, especially reverse leveraged BOs, have often been publicly traded before and have been subject to increased disclosure obligations, resulting in reduced information asymmetry and hence lower first-day returns. However, our data fails to confirm the expectation. Notwithstanding the absence of statistical significance in the matching procedure results, this adds to the rather inconclusive picture of past research.

6.2 After-Market Performance

6.2.1 Full Sample After-Market Performance Analysis

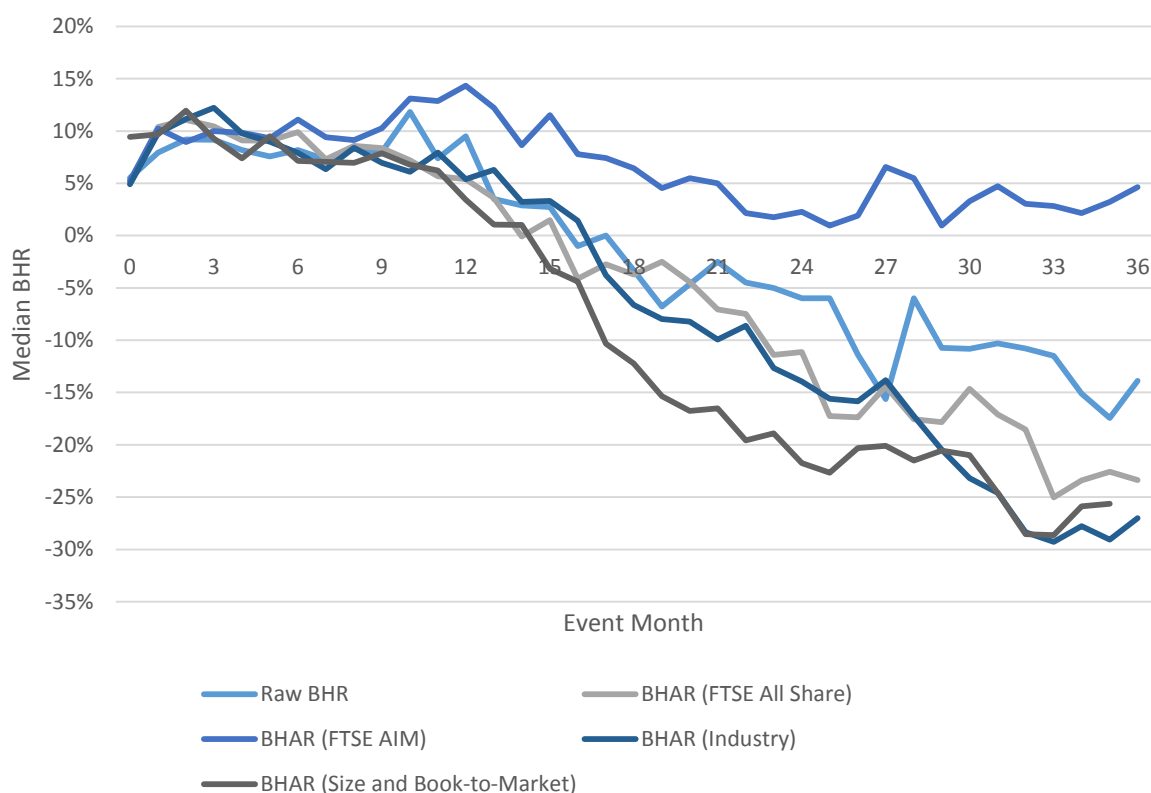
Equivalent to the phenomenon of underpricing, we shall first consider the after-market performance of the entire sample and time period underlying this paper. A post-IPO time span of 36 months is studied using buy-and-hold returns, both raw and adjusted by various benchmarks. As mentioned earlier, two benchmarks account for stock market movement, namely the FTSE All Share and the FTSE AIM index. A third benchmark accounts for industry-specific effects. Finally, raw returns are adjusted using size and book-to-market portfolios. Table 7 details median return data in intervals of six months for all used return adjustments. Figure 2 plots monthly buy-and-hold returns of the full sample for the entire event study period. We observe a similar pattern in the after-market performance using raw returns and the FTSE All Share, industry, and size and book-to-market adjustments.

Table 7 – Full Sample Median Buy-and-Hold Returns

Time Frame (Months after IPO)	Median Raw Buy-and-Hold Returns	Medians of Buy-and-Hold Abnormal Returns (%) by Benchmark			
		FTSE All Share	FTSE AIM	Industry	Size and Book- to-Market
6	8.2***	9.9***	11.1***	7.9***	9.5***
12	9.5***	5.4***	14.3***	5.4**	6.2**
18	− 3.3*	− 3.7***	6.4***	− 6.6	− 10.3
24	− 6.0	− 11.1	2.3***	− 14.0	− 18.9
30	− 10.8	− 14.6	3.3***	− 23.2	− 20.6*
36	− 13.9	− 23.4	4.6***	− 27.0	− 25.6*

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The table lists raw buy-and-hold returns as well as buy-and-hold abnormal returns adjusted by different benchmarks for the full IPO sample in intervals of six months. Significance levels, referring to Wilcoxon signed rank tests, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Figure 2 – Full Sample Median Buy-and-Hold Returns



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The figure shows the development of the raw buy-and-hold as well as buy-and-hold abnormal returns adjusted by different benchmarks for the full sample over the course of 36 months subsequent to an IPO.

Returns are positive for around fifteen months subsequent to an IPO and mostly in the range of 5% to 10%. Values satisfy significance levels of 1% or at least 5% throughout the first half of

the event study according to Wilcoxon signed rank tests. During the second half, returns turn negative and diverge in magnitude, culminating in values of between almost -30% using industry adjustment and around -15% using raw BHRs. Regardless of the higher variation in values further into the event study period, the pattern of movement in the returns is very similar in each of the four mentioned performance analyses. It has to be noted that formerly high significance levels cannot be satisfied in the later months of analysis. Overall, the results support the findings of past research suggesting long-run IPO underperformance. However, using FTSE AIM adjustment, after-market performance of the IPO sample differs considerably. Even though returns also exhibit a downtrend in the second half of the event study, values remain positive and range between 1% and 14%. Moreover, all values are highly significant at the 1% level. Building on Brav and Gompers' (1997) findings of especially severe underperformance exhibited by non-backed companies in the smallest size segment, the superior performance of our total sample versus the AIM benchmark may partly be explained by the relatively high amount of small companies contained in the AIM index, negatively affecting its performance.

6.1.3 After-Market Performance Across IPO Types

Applying our approach of IPO type differentiation, we analyzed after-market performance for all used return adjustments depending on financial backing received by an issuing company. First, medians of unadjusted raw buy-and-hold returns for every month in the event time frame with respect to IPO type are considered. Results are listed in Table 8 in intervals of six months to give an overview of the magnitude in values. Figure 3 shows the development of raw BHRs over time using data for each month. The sub-group of VC-backed firms exhibits positive returns in the range of 2% to 10% throughout the first seven months subsequent to an IPO. Thereafter, with the exception of one month of positive returns, buy-and-hold returns drop to single digit negative values of as low as -7% for the remaining months of the first year of public trading. The second year in the event study shows a gradual deterioration in the returns of VC-backed companies with values dropping to lows of -36%. For holding periods within the final twelve months, raw returns remain considerably negative and fluctuate within the range of -31% and -44%. Reasonable significance levels of at least 10% are however only satisfied in the final year of the event study. Contrary to the observations for VC-backed firms, the sub-group of BO-backed IPOs exhibits positive raw buy-and-hold returns for all holding periods in the event study. Results are significant for all holding periods. In the first half of the analyzed time frame, values are relatively stable between 7% and 14%. Subsequently, returns increase with almost every month and reach peaks of as high as 49% during the third year of trading. Turning attention to the performance of non-backed companies in the sample, we find similar overall trends as in the raw returns of the VC-backed sub-group.

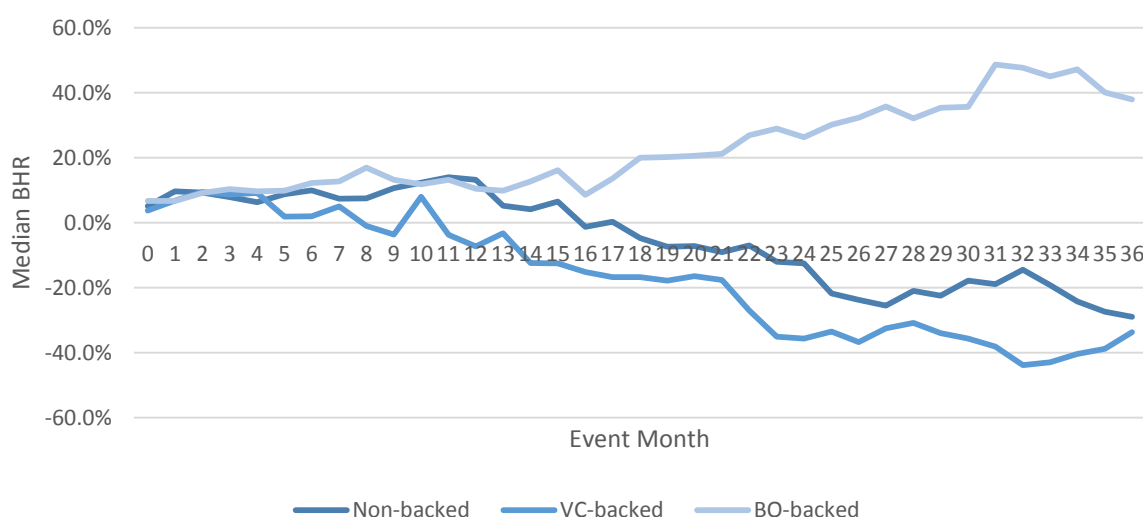
Table 8 – Raw Buy-and-Hold Returns by IPO Type

Time Frame (Months after IPO)	Medians of Buy-and-Hold Returns (%) by IPO Type		
	VC-backed	BO-backed	Non-backed
6	2.0	12.3***	10.0***
12	– 7.2	10.5*	13.3***
18	– 16.7	20.0*	– 4.7*
24	– 35.7	26.3***	– 12.5
30	– 35.6*	35.7***	– 17.8
36	– 33.6*	38.0***	– 29.0

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The table lists raw buy-and-hold returns for the IPO sub-samples in intervals of six months. Significance levels, referring to Wilcoxon signed rank tests, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

This is marked by the holding periods of up to 15 months after an IPO exhibiting statistically significant positive values within the range of 4% and 14%. Thereafter however, returns drop to negative values and gradually decline, reaching lows of -29% during the last month in the event time. Values fail to satisfy reasonable significance levels in the second half of the analyzed time span.

Figure 3 – Raw Buy-and-Hold Returns by IPO Type



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The figure shows the development of the raw buy-and-hold returns for the three IPO sub-groups over the course of 36 months subsequent to an IPO.

Beyond unadjusted raw returns, we studied long-term stock performance with respect to several benchmarks. Accounting for general stock market effects, we calculated abnormal buy-and-hold returns of the IPO type sub-samples with regard to both the FTSE All Share index as well as the FTSE AIM index. Results are shown in Table 9 in intervals of six months as well as in Figures 4 and 5,

plotting monthly data on the development of BHARs. When adjusting with the FTSE All Share index, IPO companies that received VC funding prior to going public show the same overall trend in performance as is visible in their unadjusted raw BHR. Initially, values are positive and between 0% and 7% for almost half a year after the IPO. Returns then drop and gradually decline throughout the remainder of the event study period, reaching unprecedented peaks of as low as -57% during the final months of the third year after flotation. Common significance levels are satisfied by almost all monthly values. Thus, compared to raw returns, we observe an earlier deterioration in the performance of the share prices of VC-backed companies as well as more extreme values on the downside. BO-backed firms again display a very different pattern in long-run stock performance. Medians adjusted using the FTSE All Share index remain in a relatively narrow range of values between 0% and 15% for all holding periods. Returns reach the upper end of the mentioned value span early in the first year of trading and subsequently decline until the 17th month of the event period. Statistically significant results are however only found for the first months of the studied period.

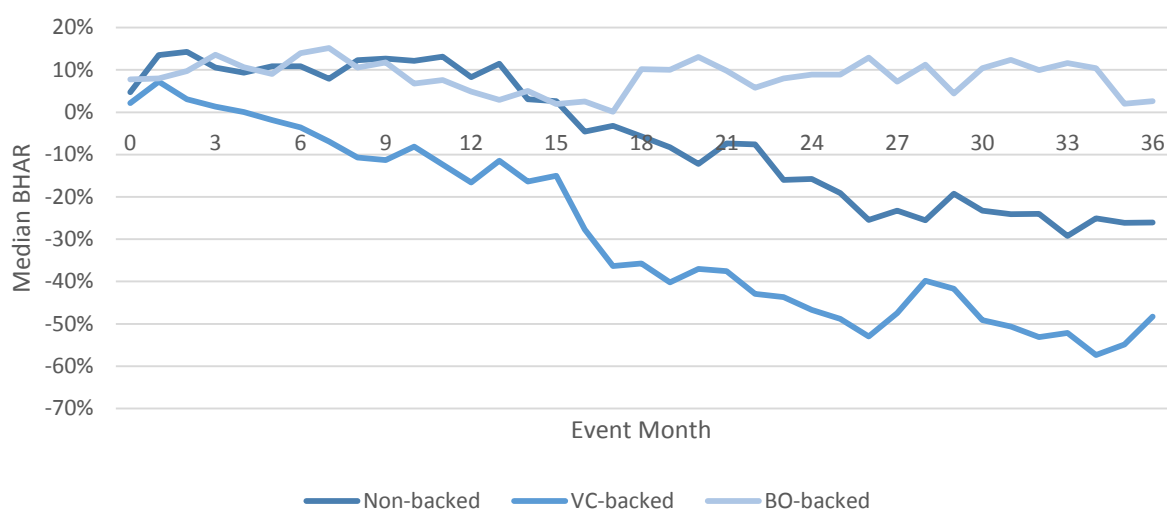
Table 9 – Buy-and-Hold Abnormal Returns by IPO Type Using Stock Market Adjustment

Time Frame (Months after IPO)	Medians of Buy-and-Hold Abnormal Returns using FTSE All Share Adjustment (%)			Medians of Buy-and-Hold Abnormal Returns using FTSE AIM Adjustment (%)		
	VC-backed	BO-backed	Non-backed	VC-backed	BO-backed	Non-backed
6	- 3.6	14.0***	10.9***	- 1.9	18.2***	9.6***
12	- 16.6*	4.9	8.3***	- 4.8	18.9**	14.6***
18	- 35.7*	10.2	- 5.7*	- 11.1	21.9**	1.9***
24	- 46.7*	8.9	- 15.8	- 18.7	28.4***	- 4.7**
30	- 49.2**	10.4	- 23.3	- 19.7	32.8***	- 6.6*
36	- 48.3**	2.6	- 26.0	- 17.5	29.1***	0.4**

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The table lists compounded buy-and-hold abnormal returns (BHAR) for the IPO sub-samples in intervals of six months. The returns are adjusted using the FTSE All Share index and the FTSE AIM index, respectively. Significance levels, referring to Wilcoxon signed rank tests, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

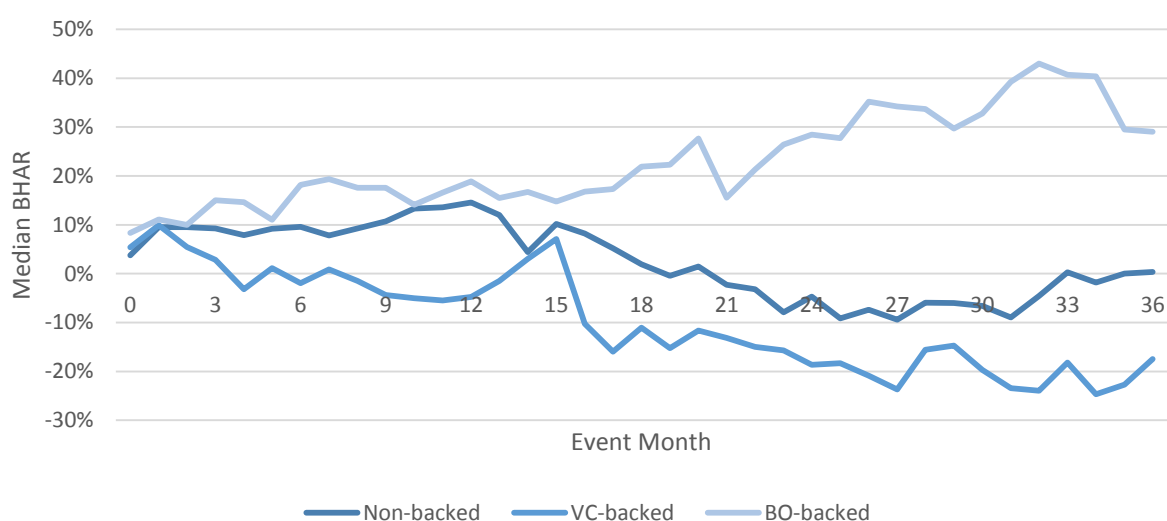
Thereafter, monthly compounded values swiftly revert back to around 10% and show only little movement for the rest of the analyzed period. Stock performance of non-backed IPO companies shows a statistically highly significant fluctuation around values of approximately 11% for the first year after an IPO, followed by a deterioration of returns and lows of -16% for holding periods in the second year of trading. In the final twelve months of the event study, abnormal returns stabilize around -25% with values failing to satisfy common significance levels.

Figure 4 – Buy-and-Hold Abnormal Returns by IPO Type Using FTSE All Share Index Adjustment



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The figure shows the development of the buy-and-hold abnormal returns adjusted with the FTSE All Share index for the three IPO sub-groups over the course of 36 months subsequent to an IPO.

Figure 5 – Buy-and-Hold Abnormal Returns by IPO Type Using FTSE AIM Index Adjustment



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The figure shows the development of the buy-and-hold abnormal returns adjusted with the FTSE AIM index for the three IPO sub-groups over the course of 36 months subsequent to an IPO.

Besides the All Share index, we studied abnormal returns with respect to the FTSE AIM index. VC-backed IPO companies again show low single digit positive abnormal returns during the first months after going public. Subsequently, values drop to as low as -6% approaching the end of the first year of trading. Interrupted by a temporary bouncing back to as high as 7% for two months in the second year of trading, abnormal returns thereafter decline for the entire period, reaching lows of negative 25%. However, returns throughout the time frame exhibit low significance. BO-backed firm performance adjusted with the AIM index is positive for every month in the event time and highly

significant according to Wilcoxon signed rank tests. Median abnormal returns are below 10% for only one month, namely the month of the IPO at 8%. Thereafter, values increase to 19% one year post-IPO, further climb to 28% two years after flotation and reach peaks of 43% during the third year of trading. Long-term stock performance for non-backed companies once more shows comparable movements to those observed in VC-backed IPO firms. However, abnormal returns turn negative later on in the event time frame. Values are observed to range from 2% to 15% between the IPO and the 18th event month, thereafter declining to as low as -9% during the third year. Notably, returns revert back to around zero for the final months of the analyzed period. Values are statistically significant for all months. Summing up the results of the adjustment of returns with respect to general stock market effects, several key characteristics can be identified. VC-backed and non-backed IPO firms follow comparable trends. The same patterns are found for the two groups in the raw unadjusted return analysis. Values are initially low and positive. As the result of a deterioration occurring between six to sixteen months after an IPO, buy-and-hold returns turn negative for both groups, with firms in the VC-backed sub-sample exhibiting more pronounced lows than the non-backed group. BO-backed flotations, however, exhibit positive returns for holding periods throughout the entire event period. In fact, there is a remarkable similarity in percentage return values between unadjusted raw BHR and returns adjusted with the FTSE AIM index. However, the values obtained by adjusting for the FTSE All Share index lack an observable upward trend in abnormal returns but are relatively stable for the entire time period.

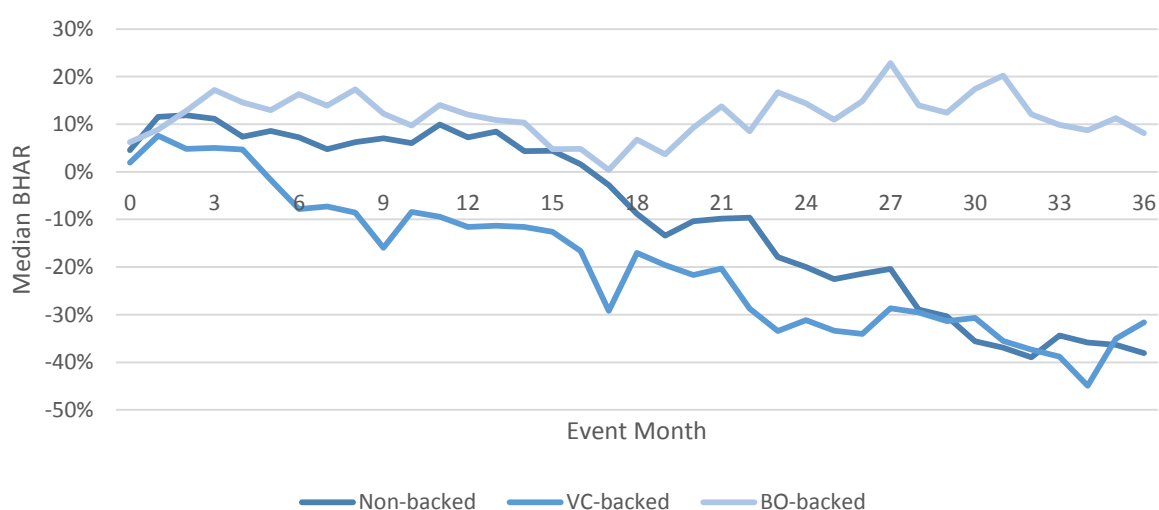
As mentioned earlier, industry-specific factors have been found to influence long-run stock returns. Thus, we grouped the companies in the IPO type sub-samples according to a broad industry classification and then adjusted buy-and-hold returns using corresponding benchmark industry portfolios. The results are detailed in Table 10 for compounded returns in intervals of six months and in Figure 6 plotting BHARs for each month in the event period. Considering VC-backed companies, we find positive abnormal returns up until the fourth month after an IPO with values between 2% and 5%. Thereafter, median returns rapidly drop to around -10%, remain at values of that magnitude up until 15 months after flotation and then further deteriorate to as low as -45% in the third year after the IPO. For the BO-backed sub-sample, returns are once more positive for every month of the event study and range between 0% and 23%. Albeit there being no general trend visible for the group, we see that, analogous to FTSE All Share index benchmarking, the lowest value of the overall time frame is found in the 17th month after the IPO. Companies of the non-backed sub-sample deliver positive abnormal returns of 2% to 12% for the first 16 months subsequent to a company's listing on a stock market. The remaining 20 months show a marked gradual decline in stock performance, culminating in negative abnormal buy-and-hold returns of -39%.

Table 10 – Buy-and-Hold Abnormal Returns by IPO Type Using Industry Adjustment

Time Frame (Months after IPO)	Medians of Buy-and-Hold Abnormal Returns (%) Using Industry Adjustment		
	VC-backed	BO-backed	Non-backed
6	– 7.8	16.3***	7.3***
12	– 11.6	12.0	7.2***
18	– 17.0*	6.7	– 8.8
24	– 31.1	14.4	– 20.0
30	– 30.7**	17.4*	– 35.6
36	– 31.6**	8.1	– 38.1

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The table lists compounded buy-and-hold abnormal returns (BHAR) for the IPO sub-samples in intervals of six months. Sample companies were assigned to broad industry classes and raw returns were then adjusted using corresponding benchmark industry portfolios. Significance levels, referring to Wilcoxon signed rank tests, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Figure 6 – Buy-and-Hold Abnormal Returns by IPO Type Using Industry Adjustment



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The figure shows the development of the buy-and-hold abnormal returns for the three IPO sub-groups over the course of 36 months subsequent to an IPO adjusted by benchmark industry portfolios.

For a few months of the third year of trading, industry-adjusted returns are even lower for the set of non-backed companies than they are for VC-backed companies. As mentioned above, the findings for industry-adjusted abnormal returns show some similarities to those obtained using the FTSE All Share index benchmark for adjustment. This is both true for patterns in the performance of the respective sub-groups, for example at what point in time after an IPO returns become negative, and for the magnitude of values.

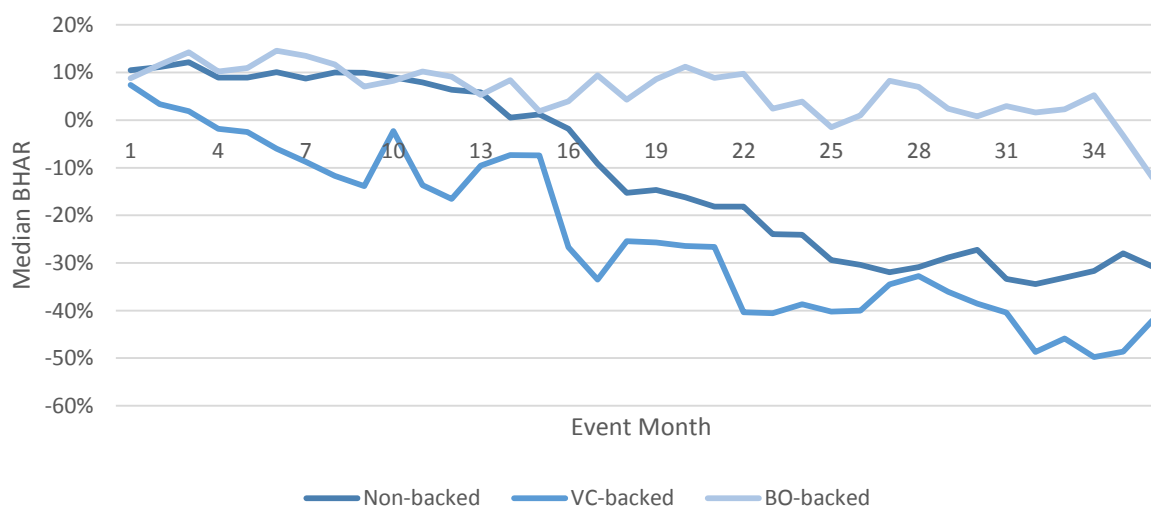
Finally, in yet another attempt to account for cross-sectional differences, we adjusted raw buy-and-hold returns using matched size and book-to-market portfolios. Obtained results are again shown in intervals of six months and plotted using monthly data of compounded returns. See Table 11 and Figure 7, respectively, for details.

Table 11 – Buy-and-Hold Abnormal Returns by IPO Type Using Size/Book-to-Market Adjustment

Time Frame (Months after IPO)	Medians of Buy-and-Hold Abnormal Returns (%) Using Size and Book-to-Market Adjustment		
	VC-backed	BO-backed	Non-backed
6	– 6.0	14.6***	10.1***
12	– 16.5*	9.2	6.4**
18	– 25.4*	4.3	– 15.3
24	– 38.7**	3.9	– 24.1
30	– 38.5**	0.8	– 27.2
36	– 42.1**	– 12.1	– 30.8

The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The table lists compounded buy-and-hold abnormal returns (BHAR) for the IPO sub-samples in intervals of six months. Sample companies were two-dimensionally separated into six sub-groups depending on firm size and book-to-market ratio. Subsequently, returns were adjusted by corresponding benchmark portfolios for the respective sub-group. Significance levels, referring to Wilcoxon signed rank tests, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Figure 7 – Buy-and-Hold Abnormal Returns by IPO Type Using Size/Book-to-Market Adjustment



The sample contains 257 IPO companies that went public in the UK between 2001 and 2011. Of these, 170 were non-backed IPOs, 55 BO-backed IPOs, and 32 VC-backed IPOs. The figure shows the development of the buy-and-hold abnormal returns for the three IPO sub-groups over the course of 36 months subsequent to an IPO adjusted by benchmark size and book-to-market portfolios.

First considering VC-backed IPOs, we observe an unprecedentedly quick deterioration of stock performance with median values of abnormal adjusted returns being positive for holding

periods of only three months subsequent to an IPO. Thereafter, values range between -17% and -2% until around the middle of the event window. The second half of the time frame is marked by even lower abnormal returns between -25% around the end of the second year of trading and -50% during the final months of the period. Results are significant for almost all event months. Results for BO-backed IPOs for the first time do not exclusively consist of positive values. Most notably, performance turns to negative 12% in the last month of the event study. Apart from the three months exhibiting negative abnormal returns, we find values between 1% and 15%. Returns for the sub-sample thus only vary in a relatively narrow range and fail to reveal a major underlying trend when compared to the other IPO types. Returns however only satisfy common significance levels during the first months after an IPO. Non-backed IPO firms show median abnormal returns of around 10% during the first year of trading, followed by a gradual decline and finally a switch to negative values after 16 months. Returns further deteriorate until the end of the three-year period and reach lows of -34%. Equivalently to the BO-backed group, values are significant only for the first months subsequent to a flotation.

Summing up the results of the long-run performance analyses, we shall now compare the findings for each IPO type across all the different approaches. Buy-and-hold returns, both raw and adjusted, follow a remarkably consistent pattern in VC-backed IPOs. This is true regardless of the benchmark used for adjusting returns. Immediately after an IPO returns are positive and below 10% for a period of three to five months (eight for raw BHRs). Thereafter, performance gradually declines. Negative peaks are found in the last months of the third year of trading. This is line with the majority of available research that finds an underperformance of VC-backed IPOs in the long run and inferior performance to other IPO types (Bergström et al., 2006; Cao and Lerner, 2009). Various authors link this observation to pre-IPO VC investors selling their shares on flotation or after the end of a lock-up period, arguing that this change in ownership is accompanied by a decrease in monitoring (Gompers, Lerner, 1998; Espenlaub et al., 2003). As both groups of PE investors sell sizable parts of their portfolio company shares in an IPO, this would imply a comparable decline in performance for BO-backed flotations. However, BO-backed IPOs are marked by a completely different pattern in long-run stock performance in our analysis. Returns for the sub-sample are positive regardless of the used benchmark in all but a few months when using size and book-to-market adjustment. In general, there is again noticeable consistency throughout all used approaches. The first half of the time frame exhibits low fluctuation in returns with values in the range of 10% to 15%. In the second half of the analyzed period, depending on what adjustment is used, returns either follow an upward trend or stay stable within the mentioned range until the end of the event time. The outperformance of BO-backed IPO companies compared to other IPO types confirms the past literature (Bergström et al., 2006; Levis, 2011). However, the persistent positive returns observed throughout the analyzed time frame are somewhat

distinctive to our paper and reinforce the view that there are major differences in IPO performance depending on received financial backing.

In comparison to the two groups of PE-backed flotations, non-backed IPOs show characteristics similar to each depending on the distance in time from the IPO date. Initially, BO- and non-backed companies exhibit relatively similar returns for the first 15 months after flotation. This translates into non-backed IPOs' returns also being relatively stable for the months in this period. Subsequently however, returns drop and, for the rest of the event window, with the exception of three months using FTSE AIM index adjustment, fail to revert to the positive values previously experienced. The deterioration of returns in this later period is similar to that found in VC-backed companies, the difference being that values for non-backed firms turn negative approximately one year later in the event study. The magnitude of underperformance is however larger for companies that received VC funding. The two groups of VC-backed and non-backed IPOs thus confirm the conclusion reached by prior research that IPOs suffer from long-term underperformance (Aggarwal and Rivoli, 1990; Ritter, 1991; Loughran et al., 1994; Loughran and Ritter, 1995). This finding is often ascribed to temporarily increased valuations at the time of a flotation declining over time. Adding to this, companies and underwriters are assumed to exploit investor optimism by conducting flotations when valuations are high. Considering the more extreme decline in returns for the VC-backed companies, initial optimism surrounding IPO companies of the sub-group might be especially strong. This could be a consequence of the fact that VCs tend to invest in highly innovative industries, companies of which are often surrounded by outstandingly positive media reception and public attention in general. In turn, the results support Lerner (1994) in his hypothesis that VC investors possess considerable abilities in identifying periods in time when maximum valuations are achievable.

A striking finding of our analysis is the remarkable difference in the long-run performance of VC- and BO-backed IPOs. This confirms the assumption that the distinction between the two PE sub-groups does matter and that the application of different approaches to the matching of PE deals to different sub-samples can significantly influence results when studying the topic of stock performance with respect to IPO type. Assigning transactions to either the group of BOs or VCs solely based on a prior classification of the company that provided capital in the respective deal can thus prove problematic in a market, such as the UK, in which PE investors tend to invest in many different development stages, company sizes and industry groups. The inconclusive picture derived from past research may thus in part be a result of varying techniques of compiling data samples. For example, several authors such as Coakley et al. (2009) or Bessler and Seim (2011a) matched members of a country's venture capital association with investors of IPO companies to assign the targets of the corresponding deals to the group of VC-backed IPOs. However, if the respective investor also invests

in BO type deals, these would have indiscriminately been assigned to the VC sub-group. To illustrate the consequences of this, we can think of the effect of applying a similar approach to the private equity IPOs in our sample. Not differentiating between BO-backed and VC-backed IPOs would have led to an off-setting of negative and positive returns and the negligence of overall differences between the sub-groups. Adding to this, grouping all PE-backed flotations in the sample under the label of VC can lead to completely different interpretations concerning the prospects of VC-backed IPOs compared to those drawn from our actual analysis. Such indiscriminate classification can on the one hand stem from a deliberate choice to pool VCs and BOs because of assumed identical effects on portfolio company IPOs and their performance or on the other hand be a result of the, predominately European, tradition to include BOs in the term of VC. Thus, an insufficiently thorough analysis of each transaction in combination with the existing disagreement on nomenclature regarding the terms PE, VC and BO can result in the practice of comparing studies that appear to analyze similar data but in fact only use the same labels of IPO type classification. As our analysis shows, different kinds of PE investments, even if often funded by the same company, are associated with significantly different long-run stock performance.

Connecting our results to the reasons for patterns in stock performance hypothesized in past research and detailed earlier, we can draw several conclusions. The severe long-term underperformance of VC-backed IPO companies, which is preceded by a relatively short period immediately after flotation exhibiting positive returns, supports the conclusions of prior literature. Firstly, VC investors are expected to be able to exit portfolio companies when valuations are temporarily high and thus favorable offer prices are realizable, which may help to explain deteriorating returns after a flotation. Secondly, a lack of monitoring subsequent to the exit of an investor is cited in an attempt to explain decreasing stock performance in formerly VC-backed companies. This can also be supported by our results, even more so as the deterioration in returns only begins after a limited time subsequent to an IPO, possibly attributable to the end of lock-up periods and thus the sale of all remaining shares pertaining to respective VC investors. Considering the observed patterns in the performance of BO-backed IPOs, our results support existing literature that found superior performance of the sub-sample compared to VC-backed IPOs and also non-backed flotations. It may thus be true that more mature portfolio companies in combination with on average larger-sized investments undertaken by highly reputable BO investors help to reduce information asymmetries, leading to fewer overly optimistic investors and less expectation adjustment after an IPO. Following Bergström et al. (2006) this could be a result of BO investors being less likely to take low-quality firms public. Strengthening this view is the absence of a decline in stock performance of BO-backed IPO companies after the usual lock-up period expiration, hinting that any further disposal of shares and

potentially diminished ability of monitoring by financial backers does not negatively affect portfolio company performance.

6.2.3 After-Market Performance and Private Equity Ownership Stake

As we obtained extensive data on pre- and post-IPO stakes pertaining to PE investors in the respective portfolio companies, we studied performance differences over time in connection to the size of the owned stake in three dimensions: stake owned pre-IPO, stake owned post-IPO and percentage stake sold. The sample was split into two groups, namely large and small, for each dimension. The cut-offs were derived from an analysis of the sample composition. For example, a PE company was assigned to the large pre-IPO stake sub-group if its financial backers owned more than 60% of the company prior to an IPO. Similarly, the sample was split in two parts depending on whether PE-investors held more or less than 15% of a portfolio company after a flotation. Finally, the cut-off for the third dimension was defined as a sale of 50% or more of the stake owned in an IPO. Moreover, we considered raw BHRs as well as BHARs using FTSE All Share and FTSE AIM index adjustment. For both VC- and BO-backed IPOs, the companies in the sub-group in which PE firms held a large pre-IPO stake performed better than those in the group in which investors only held a small stake. Results vary slightly depending on the used return metric. Values are summarized in Table 12.

Table 12 – After-Market Performance and Pre-IPO Stake Owned by Private Equity Investors

Return Measure	Percentage Point Difference in Buy-and-Hold Returns Between Sub-Groups of Large and Small Pre-IPO Stake			
	VC-backed		BO-backed	
	Average	Median	Average	Median
Raw Buy-and-Hold Returns	25.2***	20.2***	25.5***	27.5***
Buy-and-Hold Abnormal Returns (FTSE All Share Adjustment)	20.0*	23.5***	15.5***	17.3***
Buy-and-Hold Abnormal Returns (FTSE AIM Adjustment)	16.2***	17.3***	18.5***	16.9***

The PE sub-sample contains 87 companies that went public in the UK between 2001 and 2011. Of these, 55 were BO-backed IPOs and 32 VC-backed IPOs. Firms in which PE-investors held more than 60% prior to IPO were assigned to the large sub-group, firms in which investors in aggregate held less than 60% were assigned to the small sub-group. BHRs of the companies in the corresponding sub-groups were aggregated on a monthly basis and the difference between the two stake-size groups was obtained. Finally, averages and medians of the differences over the entire event period were calculated. Positive differences cited in the table imply that BHRs are (on average/median) greater for the sub-set of firms in which PE-investors held a large pre-IPO stake compared to firms in which investors held a small pre-IPO stake. Significance levels, referring to Wilcoxon signed rank tests for median values and t-tests for average values, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Considering the second dimension, the stake owned after an IPO, we find different results for the PE sub-categories. The findings are summarized in Table 13. VC-backed IPOs perform worse if investors own a large compared to a small stake subsequent to an IPO. The results are consistent across all three return metrics. For BO-backed companies, return differences between the groups containing large and small post-IPO stakes are comparably small. However, large post-IPO stakes owned in portfolio companies are associated with superior performance relative to companies in which investors hold a smaller stake.

Table 13 – After-Market Performance and Post-IPO Stake Owned by Private Equity Investors

Return Measure	Percentage Point Difference in Buy-and-Hold Returns Between Sub-Groups of Large and Small Post-IPO Stake			
	VC-backed		BO-backed	
	Average	Median	Average	Median
Raw Buy-and-Hold Returns	– 43.4***	– 39.0***	9.0**	3.5***
Buy-and-Hold Abnormal Returns (FTSE All Share Adjustment)	– 38.5***	– 36.0***	6.4***	3.5***
Buy-and-Hold Abnormal Returns (FTSE AIM Adjustment)	– 30.6***	– 32.3***	7.3***	6.1***

The PE sub-sample contains 87 companies that went public in the UK between 2001 and 2011. Of these, 55 were BO-backed IPOs and 32 VC-backed IPOs. Firms in which PE-investors held more than 15% after an IPO were assigned to the large sub-group, firms in which investors in aggregate held less than 15% were assigned to the small sub-group. BHRs of the companies in the corresponding sub-groups were aggregated on a monthly basis and the difference between the two stake-size groups was obtained. Finally, averages and medians of the differences over the entire event period were calculated. Positive differences cited in the table imply that BHRs are (on average/median) greater for the sub-set of firms in which PE-investors held a large post-IPO stake compared to firms in which investors held a small post-IPO stake immediately after flotation. Significance levels, referring to Wilcoxon signed rank tests for median values and t-tests for average values, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

Finally, we analyzed the effect of the size of stake sold. Results are summarized in Table 14. For the VC-backed sub-group, a large stake sold is associated with higher BHRs throughout all return metrics. For BO-backed IPOs, the results are for the first time inconclusive with respect to the used return metric. Moreover, differences are comparably small and not all values are statistically significant. Using raw and FTSE AIM index-adjusted returns, the group of companies in which only a small stake was sold performs better during the event period than the group in which BO-investors sold a big stake. The opposite shows using FTSE All Share index adjustment.

Table 14 – After-Market Performance and Percentage Stake Sold by Private Equity Investors

Return Measure	Percentage Point Difference in Buy-and-Hold Returns Between Sub-Groups of Large and Small Stake Sold in an IPO			
	VC-backed		BO-backed	
	Average	Median	Average	Median
Raw Buy-and-Hold Returns	52.1***	45.6***	– 7.8**	– 3.4***
Buy-and-Hold Abnormal Returns (FTSE All Share Adjustment)	55.8***	52.9***	1.2	1.5*
Buy-and-Hold Abnormal Returns (FTSE AIM Adjustment)	49.5***	46.8***	– 2.1	– 5.2

The PE sub-sample contains 87 companies that went public in the UK between 2001 and 2011. Of these, 55 were BO-backed IPOs and 32 VC-backed IPOs. Firms in which PE-investors sold more than 50% in an IPO were assigned to the large sub-group, firms in which investors in aggregate sold less than 50% were assigned to the small sub-group. BHRs of the companies in the corresponding sub-groups were aggregated on a monthly basis and the difference between the two stake-size groups was obtained. Finally, averages and medians of the differences over the entire event period were calculated. Positive differences cited in the table imply that BHRs are (on average/median) greater for the sub-set of firms in which PE-investors sell a large stake in an IPO compared to firms in which investors sell a small stake in an IPO. Significance levels, referring to Wilcoxon signed rank tests for median values and t-tests for average values, of 10% (*), 5% (**), and 1% (***) are highlighted by the respective number of asterisks.

In sum, even though the performance analysis with respect to PE ownership stakes yields somewhat consistent and interesting results, especially when considering VC-backed companies, we need to be careful with interpretation. During the collection of our data sample, we calculated aggregate stakes held by VC and BO type investors immediately before and after an IPO. Given the low level of disclosure in unlisted firms and the general discretion exhibited by the PE industry, it is extremely difficult to obtain a conclusive picture of the ownership situation in PE portfolio companies. Thus, an IPO is often the only point in time when considerable information is published. However, drawing conclusions from this data proves difficult as it only constitutes a snapshot of current ownership. For example, the stake owned by PE backers can consist of only one investor or a syndicate of firms. As financing is provided through subsequent rounds, it is possible for pre-IPO holding periods of different investors to vary widely depending on the investment rounds they participated in. The aggregate size of the stake owned by PE investors can thus significantly change leading up to the IPO. Hence, companies might be grouped together because of similar pre-IPO stakes even though PE ownership has only reached similar levels immediately prior to the flotation. The neglected disparity in PE-related ownership that existed throughout the majority of the lifetimes of the companies might result in important firm differences affecting post-IPO performance. Moreover, related to existing lock-up periods, PE investors can be prohibited from selling company shares immediately after an IPO. The sale can then occur at any point in time after the expiration of such an agreement. Investors might also decide to only gradually sell their stake to alleviate negative effects on share price. Members of a PE

syndicate can also have different motives and investment philosophies and can thus make different decisions on when to exit their position in a portfolio company. From the ownership information obtained immediately after an IPO, we cannot identify how long a PE investor held on to his stake. Grouping companies with comparable post-IPO stakes can result in comparing companies in which investors intentionally hold on to their stake with firms in which all or some of the investors sold their shares shortly after the IPO. Summarizing, the analysis of ownership stakes is problematic and we thus refrain from drawing causal inferences from the results. Despite all mentioned limitations, the obtained results exhibit noticeable variation across the different private equity sub-groups and hence reinforce our assumption about the importance of a detailed IPO type separation. Especially as comparable data has yet only rarely been collected and analyzed, we believe that the studying of ownership information and its effect on IPO stock price performance is worthwhile and could potentially be the topic of future research.

7 Conclusion

Investigating the IPO performance of a sample of 257 initial public offerings, undertaken in the UK during the years of 2001 through 2011 and consisting of venture capital-backed, buyout-backed and non-backed flotations, the main focus of this paper has been the identification of differences between the IPO types in terms of both general characteristics and overall performance. Especially important to us is the distinction between the private equity sub-groups and its implications for results.

Considering initial returns, we find positive first-day returns for the overall sample, an observation widely confirmed by past research. Underpricing is more pronounced in years of high IPO activity. Moreover, variation between periods of different market activity is larger for the flotations of private equity-backed companies. However, overall differences in underpricing between the IPO types in our sample are relatively small. Results from a synthetic IPO portfolio matching approach find VC-backed flotations to be less underpriced than non-backed IPOs, while BO-backed share issuances exhibit a greater degree of initial returns than their non-backed reference portfolios. Drawing conclusions from these findings proves difficult as explanations for the level of underpricing in private equity-backed IPOs compared to non-backed flotations suggested by past research, such as a certification or monitoring role, are often based on investor characteristics that apply both to venture capital and buyout firms. Skepticism is amplified by the lack of statistical significance in the underpricing analysis using synthetic IPO portfolios.

The second dimension of IPO performance analyzed in the paper is the after-market period, studied using both raw and adjusted buy-and-hold returns. Results for the full sample of IPO companies over the course of 36 months show underperformance across all but one return adjustment, with only the FTSE AIM index-adjusted returns deviating from the identified pattern. Applying a detailed approach regarding IPO type differentiation, we find that long-run stock price underperformance is especially pronounced in the sub-group of VC-backed companies. Notably, BO-backed IPO firms are marked by considerable positive buy-and-hold returns throughout the analyzed time frame. We find similar patterns across all used adjustments. The sustained positive returns of BO-backed IPO companies, especially in contrast to the inferior stock performance of VC-backed flotations, constitutes one of the major implications of our paper. An additional after-market performance analysis based on private equity-related ownership stake size information immediately before and after an IPO studies the effects of different sizes of pre-IPO, post-IPO and percentage sold stakes. While a larger pre-IPO stake held by the PE sponsor appears to have a positive influence on after-market performance, the impact of the size of the post-IPO stake and the percentage stake sold varies between VC- and BO-backed IPO companies. Notwithstanding limitations concerning causality, the

identified variation in results across the private equity sub-samples underscores the importance of IPO type separation utilized in this paper.

With this study we try to contribute to the so far limited amount of research studying IPOs and their performance with regard to the involvement of the various private equity sub-groups. Evidently, the techniques used to distinguish between different types of pre-IPO investors need to go beyond the identification of involved firms or the consultation of third party labeling, for example by national private equity associations. The used approach of separately analyzing and classifying every deal in the sample results in marked differences between BO-backed and VC-backed IPO companies, especially concerning long-run performance. From this, we conclude that there is merit to a more detailed analysis concerning firm and transaction specifics. Existing literature has so far often granted more importance to performance analysis techniques than to the grouping of IPO sub-types in the sample selection process. However, the underlying approach to deal classification seems to be a factor of key importance for any IPO performance analysis. We thus call for future research to consider a more detailed analysis of transaction-specific characteristics. It would be interesting to identify how differences between private equity investors, for example in terms of experience, reputation, and investment strategy, affect their respective portfolio companies' IPO performance. The ownership percentage details obtained during the sample selection in this paper could also be the starting point of further analysis. As detailed earlier, our data only reflects an ownership snapshot at the time of an IPO and thus suffers from several limitations. For this reason, we refrained from far-fetching conclusions based on the obtained results. However, the composition and development of ownership stakes held by private equity investors or investor syndicates over time could add to the explanation of patterns in IPO performance. To our knowledge, no research has yet been conducted in which ownership stakes pertaining to different private equity investors are closely monitored over an extended period of time and implications on IPO performance are analyzed. Moreover, the relationship between multiple private equity firms invested in the same portfolio company, their possibly varying strategic goals and the effects on IPO performance have up to now not been sufficiently studied.

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Appendix

Appendix 1 – Sample Firms

Company	Group	IPO Date	Listing Market
3LEGS RESOURCES PLC	NB	2011-06-14	AIM
ABCAM	NB	2005-11-03	AIM
ACCSYS TECHNOLOGIES	NB	2005-10-26	AIM
ACERTEC	BO	2006-05-16	AIM
AFRICAN BARRICK GOLD LTD	NB	2010-03-24	UK Main Market
AFRICAN COPPER	NB	2004-11-12	AIM
ALEXANDER MINING	NB	2005-04-04	AIM
ALL LEISURE GROUP PLC	NB	2007-10-01	AIM
ALLERGY THERAPEUTICS	NB	2004-10-11	AIM
ALTERNATIVE NETWORKS	NB	2005-02-18	AIM
AMINO TECHNOLOGIES	NB	2004-06-09	AIM
ANGLO ASIAN MINING	NB	2005-07-29	AIM
ANKER	NB	2004-12-23	AIM
ARDANA	VC	2005-03-09	UK Main Market
ARMORGROUP INTERNATIONAL	BO	2004-12-14	UK Main Market
ASIA ENERGY	NB	2004-04-19	AIM
ATH RESOURCES	BO	2004-06-11	AIM
ATTENTIV SYSTEMS GROUP	NB	2004-03-31	AIM
AURELIAN OIL & GAS PLC	NB	2006-08-22	AIM
AUTOCLENZ HLDGS	NB	2005-12-07	AIM
BALTIC OIL TERMINALS	NB	2006-04-27	AIM
BANGO	VC	2005-06-30	AIM
BAYFIELD ENERGY HLDGS PLC	NB	2011-07-18	AIM
BELLZONE MINING PLC	NB	2010-04-01	AIM
BETEX GROUP	NB	2006-03-03	AIM
BETFAIR GROUP PLC	NB	2010-10-27	UK Main Market
BIOFUELS CORP	NB	2004-06-17	AIM
BOWLEVEN	NB	2004-12-07	AIM
BRITVIC	NB	2005-12-14	UK Main Market
BURBERRY GROUP	NB	2002-07-18	UK Main Market
BURREN ENERGY	NB	2003-12-11	UK Main Market
CADOGAN PETROLEUM	VC	2008-06-23	UK Main Market
CAMBIUM GLOBAL TIMBERLAND LTD	NB	2007-03-06	AIM
CAMCO INTERNATIONAL	NB	2006-04-25	AIM
CAPARO ENERGY LTD	NB	2010-10-12	AIM
CAPE DIAMONDS	NB	2006-05-26	AIM
CARDINAL RESOURCES	NB	2005-04-15	AIM
CARLUCCIO'S	NB	2005-12-14	AIM
CARTER & CARTER GROUP	VC	2005-02-07	UK Main Market
CELLO GROUP	NB	2004-11-09	AIM
CENTAUR HOLDINGS	BO	2004-03-10	AIM
CENTER PARCS(UK)GROUP	BO	2003-12-11	AIM

Company	Group	IPO Date	Listing Market
CENTRAL ASIA METALS PLC	NB	2010-09-30	AIM
CENTRAL RAND GOLD LTD	NB	2007-11-08	UK Main Market
CERES POWER HLDGS	VC	2004-11-25	AIM
CHARIOT OIL & GAS LTD	NB	2008-05-19	AIM
CINEWORLD GROUP	BO	2007-05-02	UK Main Market
CIRCLE HLDGS PLC	VC	2011-06-17	AIM
CIVICA	BO	2004-03-01	AIM
CLAPHAM HOUSE GROUP(THE)	NB	2003-11-10	AIM
CLEAN ENERGY BRAZIL PLC	NB	2006-12-18	AIM
CLEARSPED TECHNOLOGY	NB	2004-07-21	AIM
CLINPHONE PLC	BO	2006-06-23	UK Main Market
CLIPPER WINDPOWER	NB	2005-09-15	AIM
CMR FUEL CELLS	VC	2005-12-22	AIM
COMPACT POWER HLDGS	NB	2002-04-24	AIM
CONTINENTAL FARMERS GROUP PLC	NB	2011-06-28	AIM
CORAC GROUP	VC	2001-07-04	AIM
CORIN GROUP	BO	2002-05-09	UK Main Market
COSENTINO SIGNATURE WINES	NB	2005-12-01	AIM
CRANEWARE PLC	VC	2007-09-13	AIM
CSF GROUP PLC	NB	2010-03-22	AIM
CUSTOMVIS	NB	2003-07-08	AIM
CVS GROUP PLC	BO	2007-10-10	AIM
CYRIL SWEETT GROUP PLC	NB	2007-10-31	AIM
D1 OILS	NB	2004-10-29	AIM
DEALOGIC(HOLDINGS)	NB	2004-05-10	AIM
DEBENHAMS PLC	BO	2006-05-09	UK Main Market
DETICA GROUP	BO	2002-04-30	UK Main Market
DIGITAL BARRIERS LTD	NB	2010-03-04	AIM
DIGNITY	BO	2004-04-08	UK Main Market
DUNELM GROUP PLC	NB	2006-10-24	UK Main Market
E2V TECHNOLOGIES	BO	2004-07-23	UK Main Market
EAG LTD	NB	2007-06-26	AIM
EAGA PLC	NB	2007-06-07	UK Main Market
EIRCOM GROUP	BO	2004-03-24	UK Main Market
EMIS GROUP PLC	NB	2010-03-29	AIM
ENEGI OIL PLC	NB	2008-03-20	AIM
ENERGYBUILD GROUP PLC	NB	2007-08-06	AIM
ENTEQ UPSTREAM PLC	NB	2011-07-01	AIM
ERINACEOUS GROUP	NB	2003-11-27	AIM
EROS INTERNATIONAL	NB	2006-07-04	AIM
ESSAR ENERGY PLC	NB	2010-05-07	UK Main Market
ETALON GROUP LTD	NB	2011-04-20	UK Main Market
EURASIAN NATURAL RESOURCES CORP	NB	2007-12-12	UK Main Market
EUROPEAN NICKEL	NB	2004-03-31	AIM
EXILLON ENERGY PLC	NB	2009-12-17	UK Main Market

Company	Group	IPO Date	Listing Market
EXPERIAN GROUP LTD	NB	2006-10-11	UK Main Market
FERREXPO PLC	NB	2007-06-20	UK Main Market
FLYBE GROUP PLC	NB	2010-12-15	UK Main Market
FONEBAK	NB	2005-03-31	AIM
FORUM ENERGY	NB	2005-08-02	AIM
FOSECO	BO	2005-05-12	UK Main Market
FRESNILLO PLC	NB	2008-05-14	UK Main Market
GEMFIELDS RESOURCES	NB	2005-11-28	AIM
GLENCORE INTL PLC	NB	2011-05-24	UK Main Market
GLOBAL OCEANIC CARRIERS	NB	2005-05-26	AIM
GLOBUS MARITIME LTD	NB	2007-06-06	AIM
GOALS SOCCER CENTRES	BO	2004-12-07	AIM
GONDOLA HLDGS	VC	2005-11-08	UK Main Market
GREENKO GROUP PLC	BO	2007-11-07	AIM
GULFSANDS PETROLEUM	NB	2005-04-08	AIM
GW PHARMACEUTICALS	NB	2001-06-28	AIM
H & T GROUP	BO	2006-05-08	AIM
HALFORDS GROUP	BO	2004-06-08	UK Main Market
HAMWORTHY	BO	2004-07-20	AIM
HARDY OIL & GAS	NB	2005-06-07	AIM
HELLENIC CARRIERS LTD	NB	2007-11-30	AIM
HIGHLAND GOLD MINING	NB	2002-12-17	AIM
HIKMA PHARMACEUTICALS	NB	2005-11-04	UK Main Market
HILTON FOOD GROUP PLC	NB	2007-05-17	UK Main Market
HMV GROUP	BO	2002-05-15	UK Main Market
HOCHSCHILD MINING PLC	NB	2006-11-08	UK Main Market
HOGG ROBINSON GROUP PLC	BO	2006-10-12	UK Main Market
HOME ENTERTAINMENT CORP	VC	2001-10-25	AIM
HOTEL CORP(THE)	NB	2004-07-12	AIM
HUMMINGBIRD RESOURCES PLC	NB	2010-12-10	AIM
IBS OPENSYSYSTEMS	NB	2005-03-23	AIM
IDATECH PLC	NB	2007-08-06	AIM
IENERGIZER LTD	NB	2010-09-14	AIM
I-MATE	NB	2005-09-28	AIM
INCAT INTERNATIONAL	NB	2004-11-30	AIM
INDAGO PETROLEUM	NB	2005-12-02	AIM
INDIAN FILM COMPANY LTD(THE)	NB	2007-06-18	AIM
INDUS GAS LTD	NB	2008-06-06	AIM
INMARSAT	BO	2005-06-22	UK Main Market
INNOVISION RESEARCH & TECHNOLOGY	NB	2001-04-06	AIM
INSPACE	NB	2005-05-26	AIM
INTEGRATED DENTAL HOLDINGS	BO	2002-02-14	UK Main Market
INTERTEK TESTING SERVICES	BO	2002-05-29	UK Main Market
JESSOPS	BO	2004-11-03	UK Main Market
KENTZ CORPORATION LTD	NB	2008-02-05	AIM

Company	Group	IPO Date	Listing Market
KOLAR GOLD LTD	NB	2011-06-17	AIM
KSK POWER VENTUR PLC	NB	2006-11-01	AIM
LA TASCA GROUP	BO	2005-02-16	AIM
LAND OF LEATHER HLDGS	BO	2005-07-21	UK Main Market
LANDKOM INTERNATIONAL PLC	NB	2007-11-22	AIM
LEED PETROLEUM PLC	NB	2007-08-15	AIM
LIDCO GROUP	NB	2001-07-05	AIM
LOCAL RADIO CO(THE)	NB	2004-05-21	AIM
LOMBARD MEDICAL TECHNOLOGIES	VC	2005-12-13	AIM
LSL PROPERTY SERVICES PLC	NB	2006-11-21	UK Main Market
M&C SAATCHI	NB	2004-07-14	AIM
MARLBOROUGH STIRLING	VC	2001-04-09	UK Main Market
MATCHTECH GROUP PLC	NB	2006-10-27	AIM
MAX PETROLEUM	NB	2005-10-27	AIM
MAY GURNEY INTEGRATED SERVICES	NB	2006-06-21	AIM
MEDICSIGHT PLC	NB	2007-06-21	AIM
MICHAEL PAGE INTERNATIONAL	NB	2001-04-02	UK Main Market
MICRO FOCUS INTERNATIONAL	BO	2005-05-17	UK Main Market
MILESTONE GROUP	NB	2003-07-01	AIM
MINERA IRL LTD	NB	2007-04-12	AIM
MISSION MARKETING GROUP(THE)	NB	2006-04-13	AIM
MODERN WATER PLC	VC	2007-06-12	AIM
MONEYSUPERMARKET.COM GROUP PLC	NB	2007-07-31	UK Main Market
MORSON GROUP	NB	2006-03-30	AIM
MOUCHEL	NB	2002-06-28	UK Main Market
MWB BUSINESS EXCHANGE	NB	2005-12-21	AIM
NANDAN CLEANTEC PLC	NB	2011-11-09	AIM
NATIONWIDE ACCIDENT REPAIR SERVICES	BO	2006-07-04	AIM
NCC GROUP	BO	2004-07-14	AIM
NETSERVICES	NB	2006-03-08	AIM
NEUTEC PHARMA	VC	2002-02-20	AIM
NEWPORT NETWORKS GROUP	NB	2004-05-12	AIM
NIKANOR PLC	NB	2006-07-17	AIM
NORCROS PLC	BO	2007-07-16	UK Main Market
NORTHUMBRIAN WATER GROUP PLC	NB	2003-05-23	AIM
OCADO GROUP PLC	NB	2010-07-26	UK Main Market
OFFICE2OFFICE	BO	2004-06-29	UK Main Market
OFFSHORE HYDOCARBON MAPPING	VC	2004-03-11	AIM
OPG POWER VENTURE PLC	NB	2008-05-30	AIM
OPHIR ENERGY PLC	NB	2011-07-13	UK Main Market
OPTOS	VC	2006-02-15	UK Main Market
ORIEL RESOURCES	NB	2004-03-11	AIM
OXFORD CATALYSTS GROUP	VC	2006-04-26	AIM
PANGEA DIAMONDFIELDS PLC	VC	2006-10-17	AIM
PARK PLAZA HOTELS LTD	NB	2007-07-17	AIM

Company	Group	IPO Date	Listing Market
PARKMAN GROUP	BO	2001-07-05	UK Main Market
PATIENTLINE	VC	2001-03-22	AIM
PAYPOINT	NB	2004-09-24	UK Main Market
PD PORTS	BO	2004-07-12	AIM
PERFORM GROUP LTD	NB	2011-04-13	UK Main Market
PETER HAMBRO MINING	NB	2002-04-29	AIM
PETROFAC	VC	2005-10-07	UK Main Market
PHOENIX IT GROUP	BO	2004-11-16	UK Main Market
PHS GROUP	BO	2001-06-29	UK Main Market
PLATINUM MINING CORP OF INDIA	NB	2005-04-19	AIM
PLEXUS HLDGS	NB	2005-12-09	AIM
PLUSNET	NB	2004-07-14	AIM
POLYMETAL INTL PLC	NB	2011-11-02	UK Main Market
POWERLEAGUE GROUP	BO	2005-05-26	AIM
PREMIER FOODS	NB	2004-07-23	UK Main Market
PROACTIVE SPORTS GROUP	NB	2001-05-17	AIM
PRODUCE INVESTMENTS PLC	NB	2010-11-18	AIM
PROMETHEAN WORLD PLC	BO	2010-03-24	UK Main Market
PROSPERITY MINERALS HLDGS	NB	2006-05-24	AIM
PROSTRAKAN GROUP	VC	2005-06-16	UK Main Market
PROXIMAGEN NEUROSCIENCE	VC	2005-03-31	AIM
PUNCH TAVERNS	BO	2002-05-27	UK Main Market
PURICORE PLC	NB	2006-06-30	UK Main Market
PV CRYSTALOX SOLAR PLC	NB	2007-06-11	UK Main Market
QINETIQ GROUP	BO	2006-02-15	UK Main Market
RAMBLER MEDIA	NB	2005-06-15	AIM
RAYMARINE	BO	2004-12-06	UK Main Market
RDF MEDIA	VC	2005-05-04	AIM
RENEWABLE ENERGY GENERATION	NB	2005-05-16	AIM
RENEWABLE POWER & LIGHT PLC	NB	2006-12-14	AIM
RIGHTMOVE	NB	2006-03-15	UK Main Market
ROCKHOPPER EXPLORATION	NB	2005-08-15	AIM
ROXI PETROLEUM PLC	NB	2007-05-22	AIM
SALAMANDER ENERGY PLC	VC	2006-12-05	UK Main Market
SANDERSON GROUP	BO	2004-12-16	AIM
SCOTT WILSON GROUP	NB	2006-03-15	UK Main Market
SERICA ENERGY	NB	2005-12-13	AIM
SHAFT SINKERS HLDGS PLC	NB	2010-12-23	UK Main Market
SHED PRODUCTIONS	NB	2005-03-18	AIM
SILANIS INTERNATIONAL LTD	VC	2007-06-26	AIM
SKIL PORTS & LOGISTICS LTD	NB	2010-10-07	AIM
SOUTHERN CROSS HEALTHCARE GROUP PLC	BO	2006-07-12	UK Main Market
SPHERE MEDICAL HLDG PLC	VC	2011-11-17	AIM
SPICE HLDGS	NB	2004-08-26	AIM
SPORTS DIRECT INTL PLC	NB	2007-03-02	UK Main Market

Company	Group	IPO Date	Listing Market
SSP HLDGS PLC	VC	2006-10-02	AIM
STAR ENERGY GROUP	VC	2004-05-12	AIM
STYLES & WOOD GROUP PLC	BO	2006-11-07	UK Main Market
SUBSEA RESOURCES	NB	2004-11-04	AIM
SUNKAR RESOURCES PLC	NB	2008-06-30	AIM
SUPERGLASS HLDGS PLC	BO	2007-07-12	UK Main Market
SUPERGROUP PLC	NB	2010-03-24	UK Main Market
SYNAIRGEN	VC	2004-10-26	AIM
SYSTEM C HEALTHCARE	BO	2005-06-28	AIM
TELECITY GROUP	BO	2007-10-29	UK Main Market
TELIT COMMUNICATIONS	BO	2005-04-04	AIM
TIMAN OIL & GAS PLC	NB	2006-12-28	AIM
TITAN EUROPE	NB	2004-04-07	AIM
TOREX RETAIL	NB	2004-03-02	AIM
TRANS-SIBERIAN GOLD	NB	2003-11-25	AIM
TRAP OIL GROUP PLC	NB	2011-03-17	AIM
TRL ELECTRONICS	NB	2004-07-21	AIM
UBIQUITY SOFTWARE CORP	VC	2005-05-23	AIM
UMBRO	BO	2004-06-03	UK Main Market
UTV MOTION PICTURES PLC	NB	2007-07-02	AIM
VALIANT PETROLEUM PLC	NB	2008-03-13	AIM
VANCO	NB	2001-11-06	UK Main Market
WATERLOGIC PLC	NB	2011-07-11	AIM
VEDANTA RESOURCES	NB	2003-12-10	UK Main Market
WELLSTREAM HLDGS PLC	BO	2007-05-01	UK Main Market
VELTI	NB	2006-05-03	AIM
WEST CHINA CEMENT LTD	NB	2006-12-04	AIM
WILLIAM HILL	BO	2002-06-20	UK Main Market
WIN	BO	2004-10-06	AIM
VIRGIN MOBILE HLDGS(UK)	NB	2004-07-26	UK Main Market
VOLGA GAS PLC	NB	2007-04-25	AIM
WORK GROUP	BO	2006-03-01	AIM
XCHANGING PLC	VC	2007-04-30	UK Main Market
XSTRATA PLC	NB	2002-03-25	UK Main Market
YELL GROUP	NB	2003-07-15	UK Main Market

'Group' refers to venture capital-backed (VC), buyout-backed (BO) and non-backed (NB) IPO companies. Listing markets are the London Stock Exchange's (LSE) Main Market ('UK Main Market') and the London Stock Exchange's Alternative Investment Market (AIM).