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# Underpricing and Aftermarket Performance of IPOs in the UK

*An empirical review*

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# Abstract

This thesis contributes to the literature on Initial Public Offerings (IPOs). It seeks to uncover and explain underpricing and aftermarket performance for companies that go public for the first time in the United Kingdom (UK).

By creating a novel dataset of 194 UK IPOs that occur between 2006 and 2017, I find evidence that the UK IPOs exhibit first day returns equal to 7.4%. The underpricing is evident in all the years examined, showing that positive first day returns are a consistent phenomenon. IPOs that are issued during periods of above average first day returns, called hot markets, exhibit an average underpricing of 12.6%. Further, IPO firms that have higher profit margins in the year prior to the IPO, experience a positive 0.2% addition to their first day return on average. Finally, private-equity backed IPOs exhibit significantly lower first day returns of 3.1% on average, while their venture-backed counterparts do not.

Regarding aftermarket performance, I find varying evidence of outperformance and underperformance depending on the benchmark and method employed. My IPO sample significantly outperforms the FTSE benchmarks on a six-month basis, but for the longer periods of one-, three-, and five-years the results are inconclusive. Further, the wealth relatives confirm that the IPOs outperform the benchmark for the six-month holding period, showing a wealth relative equal to 1.06 and 1.05 when compared to FTSE All Share Index and the FTSE Small Cap Index, respectively. For the six-month holding period, private equity-backed IPOs increase returns by about 18%, while the one-year holding period is even more pronounced, increasing returns approximately 30%. Finally, I use the CAPM (Sharpe 1964), the Fama-French three-factor model (Fama and French 1993), and a newer three-factor model by Asness, Moskowitz et al. (2013) to examine abnormal returns of the IPOs in terms of alpha. However, none of the factor models show significant alphas.

# Acknowledgements

This thesis is written as a part of my master's degree in finance at the Norwegian School of Economics (NHH). My interest in IPOs arose while I was working in private equity and looking for ways for them to exit their investments while analysing a UK company. Digging into the subject matter further, I found that the literature regarding IPOs in the UK was relatively dated and my hope has been to provide a comprehensive update to this. Writing this thesis has been extremely challenging and exciting and I hope that it contributes to the literature.

Finally, I would like to thank my advisor, Francisco Santos, for his valuable feedback and encouraging words. My supervisor was always available to answer any questions or concerns, especially during the more frustrating phases of this thesis.

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# 1. Introduction

This thesis looks to examine potential underpricing and aftermarket performance for Initial Public Offerings (IPOs) in the United Kingdom (UK) between 2006 and 2017. The London Stock Exchange (LSE) is the third largest exchange and one of the oldest in the world (London Stock Exchange plc 2018). While doing research for this thesis, a majority of the literature specific to the UK was older. The combination of the prominence of the UK stock market and the want to provide a comprehensive update on the UK market has driven the motivation for the topic. To my knowledge, there has not been an analysis done on the UK IPO market as part of a master's thesis at NHH.

Two of the most important motivations for going public through an IPO include greater liquidity and greater access to outside capital (Berk and Demarzo 2014). Several studies explore the effects of the IPO decision and there are three main puzzles that exist. IPOs tend to be underpriced based on first day returns, they tend to exhibit timing trends, and they tend exhibit an aftermarket market underperformance in the long run (Berk and Demarzo 2014).

Moreover, I construct my own dataset of 194 UK IPOs that occur between 2006 and 2017 to analyse underpricing, aftermarket performance, and the variables that drive the performance. I collect data from listings on the London Main Market and AIM for the 12-year period through London Stock Exchange plc (2018) and SDC Platinum (2018). Total assets, revenue, total debt, and share price information are collected from Orbis (2018) and Datastream (2018) before it is merged together with the IPO dataset to get the complete dataset with all the necessary variables.

From my sample of 194 UK IPOs between 2006 and 2017, I find an average underpricing of 7.4% on an equally-weighted basis. This is lower compared to recent studies, as well as for the older literature. One of the more recent studies on the UK is Unlu, Ferris et al. (2004) who find an average underpricing of 28.0% between 1993 and 2001. Additionally, Levis (1993), who is known for his UK IPO analysis, finds an underpricing of 14.3% on 712 UK IPOs between 1980 and 1988.

Further, I explain the underpricing with OLS regressions. First, Ritter (1984) finds that younger firms tend to have a higher degree of underpricing. I find no evidence that company

age, defined as the age of the firm up until to the IPO, explains the initial return. Second, Levis (1990) and Burrowes and Jones (2004) analyse company size and underpricing. Levis (1990) finds that the larger the firm, the larger the initial return. Contrastingly, Burrowes and Jones (2004) find that UK IPOs listed on the Alternative Investment Market (AIM), which is a market reserved for smaller and growing firms, are conservatively mispriced relative to the London Main Market and main listings in the US. From my analysis, I find that the larger the offer size, the larger the degree of underpricing. However, when looking at total assets of the firms, for a one unit increase in assets, the initial return drops -1.6% on average. A gap in literature exists when looking at the profitability of the firms. I contribute to this by creating a variable for profit margin, defined as the profit divided by revenue. On average, for a unit change in the profit margin, the underpricing increases 0.2% in my sample.

Moreover, existing literature analyses the timing and market conditions present when a firm chooses to go public. Ritter (1984) finds evidence that IPOs that go public in hot markets, defined by either the degree of IPO volume or degree of IPO underpricing, tend to exhibit higher first day returns. Santos (2017) states that firms tend to go public when they can exploit the investor's positive sentiment and take advantage of overvaluations. I find that my sample of UK IPOs that are issued during a hot market, defined by their relative degree of initial return compared to the overall, exhibit higher underpricing than those that are not issued during these periods. On average, IPOs issued in a hot market environment show a positive 7.0% bump on their first day return.

Moving to deal-specifics of IPOs, the existing literature examines the role of underwriters, private equity investors, and venture capitalists. First, underwriters generally take a stake in the IPOs and thus if the issue is more underpriced, they face a lower risk (Jenkinson 1990). In my analysis, I find no evidence that IPOs underwritten by a syndicate nor the reputation of the investment bank provides a significant difference in the initial return. However, when I compare the IPOs that are part of a syndicate versus those that have a single underwriter, I find that syndicates exhibit an initial return of 4.2%, whereas the single underwriter IPOs have an underpricing of 9.6%. This may be due to that a syndicate has a group of investment banks that can arrive at a consensus offer price for the IPO, and thus get closer to the true value. Furthermore, I look at the reputation of the banks by creating a variable for the IPOs that have a bulge bracket underwriter versus those that do not, based on League Tables from the

Financial Times (2018). Differences also emerge here, indicating that bulge bracket underwriters have an average underpricing of 4.0%, whereas their counterparts have an initial return of 9.0%. However, this does not show up in any of the regressions, only when comparing the two sets of groups.

Finally, private equity- and venture capital-backed IPOs generally show a lower degree of underpricing than their non-sponsored counterparts. Levis (2011) finds private equity-backed IPOs have an average underpricing of 14.1%, while venture capital-backed IPOs have an average underpricing of 9.1%. Through my analysis, I find that private equity-backed IPOs lower the initial return by -4.0% on average. When delving deeper by comparing private equity- and venture capital-backed IPOs to their non-sponsored counterparts, I find that private equity-backed IPOs exhibit an underpricing equal to 3.1%, while their counterparts have an initial return of 8.6%. However, when comparing the venture capital-backed IPOs, they do not exhibit a significant difference. Compared with Levis (2011), I find support that private equity-backed IPOs exhibit a lower degree of underpricing, likely due to the fact that they are private investors that want to capitalise on exiting their investment.

Moving to the aftermarket performance of IPOs, I find ambiguous support for outperformance and underperformance for my UK IPO sample relative to the two main benchmarks, the FTSE All Share Index and the FTSE Small Cap Index. I look at four different holding periods: six months, one year, three years, and five years. From my sample of 194 UK IPOs, I find evidence of outperformance on a six-month basis equal to 4.4% for the cumulative abnormal return (CAR) and 5.4% for the buy-and-hold abnormal return (BHAR) when compared to the FTSE Small Cap Index and including the first month of return. There is no evidence that the one-year holding period is significant. However, the three-year holding period also exhibits outperformance for both indices. For example, the three-year BHAR is 6.1% when excluding the first month return compared to the FTSE All Share Index, which contradicts Levis (1993) who finds an average underperformance of -11.4% when excluding first month returns. The difference could likely be due to the period analysed. Finally, the five-year holding period shows varying results, indicating an underperformance of -9.6% on BHAR when excluding the first month return compared to the FTSE Small Cap Index, however this does not show up for the CARs.

To complement the BHAR, I use wealth relatives like to Ritter (1991). A wealth relative is defined as one plus the returns of the IPO sample divided by one plus the returns of the benchmark. Only the six-month holding period emerges as significant and outperforms both benchmarks, further supporting that my sample of IPOs tend to outperform for the shorter holding period.

Further, I run several regressions to explain the aftermarket performance. For the six-month holding period I find that private equity-backed IPOs increase the aftermarket performance 18% on average, and this close to doubles for the one-year holding period. This is consistent with Levis (2011) who states that private equity-backed IPOs tend to outperform the benchmark in the aftermarket. I find support for this on the shorter periods of six months and one year, but this disappears when analysing three- and five-year returns. When analysing the IPOs that participate in a syndicate, for the shorter holding periods of six months and one year, they contribute to an underperformance, ranging from -10% to -25% for the CARs.

As it relates to timing of IPOs, I find varying degrees of evidence. Unlike the underpricing analysis, I find no evidence that hot markets, defined by either the initial return or volume, show signs of underperformance or outperformance. However, the year of the IPO has some impact on the aftermarket performance. Specifically, 2011 has a positive and significant impact of 166% on the five-year BHARs, regardless of benchmark.

Similar to Levis (1993), I analyse whether the firms that experience higher first day returns experience a significantly worse performance in the aftermarket for a three-year holding period. Therefore, I construct a dummy variable that classifies those IPOs that have first day returns equal to or greater than the median of 11.3%. For the six-month BHARs, these firms have a positive bump ranging from 9.4% to 11.9%. Similarly, for the three-year holding period, they see a positive bump of 28.5% for the CARs when compared to the FTSE All Share Index. This is contrary to Levis (1993) for the three-year holding period.

Finally, I employ the CAPM (Sharpe 1964), the Fama-French three-factor model (Fama and French 1993), and a newer three-factor model based on value and momentum developed by Asness, Moskowitz et al. (2013) to uncover excess returns in the form of alpha. I use UK, European, and global factors to capture the most breadth. Unfortunately, I find no evidence of significant alphas for any of the factor models I use.

The following provides the structure of the thesis: Section 2 provides a literature review of IPO underpricing, cyclicality, and aftermarket performance. Section 3 explains my sample and the data collection procedure, along with summary statistics. Section 4 first presents the methodology applied before delving into the results, for each respective analysis. Finally, Section 5 provides an overarching summary. A few tables and figures are listed in the appendix and denoted with an A in their caption.

# 2. Literature Review

This section examines existing literature on IPOs in the UK, as well as across the rest of the world. The focus is on empirical evidence and theories related to IPO underpricing, cyclicality, and aftermarket performance.

## 2.1 Underpricing

Underpricing is widely discussed when it comes to IPOs. Berk and DeMarzo define underpricing as the IPO price being lower than the closing price at the first trading day of an IPO (Berk and Demarzo 2014). Underpricing is widely researched in academic literature, both for the UK and the rest of the world.

Levis (1990) shows an average first day return of 8.6% on UK IPOs. Further, Jenkinson (1990) examines IPOs in the UK, the US, and Japan. He observes an average underpricing in the UK of 12.2% after a week of trading on a sample of 553 IPOs between 1985 and 1988. Another study by Levis (1993) observes an average underpricing of 14.3% on 712 IPOs on the LSE between 1980 and 1988. Brennan and Franks (1997) carry out a similar study on UK firms, however they only have 69 IPOs in their sample. Overall, this results in average underpricing of 5.0% between 1988 and 1992. Filatotchev and Bishop (2002) find an average level of underpricing corresponding to 29.6% between 1999 and 2000 on 251 IPOs on the London Stock Exchange (LSE). Similarly, Unlu, Ferris et al. (2004) find a range of underpricing of 3.1% to 64.5% from 513 IPOs on the LSE from 1993 to 2001. The wide range is due to differences in firms and IPO timing (see section 2.2). In their study, they observe that money-left-on-table[1] increases over the sample period until 2000 and then falls dramatically in 2001 (due to the technology bubble burst). Burrowes and Jones (2004) analyse IPOs that are only on the Alternative Investment Market (AIM) of the London Stock Exchange. They collect a sample of 129 companies that went public between 1995 and 1997 and finds an average return of 16.9% and a median of 11.5% on the fifth day of trading. This is an interesting study as it only focuses on smaller companies that list on the AIM. The London Stock Exchange

[1] Unlu, Ferris, et. All (2004) calculates money-left-on-the-table as the profits earned by investors after the first day of trading.

established the AIM to encourage smaller, growing firms to go public and float their shares (Burrowes and Jones 2004). There is wide variation even on the studies in the UK, due to different benchmarks and methodologies used. I find an average underpricing of 7.4% on my sample of 194 UK IPOs between 2006 and 2017. This is close to the middle of the studies I review. However, my sample provides an updated view of the UK IPO market.

Moving away from the UK, there is a lot of academic literature on IPO underpricing in the rest of the world, specifically in the US due to the amount of data available. As mentioned above, Jenkinson (1990) examines the IPO underpricing phenomenon in the US and Japan, in addition to the UK. He finds that the average US underpricing is equal to 10.4%, while Japan exhibits an average underpricing of 54.7% after one week of trading. This represents one of the higher discounts observed in academic literature. Moving to the US, Ritter (1984) finds an average underpricing 16.3% over a six-year period between 1977 and 1982 on a sample of 1,028 IPOs. Miller and Reilly (1987) examine the US market between 1982 and 1983 with a sample size of 510 IPOs. They find an average return after the first five days of trading equal to 9.9% (Miller and Reilly 1987). Finally, Tinic (1988) analyses a period before and after the establishment of the Securities and Exchange Commission (SEC). During the pre-SEC period, he finds an average discount equal to 5.2% after the first week of trading, while during the post-SEC period between 1996 and 1971 shows an average underpricing of 11.1% after the first week of trading. Moving to Italy, Dell'Acqua, Etro et al. (2015) find that 129 IPOs on the Italian Stock Exchange are on average underpriced by 6.8%, which is on the lower end of previous studies.

Ritter (2003) provides an overarching summary of the differences between the European and American IPO markets. In this academic paper, he summarizes initial returns from past studies. See Figure A1 for a full summary of all initial returns by country. Denmark, France, Germany, Norway, and Spain have stated initial returns of 5.4%, 11.6%, 27.7%, 12.5%, and 10.7%, respectively. Compared to the rest of the world, the average underpricing of 7.4% I find is largerly in line with previous academic studies of developed financial markets, with the exception being the US.

Underpricing is generally found to be the norm and represents the direct transfer of wealth from the original owners to external investors (Jenkinson 1990). There are several theories on

underpricing and what the causes are. Most of the academic theories and subsequent results focus on two specific areas: the company-specific characteristics and the deal-specific characteristics.

Firm-specific characteristics relate to the individual characteristics related to a specific firm. I focus my literature review on size and company age. Ritter (1984) argues that if the proportion of riskier stocks increases over a time-period, then underpricing should also increase. This is because underpricing relates to the riskiness of the firms going public. Younger firms tend to be the ones that carry more risk due to the concern that they may not establish themselves and stay in business in the future. In conclusion, the underpricing phenomenon relates to the uncertainty about the value of an IPO, and this directly correlates to a firm's age. In my analysis, I do not find evidence that firm age plays a role in the degree of underpricing.

Related to firm size, Levis (1990) finds that the larger the UK firm[2], the larger the first day returns. He splits his sample into two equal parts and finds that smaller firms under £30 million in terms of market value, have underpricing equal to 2.5% whereas the larger companies have returns of 11.2% on average. This is contrary to Burrowes and Jones (2004), where IPOs listed on the AIM[3] are conservatively mispriced when compared to Main Market listings in the UK and different main markets across the world. The average underpricing of 16.9% is not significantly different from stock market listings in the US and the Main Market in London (Burrowes and Jones 2004). When looking at offer size, Jenkinson (1990) finds that underpricing is much less of an issue for large IPOs. He illustrates that US IPOs from 1985 to 1988 with an offer size between $0 and $5 million are underpriced 22.6%, whereas those that have an offer size of more than $100 million have an average underpricing of 2.1%. In my analysis, I find that the larger the offer size, the greater the first day return, which is in line with Levis (1990), but contradicts Jenkinson (1990). Furthermore, I analyse the assets in the year prior to the IPO and find that for every one-unit change in assets, the first day return decreases by approximately 1.6%.

[2] Relates to market value, amount raised, or sales (Levis 1990).

[3] AIM historically associated with younger, smaller, and growing companies.

Moving on to deal-specifics, I review the role underwriters, private equity, and venture capitalists play in IPOs. Underwriters face less risk if the IPOs are underpriced to a greater extent, since they take on some of the risk of IPOs by purchasing a stake in the issuing company (Jenkinson 1990). This underpricing is further reinforced because an underwriter will likely take part in many public offerings (Beatty and Ritter 1986). There is an incentive for investment banks to underprice an issue "just right", not too much because it may damage their reputation, but not too little because of the increased risk. In conclusion, companies may be employing a signalling effect with their choice of underwriters for their IPO. Contrary to the literature, I do not find evidence that bulge bracket or syndicates increase first day returns. However, when comparing the groups to each other directly, syndicates show a first day return of 4.3% whereas those IPOs with a single underwriter exhibit first day returns of 9.6%.

Levis (2011) finds a relatively lower underpricing for private equity-backed (PE-backed) IPOs, and that it relates to the size and maturity of these companies. He finds that PE-backed and venture capital-backed (VC-backed) IPOs experience an average underpricing of 14.1% and 9.1%, respectively, while their unsponsored counterparts have underpricing equal to 21.1%. This is likely due to a combination of lower risk represented by private equity and venture capital, in addition to the more aggressive pricing strategy to generate the most amount of money for their investors (Levis 2011). Similarly, I find that PE- and VC-backed IPOs exhibit underpricing of 3.1% and 4.6%, respectively. However, based on the Wilcoxon rank-sum test only the PE-backed IPOs exhibit significantly different results from their counterparts.

In conclusion, underpricing as it relates to IPOs is present across the world. Although, the magnitude of the initial discount varies, most academic literature agrees that it is a persistent phenomenon. There is no single theory that fully explains underpricing. The cyclicality of IPOs explains part of the variation, which is considered next.

## 2.2 Cyclicality of IPOs

The initial return of IPOs after one day of trading (or after a five-day week) is widely observed and significant, although this varies across different countries and time-periods. The

cyclicality of IPOs is widely researched in academic literature, which I emphasize since I perform analysis related to the timing of IPOs.

Loughran and Ritter (2004) examine an IPO period from 1980 to 2003 and considers various blocks of time. They find that in the 1980s initial returns were 7%, before doubling to 15% between 1990 and 1998. During the internet bubble between 1999 and 2000, underpricing jumped to 65%, before reducing to 12% between 2001 and 2003.

Another study by Loughran and Ritter show that much of the "time-varying misvaluations and changes in growth opportunities may account for much of the time-series variation in IPO volume", specifically for the US and UK (Loughran, Ritter et al. 1994). They also show that there is a positive correlation between the level of the market and IPO volume in 93% of the countries examined (Loughran, Ritter et al. 1994). However, they state that this is only indirect evidence on the ability to time the market.

Ritter (1984) analyses the "hot issue" market of the 1980s and shows that IPOs that go public during such "hot" markets tend to yield higher first-day returns. Furthermore, he goes on to analyse whether high-risk firms have higher initial returns, and whether this change in composition of risk can explain the "hot issue" market of the 1980s (Ritter 1984). However, he concludes that the change in risk composition cannot explain "hot issue" markets, as it holds for both hot and cold markets, i.e. that on average higher risk firms have higher initial returns.

Finally, Ritter and Welch (2002) evaluate the IPO market in terms of activity, and finds there is evidence of market timing by issuing firms. They come up with their own theory that entrepreneurs of firms are more likely "to sell shares after valuations in the public markets have increased" (Ritter and Welch 2002). This means that the issuing firms essentially time their IPOs to when prices in the market are higher and investors are optimistic. Furthermore, Santos (2017) develops a model that shows that firms prefer to go public when they can exploit the over-exuberance of investors' valuations.

In conclusion, the IPO markets have varied over time, with the number of firms going public in any given year changing. Although this pattern has been observed in both hot and cold periods over the past few decades, it is difficult to assess what this is due to because of the

difficulty in empirically testing the hypotheses. As it relates to underpricing, I find that hot markets, defined by periods of high underpricing for a prolonged time, exhibit higher first day returns of 12.6%. Overall, a difference is observed between years in Table 3.1. Further, aftermarket performance shows differences among years, with 2010, 2011, and 2012 exhibiting higher aftermarket performance on a six-month, one-year, and five-year basis. While IPOs issued during 2006 and 2017 exhibit lower performance on a one-year buy-and-hold return.

## 2.3 Aftermarket Performance

In the preceding sections, I outline the existing literature on IPOs when it comes to underpricing and cyclicality. In this section, I describe existing evidence of aftermarket performance of IPOs, focused on the UK. Unlike underpricing, IPOs tend to exhibit negative aftermarket performance in the long-run.

In his study, Levis (1993) uses three alternative benchmarks to measure aftermarket performance of UK IPOs in the 1980s. The three benchmarks used are the market capitalization weighted FTA index, the capitalization weighted HGSC index, and the all share equally weighted index. Based on these benchmarks, he finds a 36-month return excluding the first month returns equal to -11.4%, -8.3%, and -23.0% for the FTA, HGSC, and all share index, respectively. Goergen and Renneboog (2003) find that over a period of five years from a total of 764 British firms that went public between 1981 and 1988, that the IPOs have an aftermarket performance of -33%. Furthermore, Espenlaub, Gregory et al. (2000) find evidence that after 36 months, UK IPOs issued between 1985 and 1992 underperform based on the CAPM and Fama-French three-factor model, -15.9% and -28.2%, respectively. However, the 60 month returns shows that the deterioration of returns slows down, depending on the benchmark chosen, with cumulative abnormal returns ranging from -4.3% to -42.8% (Espenlaub, Gregory et al. 2000). Looking at PE- and VC-backed IPOs, Levis (2011) compares these two groups to a selection of non-sponsored UK IPOs from 1992 to 2005. Using various FTSE benchmarks, he shows that based on the Financial Times All-Share Index, PE-backed IPOs have a positive 36 month equally-weighted return of 13.8%, while VC-backed and non-sponsored IPOs both had negative returns of -3.9% and -20.2%, respectively. Overall, the sample of IPOs generate an abnormal return of -13.5% after 36 months, demonstrating that

overall IPOs underperform in the long-run. However, both Levis (2011) and Espenlaub, Gregory et al. (2000) find that the amount of underperformance depends on the benchmark chosen. For my sample of 194 UK IPOs between 2006 and 2017, I find varying degrees of both underperformance and outperformance. The six-month holding period exhibits outperformance relative to the FTSE All Share Index and FTSE Small Cap Index equal to 4.9% and 4.4%, respectively, on a cumulative abnormal return basis. The six-month period is not often analysed, but I chose to analyse it because of the common lockup period of 180 days. For the five-year buy-and-hold abnormal returns, the UK exhibits underperformance to the FTSE All Share Index and FTSE Small Cap Index equal to -7.0% and -9.3%, respectively. Having examined the literature surrounding aftermarket performance, I review what drives the performance next.

Ritter and Welch (2002) favour the behavioural point of view when observing long-term aftermarket underperformance. They find an average market-adjusted underperformance of -23.4% over three years for US firms between 1980 and 2001 (Ritter and Welch 2002). However, this is highly dependent on the benchmark chosen. Furthermore, Espenlaub, Gregory et al. (2000) finds statistically significant negative aftermarket performance regardless of the benchmark used. They find that the oil and gas industry consistently performs the worst, along with the fact that smaller firms tend to experience larger underperformance (Espenlaub, Gregory et al. 2000). In my study, I find that the aftermarket performance varies depending on the benchmark chosen, and I therefore focus my study on two benchmarks, the FTSE All Share Index and FTSE Small Cap Index, in order to get a picture based on the overall market and for the smaller firms. However, I do not uncover many significant differences between industries.

From a timing perspective, Loughran, Ritter et al. (1994) find that there is a tendency for high volume timeframes to experience lower long-term returns. Specifically in the US, older and more established firms have smaller initial average returns, but higher long-term returns when compared with their younger counterparts (Loughran, Ritter et al. 1994). Although as mentioned above in Section 2.2, I find differences among years in aftermarket performance, I do not see significant differences in periods defined as hot or cold, as defined by IPO volume or IPO initial returns.

Ritter (1991) attributes long-term aftermarket underperformance to risk mismeasurement, bad luck, or fads and over optimism. To explain whether risk mismeasurement plays a role, he uses different benchmarks to find robust results (Ritter 1991). Levis (1993) takes it a step further by finding that firms with the highest initial return tend to experience the worst aftermarket performance in the long-term[4]. Inspired by Levis (1993), I find that the IPOs that have initial returns equal to or greater than the median in the sample experience a boost on the six-month buy-and-hold abnormal returns ranging from 9.4% to 11.9% depending on the benchmark and inclusion of first month return. However, only the three-year cumulative abnormal returns are significant and equal to a 28.5% boost on the average three-year return, which is contrary to Levis (1993)

Finally, academic literature related to PE- and VC-backed IPOs, Levis (2011) finds that PE-backed IPOs consistently have positive and significant cumulative abnormal returns which is related to the firms' leverage ratios and proportion of shareholders, on an equally- and value-weighted basis. On the contrary, VC-backed IPOs and other non-sponsored IPOs perform poorly in the aftermarket (Levis 2011). My results are mixed, where PE-backed IPOs see a boost in the high teens for the six-month buy-and-hold returns and this approximately doubles to 30% when looking at the one-year holding period. This is less pronounced in the longer holding periods of three- and five-years. Furthermore, I find no significant underperformance for VC-backed IPOs, although the coefficients are negative.

Having discussed the literature surrounding IPOs related to underpricing and aftermarket performance, the next section discusses the data collection process and the characteristics of the data.

[4] Over a period of 36 months.

# 3. Data

The following section describes how I collect the data and create the unique sample of UK IPOs used in this analysis. This data is constructed with the purpose of answering whether UK IPOs are initially underpriced and experience an aftermarket underperformance in the long-run, before uncovering what variables contribute to the performance. First, I will discuss the sample and how it was collected, then move to the data variables and characteristics that are used to conduct the empirical analysis on the sample of IPOs.

## 3.1 The Sample and Characteristics

The collection and creation of this novel dataset has been the time-consuming part of my research. I collect the data from various sources and cross-check that the data aligns. The final sample consists of 194 IPOs issued on the London Stock Exchange between January 2006 and December 2017. The London Stock Exchange is split into two markets: Main Market and Alternative Investment Market (AIM) (London Stock Exchange plc 2018). Therefore, I collect IPOs from both markets. The 12-year period is selected to capture as many data points as possible. By including 2008 as an IPO year, I capture the volatile times of the Financial Crisis in 2008 to examine the potential effect it might have.

I find lists of the relevant IPOs from the London Stock Exchange plc (2018) and SDC Platinum (2018). The companies I use for the analysis are firms incorporated in the UK and are listed on the Main Market or AIM for the first time. Therefore, this excludes any secondary offerings and transfers. In order to avoid survivorship bias, the companies that delist during the sample period are included. These are then merged together to form one ultimate dataset of IPOs based on matching the International Securities Identification Numbers (ISIN) across the two datasets to avoid duplicates. This results in 785 unique IPOs. By combining from two different data sources, I ensure that I receive the most relevant characteristics and variables that cover the largest breadth. Furthermore, I collect accounting and share price information from Orbis (2018) and Datastream (2018). When I combine the IPO, Orbis, and Datastream datasets based

on ISIN and partial string matching[5], it results in 467 IPOs. However, due to missing data for variables such as total assets and total debt and the difficulty in matching across databases based on a unique variable such as ISIN in addition to using partial string matching, this is narrowed down to the final and complete set of 194 IPOs. This could potentially bias my result. I consider the initial sample of 194 IPOs as a sufficient sample size to run further analysis for this thesis. Table 3.1 summarises the distribution by year and issue characteristics of the sample collected.

| IPO Year | Count of IPOs | Average First Day Return | Adj. Offer Size (£MM) | Average Company Age |
|---|---|---|---|---|
| 2006 | 16 | 8.06% | 220.6 | 25.1 |
| 2007 | 20 | 7.73% | 202.4 | 17.0 |
| 2008 | 1 | 22.50% | 1.0 | 3.5 |
| 2010 | 7 | 8.04% | 168.3 | 20.8 |
| 2011 | 6 | 13.13% | 30.9 | 14.6 |
| 2012 | 6 | 5.79% | 183.4 | 11.1 |
| 2013 | 20 | 7.95% | 180.9 | 16.7 |
| 2014 | 43 | 7.00% | 167.7 | 15.9 |
| 2015 | 26 | 5.83% | 169.5 | 17.0 |
| 2016 | 27 | 8.31% | 112.1 | 14.6 |
| 2017 | 22 | 5.63% | 69.2 | 32.6 |
| Total | 194 | 7.40% | 153.8 | 18.6 |

*Table 3.1: Distribution and Characteristics of UK IPOs by year, 2006-2017*

*The table illustrates the distribution and basic issue characteristics of 194 UK IPOs completed between 2006 and 2017, by year. Adj. offer size is in £ millions and inflation adjusted to a base year of 2017. The year 2009 is not included as there are no observations in the sample for this period.*

A graphical representation of the UK IPOs by year and first day return is shown in Figure 3.1 below. The IPO volume in the UK has fluctuated over time, similar to trends observed across the world[6]. The financial crisis hit in 2008, which explains the exceptionally low volume in 2008 and no IPOs in the sample for 2009, after which volume increases until its peak in 2014. The high first day return in 2008 is explained by a single company, The Rethink Group Limited, which was subsequently delisted in 2014. The first day returns stay relatively stable from 2013 onward, at around 7% on average.

[5] Partial string matching was done by matching the partial text of the company name across the datasets and is checked manually to ensure that the correct company is matched with the correct data from each dataset.

[6] See for example Loughran and Ritter (2004), Loughran and Ritter (1994), Ritter (1984), or Ritter and Welch (2002).

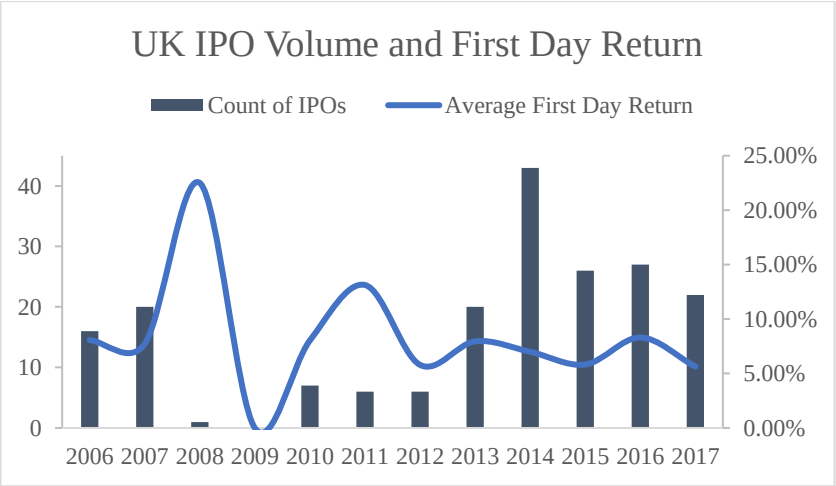


*Figure 3.1: Sample of UK IPOs by year and first day returns, 2006-2017*

*The figure illustrates the number of IPOs by year and their respective first day returns.*

## 3.2 The Variables and Characteristics

In order to conduct an empirical analysis, I am highly dependent on gathering data on critical variables such as IPO characteristics, historical prices, and firm characteristics. The coming paragraphs explain the variables, how they were constructed, and the basic characteristics.

To analyse the effect that offer size might have on the UK IPOs, I construct a variable called ADJ_Offer_Size. This is the product of the offer price of the IPO and the number of shares offered. For the 10 that did not have data, I examine their individual prospectuses. To make the offer size comparable across companies and years, I inflation-adjust the variable based on the CPI Index between 2006 and 2017, and use 2017 as the base year (The World Bank 2018). The average offer size over the sample period is £153.8 million, with the median being equal to £44.3 million. This means that some large offer sizes impact the sample. The largest adjusted offer size is £2.2 billion and occurred in 2015 by Worldpay Group Limited, an online payment system. Figure 3.2 shows the distribution of the offer sizes in six different categories. Two-thirds of the sample is concentrated in the adjusted offer size range of £0 to £100 million, meaning that most of the sample consists of relatively small IPO offer sizes. In order to adjust for any outliers, a variable for the natural logarithm of the offer size is created as well.

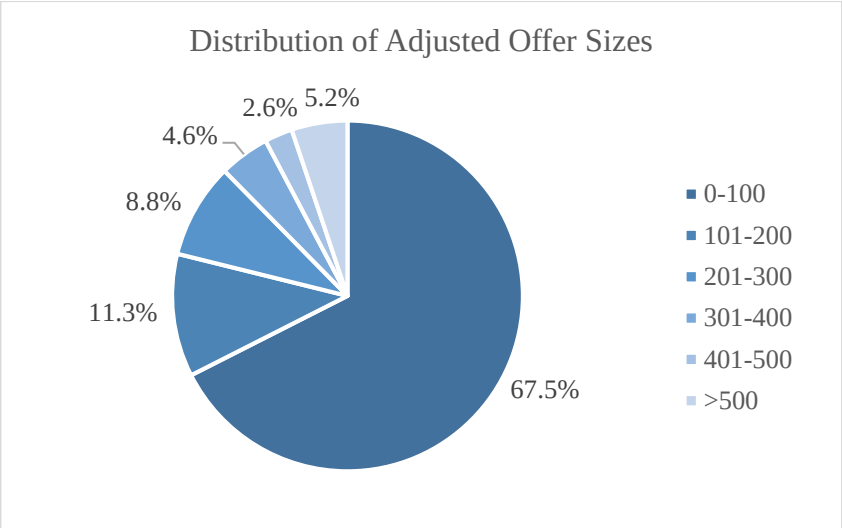


*Figure 3.2: Distribution of Offer Size, 2006-2017*

*The figure shows the distribution in percent of adjusted offer sizes in £ millions in constant 2017 terms for the 194 IPOs. The offer size is the product of the offer price multiplied by offer shares.*

Furthermore, to enable analysis of firm-specific characteristics, I collect accounting data for the sample firms. In order to capture the firm in the pre-IPO period, I collect the accounting data from Orbis (2018) in the year of the IPO. This is under the assumption that in the year of the IPO, the firm will not have changed too much from the pre-IPO period. Approximately a third of the final sample of 194 are missing accounting data from Orbis (2018). Those firms that do not have the data available in Orbis are collected from Datastream (2018) and manually matched to the sample with partial string matching in R and then cross-checked manually. From the accounting data I collect, I construct ADJ_Assets, ADJ_Revenue, and ADJ_Debt variables by adjusting the raw numbers to CPI-adjusted values with a base year of 2017. Additionally, I create the three variables in a logarithmic form as well to control for outliers when running the linear regressions.

Moreover, to calculate the relevant share price returns for this thesis, I collect share price information for each company in the sample. To calculate the first day return, I obtain the daily share prices for each company from Datastream (2018) for the sample period. To calculate the longer periods of six months, one-year, three-year, and five-year returns, I collect the monthly Total Return Index values from Datastream (2018) and use these to calculate the timeframes needed. By using the Total Return Index, the share prices capture any reinvestment of

dividends. Random returns are spot-checked with Bloomberg L.P. (2018) and Yahoo Finance (2018)[7].

In order to examine any industry differences, I apply the NACE Rev. 2 Main Section classifications to the UK IPO sample in order to view differences that may arise between industries[8]. Table A1 in the appendix provides an overview and characteristics by industry. Based on the volume of IPOs, the top three industries are Manufacturing, Wholesale and Retail Trade, and Financial and Insurance Activities.

Furthermore, to isolate any effect that the market size of the company may have, I create two main variables to analyse this. First, I construct a dummy variable based on whether the sample company listed on AIM or the Main Market. 102 out of 194 listed on AIM during the sample period, meaning that most firms were smaller capitalised firms[9]. Secondly, I classified the 194 IPOs into small-, mid-, and large-cap stocks based on a Morningstar (2015) article that classified UK equities on the FTSE Indices. 184 out of the 194 are small-cap stocks, which further illustrates that the sample skews toward smaller firms. This makes sense as AIM is intended for smaller companies to raise money from outside investors (London Stock Exchange plc 2018).

Additionally, by looking at company age I can examine age effects that may play a role. Company_AGE is the difference between the IPO date and the date the company was founded. For the 100 companies that did not have a founding date, I manually desktop-searched for this. The mean and median age for the initial sample are 18.7 years and 9.5 years, respectively. This indicates that there are firms that skew the firm age by being older. In fact, the oldest company is 256 years old before listing, while the youngest firms are listed in the same year as they were founded.

When companies list on an exchange, it is typically for a reason. Whether to improve liquidity or they need funds to pay off debt. Therefore, to measure any effects of the use of proceeds could have, I classified the sample companies based on this. 48% of firms state that they intend

[7] This is to ensure data validity
[8] The sample has companies from 16 different NACE Rev. 2 main section codes, total is 21 sections
[9] This is further backed up by the distribution of offer size as discussed previously

to use the proceeds for "general corporate purposes", which can mean almost anything. The second most stated reason is for an "investment/loan" and "secondary", with 17 companies each. 58 companies state they plan to use the proceeds from the IPO for capital expenditures, reduce debt, industrial development, working capital, payment of borrowings, future acquisitions, or improve the balance sheet. For further detail, see Table A2 for the detailed breakout of the use of proceeds. Although the majority are for general reasons, it is still interesting to include as a variable to see if it has an impact.

IPOs tend to move in waves of high and low volumes and returns, and therefore I want examine how the timing of the IPO can impact returns and results. Loughran and Ritter (2004) show that IPO volume and underpricing has changed over time when they examine IPOs from 1980 to 2003. Santos (2017) further examines IPO timing by developing a model to examine cyclicality and what it means. Based on this, several variables are constructed to examine the effect of different market conditions and timing of the IPOs.

As is shown in Figure 3.1, the issuance and first day returns fluctuate over time in the sample. Additionally, market conditions do fluctuate within a year. Therefore, I choose to measure certain market conditions by month. Consistent with prior literature[10], the market is divided in periods of hot, cold, and neutral based on IPO volume. If the volume of IPOs is equal to or greater than the 75$^{th}$ percentile, the month is classified as a high-volume month. If the volume is equal to or less than the 50$^{th}$ percentile, the month is categorised as a low-volume month. The remainders are neutral months. Santos (2017) classifies a high month as anything in the top quartile, while the rest are low. However, due to several missing months in my dataset, I choose to employ anything below the 50$^{th}$ percentile as a low month, while anything in between is neutral. Finally, I define high, low, and neutral months in hot, cold, or neutral periods. A hot period is defined as three consecutive months of high months, while a cold period defined as three consecutive of low months. The remainders are classified as neutral. A dummy variable, HOT_Mkt_Vol, is created to capture the periods that are hot or neutral. A similar process is carried out for the level of first day return, constructed from the monthly

[10] See for example Santos (2017) and Ritter (1984).

period returns, and classified in the same manner. The variable HOT_MKT_RET is created from this, where 1 equals a hot or neutral period.

In addition to creating variables based on market conditions, I construct dummy variables based on the year that the IPO occurs. The year 2014 is excluded when creating the dummy variable set as it has the most IPOs.

Continuing the analysis, I also want to look at whether the first day return has an impact on the aftermarket performance. I therefore construct the per50 variable, which is a dummy variable based on whether the IPO firm has an initial return equal to or above the $50^{th}$ percentile of first day returns. The $50^{th}$ percentile first day return is 11.3%. 97 companies exhibit initial returns that are equal to or above the median.

After the IPO, companies have a lockup period for insider investors. Field and Hanka (2001) state that a lockup agreement is in place to prevent pre-IPO shareholders from selling their shares for a pre-determined time following the IPO. Therefore, it is interesting to analyse whether a lockup period has an impact on returns of the IPO. In my sample of 194 IPOs, 98 of the companies had a lockup period of 360 or 365 days, whereas 87 had a lockup period of 180 days. The remaining IPOs had various lockup periods ranging from 90 days to 720 days.

Moving from characteristics of the IPO to the organisations behind the IPO, underwriters play a critical role in taking companies public, by providing an issue price and a market for the listed shares. This may be a changing trend based on the Spotify IPO, where the company listed directly on the New York Stock Exchange, with no underwriter (Turner 2018). For now, underwriters play an important role in the IPO process. To examine the effect underwriters may have on returns, I construct several variables. Firstly, I classify the lead underwriter based on whether they are a top 10 bulge bracket bank based on League Tables from the Financial Times (2018). I create the dummy variable BULGE_BRACKET that indicates whether the lead underwriter is a bulge bracket bank or not. Of the 194 sample IPO companies, 62 are classified as having a bulge bracket underwriter. Secondly, underwriters may participate in a syndicate, which just means that several banks underwrite the issue. In order to measure this, I create a dummy variable called SYNDICATE to examine whether having a syndicate underwrite the issue has an impact on returns. 79 out of 194 sample firms are underwritten by a syndicate.

Other key stakeholders include IPOs that are backed by institutional owners, such as private equity investors or venture capitalists. PE- or VC-backed IPOs are IPOs that are put forward by a professional owner, hence there may be an incentive for them to withhold information to profit. Levis (2011) finds that private equity-backed IPOs have relatively modest first day returns and that they have superior aftermarket performance over 36 months. Therefore, I construct variables to examine the effects of these types of ownerships. The first variable is whether the IPO is backed by private equity or not, which results in 43 firms of the 194. Secondly, I examine whether an IPO is venture capital-backed, which results in 10 of the 194. This results in a total of 53 IPO firms that are either PE- or VC-backed from my total sample.

Finally, when measuring aftermarket performance, it is important to have an appropriate benchmark. Existing literature employ two main benchmarks. The first is to pick an index, like the FTSE 100, to measure the aftermarket performance of the IPO firms. The second is to create a portfolio of matched companies that have already gone through an IPO, based on firm characteristics to the IPO firms being analysed. The first is the easiest to implement, while the second option is more complex and time-consuming. In this study, I choose to implement a variety of benchmarks based on indices as I believe they capture the risk appropriately for this thesis. Several academic papers only implement the benchmarking procedure with one or several indices[11]. Although, it is becoming more common to use a portfolio of matching firms, I believe using a variety of benchmarks is sufficient.

In order to most accurately capture the risk of the 194 IPOs I collect data for, I use five benchmarks as comparison when evaluating aftermarket performance. The five benchmarks employed are: FTSE All-Share Index, FTSE 100, FTSE 250, FTSE 350, and FTSE Small Cap Index. According to a report by FTSE Russell (2017), the FTSE All-Share Index captures 98% of the UK market capitalisation and has a total market capitalisation of £2.6 trillion. This benchmark is used to capture the entirety of the UK market. Secondly, I use the FTSE 100, which captures 78% of the UK market and has a total market capitalisation of £2.0 trillion (FTSE Russell 2017). These two benchmarks are the largest and most common to use.

[11] See for example Levis (1993) and Goergen and Renneboog (2003).

The FTSE 250 and 350 capture more of the middle of the range of the market. The FTSE 250 captures 17% of the UK market, with a total market capitalisation equal to £453.2 billion (FTSE Russell 2017). Further, the FTSE 250 index captures the mid-market, representing 250 of the largest UK companies outside of the FTSE 100. I use this index to compare the UK IPOs and how they do relative to the middle market. The FTSE 350 combines the FTSE 100 and FTSE 250, represents 96% of the UK market capitalisation and is worth around £2.5 trillion (FTSE Russell 2017). By using the FTSE 350, I capture both the large- and mid-capitalised market.

Lastly, the FTSE Small Cap Index are all the shares that are not large enough to take part in the other indices. It represents approximately 4% of the total UK market and has a market capitalisation of £95.0 billion (FTSE Russell 2017). The FTSE Small Cap Index is believed to best capture the risk of 194 IPOs, due to the small market capitalisation of the sample and that most of the issues are listed on AIM.

The breadth of indices is used to accurately measure risk across different capitalisation groups. For my main analysis in this thesis, I choose to focus on the FTSE All Share Index and the FTSE Small Cap Index, although all other results are available upon request. Even though several scholars apply a benchmark that is constructed with a set of matching IPO firms that have gone public in the past, this thesis does not employ that strategy. Instead, I use several indices that I believe capture the adequate level of risk for this sample. Furthermore, by focusing on these two indices, FTSE All Share and FTSE Small Cap, I capture both the larger overall market and the smaller capitalised firms, respectively.

# 4. Empirical Analysis

In this section, I discuss my methodology and empirical findings. Before each section, I discuss the method used to achieve the results. First, I discuss the methodology for underpricing and the empirical results of the analysis, before presenting the methods for aftermarket performance as it relates to CARs, BHARs, and WRs along with the results. Finally, I show the methodology and results for the factor models.

## 4.1 Methodologies of Underpricing

Similar to existing literature, IPO underpricing is calculated by taking the difference of the initial price of the issue and the closing price on the first day of trading. I refer to underpricing as the first day return (FDR). Equation 4.1 illustrates the formula for the first day return. This is not compared to any market return, because market movements are less of a problem over a short time period (Burrowes and Jones 2004).

$$FDR_i = \frac{ClosingPrice_i}{OfferPrice_i} - 1 \qquad (4.1)$$

From the initial sample of 194 IPOs, I calculate equally-weighted and value-weighted first day returns. Since my dataset is focused on smaller offer sizes, I use the value-weighted to not overweight the small offerings. This is done because existing literature shows that smaller firms tend to exhibit higher underpricing[12]. Equation 4.2 shows the equally-weighted first day return, assigning the same weight to each individual IPO. In order to capture any size effect, Equation 4.3 shows the value-weighted, weighted by the adjusted offer size in Equation 4.4.

$$FDR^{EW} = \frac{1}{n}\sum_{i=1}^{n} FDR_i \qquad (4.2)$$

$$FDR^{VW} = \sum_{i=1}^{n} w_i * FDR_i \qquad (4.3)$$

$$w_i = \frac{Adj.OfferSize_i}{\sum_{i=1}^{n} Adj.OfferSize_i} \qquad (4.4)$$

[12] See for example Burrowes and Jones (2004) and Jenkinson (1990).

The adjusted offer size is adjusted by CPI inflation in Equation 4.5, to a base year of 2017. This is to obtain real values to examine the offer size over time comparably.

$$Adj.OfferSize = OfferSize_i * CPI\ Index \quad (4.5)$$

I test whether the equally- (EW) and value-weighted (VW) first day returns are significantly different from zero. With the methodology explained, I analyse the results and drivers of underpricing.

## 4.2 Underpricing in the UK Market

The average first day equally-weighted return is 7.4%, with the value-weighted showing an average of 6.5%. Table 4.1 shows that the mean of 7.4% is greater than the median of 4.7%, indicating a right skewed distribution. Figure 4.1 confirms this, by showing a distribution that skews to the right of zero[13]. Since the distribution is non-normal, I employ the Wilcoxon signed-rank test to test whether the first day return is significantly different from zero. Both the equally- and value-weighted returns reject the null hypothesis that they are equal to zero, and therefore the sample of UK IPOs exhibits positive first day return[14].

To get an overview of the first day return, Table 4.1 shows various summary statistics. The first day return ranges from -10.7% to 57.4%, on an equally-weighted basis. The minimum first day return comes in a low period month[15]. The maximum value of 57.4% surprisingly occurs in a neutral period month. Overall, 73.7% of the initial sample show positive initial returns, with 11.3% exhibiting returns above 20% on the first day of trading.

The first day returns also vary by year[16], with 2008 exhibiting the highest first day return of 22.5%. However, this is for one IPO that occurred that year, likely due to the looming financial crisis. Overall, all the years examined exhibit positive initial returns. Additionally, using the Wilcoxon signed-rank test, I discover that every year except for 2008 and 2012 are

[13] The Shapiro-Wilk test confirms that this is a non-normal distribution.
[14] Results of the tests are available upon request, with additional t-tests also available.
[15] Defined by low, neutral, high based on initial return.
[16] Refer to Table 3.1 for a detailed summary.

significantly different from zero at a minimum the 5% level[17]. This indicates that underpricing is a consistent phenomenon in the UK IPO market.

| | EW First Day Return | VW First Day Return |
|---|---|---|
| Mean | 7.40% | 6.50% |
| Median | 4.65% | 2.86% |
| Standard Deviation | 10.77% | 11.58% |
| Minimum | -10.67% | -10.67% |
| Maximum | 57.35% | 57.35% |
| Kurtosis | 6.46 | 4.66 |
| Skewness | 1.59 | 1.35 |
| n | 194 | 194 |

*Table 4.1: Summary Statistics of First Day Return of UK IPOs, 2006-2017*

*The table summarises first day returns, on both an equally- and value-weighted basis from the initial sample of 194 IPOs in the UK between 2006 and 2017.*

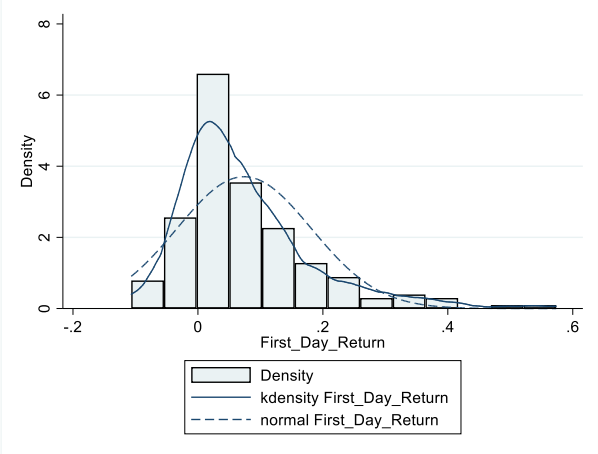


*Figure 4.1: Density Distribution of First Day Returns of UK IPOs, 2006-2017*

*The figure shows the density function of the first day returns, showing a rightly-skewed distribution. The solid line represents the normal bell curve, while the dotted line illustrates the kernel density curve.*

Relating these results to the existing literature on the UK, I find an average underpricing that is on the lower end of existing literature. As I mention earlier, Filatotchev and Bishop (2002) uncover an average underpricing of 29.6% between 1999 and 2000. This is likely due to the internet bubble. Additionally, Levis (1993) reports an average underpricing of 14.3% between 1980 and 1988. The initial discount I find is more in line with Levis' (1990) previous study of

[17] Results of the tests are available upon request. Three years are significant at the 5% level while the remaining years are significant at the 1% level.

8.6%. Finally, the lowest underpricing I have uncovered in academic literature is by Brennan and Franks (1997) who find that 69 IPOs listed on AIM have an average underpricing equal to 5.0% between 1988 and 1992. Based on this, the initial discount of 7.4%, equally-weighted, is toward the lower end of the spectrum. However, like existing literature, I find that the initial return is significantly different from zero. The deviations from existing literature could be due to the time-period analysed, as my thesis provides an updated view of underpricing on the UK market.

To investigate what drives the first day return, I run several multiple regressions to investigate deal- and firm-characteristics. These can be found in Table 4.2[18]. Equation 4.6 represents regression (4) in Table 4.2.

$$FDR_i = \alpha_i + \beta_i ADJ\_Offer\_Size_i + \beta_i lnADJ\_Assets_i + \beta_i Profit\_Margin_i + \beta_i HOT\_Mkt\_Ret_i + \beta_i PEorVC_i \quad (4.6)$$

From regression (4) in Table 4.2, I find that the adjusted offer size has a positive impact on the first day return, along with the profit margin and hot market return[19]. The adjusted assets have a negative impact on first day returns, along with PE- or VC-backed IPOs. Interestingly, the larger the offer size, the larger the first day return, whereas the larger the firm in terms of assets, the lower the first day return. This contradicts with Levis (1990) who finds that the larger the firm in terms of assets, the larger the first day return. None of the other accounting variables related to size and leverage are significant for any of the regressions. Analysing where a company lists[20] and the company age, regression (1) and (2) in Table 4.2 show that neither of these variables are statistically significant. In the paragraphs below, I deep dive into detail about market conditions, profit margin, underwriter reputation, and PE- or VC-backed IPOs.

[18] Several regressions were run for this analysis and are available upon request.
[19] Hot market return is defined as the dummy variable where the month of the IPO occurs in a hot period or not based on the initial return. More details in section 3.2.
[20] For this analysis, it was the Main Market or AIM.

| | (1) First Day Return | (2) First Day Return | (3) First Day Return | (4) First Day Return | (5) First Day Return |
|---|---|---|---|---|---|
| AIM_Listed | 0.0156 | 0.0137 | | | |
| | (0.0225) | (0.0229) | | | |
| ADJ_Offer_Size | 0.0000649** | 0.0000646** | 0.0000607** | 0.0000611** | 0.0000589** |
| | (0.0000269) | (0.0000270) | (0.0000252) | (0.0000251) | (0.0000257) |
| lnADJ_Assets | -0.0171** | -0.0168** | -0.0157*** | -0.0156*** | -0.0171*** |
| | (0.00719) | (0.00730) | (0.00366) | (0.00363) | (0.00478) |
| lnADJ_Revenue | -0.00144 | -0.00173 | | | |
| | (0.00612) | (0.00617) | | | |
| lnADJ_Debt | 0.00316 | 0.00310 | | | |
| | (0.00390) | (0.00392) | | | |
| Profit_Margin | 0.00220 | 0.00228* | 0.00207* | 0.00209* | 0.00206* |
| | (0.00135) | (0.00137) | (0.00106) | (0.00106) | (0.00107) |
| PE_Backed | -0.0436** | -0.0443** | -0.0391** | | -0.0408** |
| | (0.0189) | (0.0190) | (0.0175) | | (0.0179) |
| VC_Backed | -0.0554* | -0.0540* | -0.0509 | | -0.0522* |
| | (0.0320) | (0.0323) | (0.0309) | | (0.0314) |
| Syndicate | 0.00523 | 0.00333 | | | 0.00175 |
| | (0.0282) | (0.0286) | | | (0.0265) |
| BULGE_BRACKET | 0.0114 | 0.0117 | | | 0.00972 |
| | (0.0290) | (0.0292) | | | (0.0277) |
| Company_AGE | -0.000373 | -0.000386 | | | |
| | (0.000242) | (0.000244) | | | |
| HOT_Mkt_Vol | 0.00570 | 0.00675 | | | |
| | (0.0214) | (0.0216) | | | |
| HOT_Mkt_Ret | 0.0701*** | 0.0698*** | 0.0710*** | 0.0708*** | 0.0713*** |
| | (0.0149) | (0.0149) | (0.0144) | (0.0143) | (0.0145) |
| Lockup365 | | 0.0176 | | | |
| | | (0.0345) | | | |
| Lockup180 | | 0.0183 | | | |
| | | (0.0348) | | | |
| PE or VC | | | | -0.0416*** | |
| | | | | (0.0158) | |
| Constant | 0.226*** | 0.210*** | 0.233*** | 0.232*** | 0.247*** |
| | (0.0643) | (0.0721) | (0.0416) | (0.0412) | (0.0500) |
| Observations | 194 | 194 | 194 | 194 | 194 |
| $R^2$ | 0.275 | 0.276 | 0.259 | 0.258 | 0.260 |
| Adjusted $R^2$ | 0.222 | 0.215 | 0.235 | 0.239 | 0.228 |

*Table 4.2: Regression results of First Day Returns of UK IPOs, 2006-2017*

*This table illustrates the regression results of the final sample of 194 IPOs on the UK market between 2006 and 2017. The first day return is calculated as the percentage change of the first day of trading over the initial offer price. Standard errors are in parentheses and significance levels are represented by* $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

First, I discuss the results of market conditions. By constructing two variables related to market conditions, HOT_Mkt_Ret and HOT_Mkt_Vol, I can examine the potential effects this has on the first day return. As seen in regression (1) and (2) in Table 4.2, the hot market dummy based on IPO volume is statistically insignificant, which is further confirmed by the Wilcoxon two sample rank-sum test[21]. Since it is shown to be insignificant, I stop my analysis of market conditions based on volume here. However, the dummy variable that defines a hot market based on initial return is significant for all regressions that are presented in Table 4.2. Therefore, to further analyse this I subset this sample group to take a closer look. As shown in Table 4.3, hot markets have an average underpricing of 12.6%, whereas the cold markets average 8.1% below that. The median shows a similar story. This is also a statistically significant difference, meaning that on average IPOs issued during hot markets as defined by initial return experience a higher degree of underpricing. Ritter (1984) found similar results on his study of the hot market in 1980, stating that IPOs during such hot periods tend to exhibit higher initial returns.

| Hot Issue Market vs. Cold, Return-based | | | | |
|---|---|---|---|---|
| | Mean | Median | n | z-value |
| Hot | 12.57% | 10.29% | 70 | |
| Cold | 4.48% | 3.46% | 124 | |
| Diff. | 8.09% | 6.83% | | -3.48*** |

*Table 4.3: First Day Returns in Hot vs. Cold issue markets*

*The table shows summary statistics of hot vs. cold markets defined by initial return. The averages are equally-weighted. The z-value is two sample Wilcoxon rank-sum test. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1.*

Examining all the regressions in Table 4.2, the HOT_Mkt_Ret variable is significant and hovers around 7%[22]. This means that on average, IPOs issued during a hot period defined by the initial returns exhibits an underpricing of 14.4%[23]. The reasons for these results may be the fact that firms time the market to take advantage by investor exuberance, as Ritter and Welch (2002) and Santos (2017) illustrate. Another theory is that smaller firms tend to experience higher initial returns, due to risk and age. In scholarly articles, there is some disagreement on this, as some say larger firms have higher underpricing while others find

[21] The results of this test are available upon request.
[22] Since this is a dummy variable, it can be interpreted directly as a pure percentage.
[23] Average underpricing of 7.4% + 7%.

lower[24]. From my analysis, there is a size affect that supports that the larger the firm is in terms of the adjusted offer size, the higher the underpricing will be. This is statistically significant at the 5% level in regression (4) in Table 4.2. However, based on firm size with the logarithmic adjusted assets, regression (4) shows a negative relationship with first day returns. Overall, my findings show that an IPO issued during a hot market defined by initial return will on average have a higher initial return.

Second, I choose to analyse the profit margin, defined as the profit divided by the revenue of a firm. To my knowledge, there are limited academic articles that relate the profit margin of firms before their IPO and the impact on underpricing. From Table 4.2, four out of the five regressions show that the Profit_Margin variable is significant at the 10% level and positive. This means that the higher profit margin firms in the year of the IPO tend to exhibit higher underpricing. From regression (4), this means that for a one unit increase in profit margin, the first day return increases 0.2%, resulting in an average return of 7.6%[25]. Although earnings management is a common form of accounting manipulation, Ball and Shivakumar (2008) show that IPO firms report more conservatively due to the higher quality of reporting needed by public firms and the risk of getting audited by accounting firms, the board, and rating agencies. This gives more credibility to the fact that I find a result that the higher profit margin contributes to a higher first day return.

In order to examine this further, I test whether those that have a profit margin greater than zero are different from those that are not. However, the statistical tests I run show that these two groups are not different from each other[26].

The third set of critical variables relate to underwriters. Underwriters play an important role in IPOs, from taking a stake in the company to pricing the offer. I find no clear evidence that the reputation of the underwriter, defined as BULGE_BRACKET, shows any differences in underpricing. Likewise, I find no clear evidence that the number of underwriters, in the form of the dummy variable SYNDICATE, contribute to the degree of underpricing as Beatty and Ritter (1986) suggest. Regression (1) and (2) in Table 4.2 show that neither of the two variables

[24] See for example Levis (1990) and Jenkinson (1990) for contradictory results.
[25] 7.4% + 0.2%.
[26] Results are available upon request. The test that I use is the Wilcoxon rank-sum test to see any differences.

are significant. However, when comparing the groups using a Wilcoxon rank-sum test, differences arise.

Based on the SYNDICATE variable, I analyse the difference between those IPOs that participate in a syndicate versus those that do not. As seen in Table 4.4, those IPOs in a syndicate exhibit smaller first day returns when compared to single underwriter IPOs. This difference is significant at the 1% level. A theory is that perhaps those participating in a syndicate have several companies put together that come closer to the true value of the firm, although academic literature is limited on this aspect of IPOs.

| Syndicate vs. One underwriter | Mean | Median | n | z-value |
|---|---|---|---|---|
| Syndicate | 4.24% | 2.22% | 79 | |
| 1 Underwriter | 9.57% | 6.88% | 115 | |
| Diff. | -5.33% | -4.66% | | 3.66*** |

*Table 4.4: First Day Returns Syndicate vs. Single Underwriter*

*The table shows summary statistics of syndicate vs. single underwriter. The averages are equally-weighted. The z-value is two sample Wilcoxon rank-sum test. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1.*

Furthermore, Table 4.5 illustrates the difference between those firms that choose a bulge bracket bank as defined by Financial Times (2018) and those that are not. Underpricing for IPOs that have bulge bracket underwriters are lower than their counterparts. This is statistically significant at the 1% level. The lower initial discount by bulge bracket is supported by existing literature, because underwriters have a reputation to maintain. This is mainly due to that the underwriter likely has several IPOs they will underwrite in the future and therefore want to build a solid reputation (Jenkinson 1990). In line with Carter and Manaster (1990), prestigious underwriters are correlated with lower risk offerings and are therefore associated with lower returns and lower price run-ups. Furthermore, underpricing is costly for the issuing firm and therefore they want to signal a low risk characteristic to the market by hiring a prestigious underwriter (Carter and Manaster 1990).

| Bulge bracket vs. Non-bulge bracket | | | | |
|---|---|---|---|---|
| | Mean | Median | n | z-value |
| Bulge bracket | 4.02% | 2.46% | 62 | |
| Non-bulge bracket | 8.99% | 5.83% | 132 | |
| Diff. | -4.97% | -3.37% | | 3.13*** |

*Table 4.5: First Day Returns by Underwriter reputation*

*The table shows summary statistics of bulge bracket vs. not a bulge bracket. The averages are equally-weighted. The z-value is two sample Wilcoxon rank-sum test. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1.*

Even though I find differences when comparing the two sets of groups, neither are significant in the regression models run as part of this thesis. Nevertheless, it is an interesting finding as the number of underwriters and first day returns have limited existing literature, and the prestige of the underwriters in this thesis ties well with existing literature.

Finally, an IPO is a way for private equity or venture capitalists to exit their investments. Therefore, it is interesting to analyse whether this has an impact on first day returns. Looking at regression (4) in Table 4.2, the PE or VC variable has a significant and negative effect on first day returns, of -4.2%. This means on average, a PE- or VC-backed IPO has underpricing equal to 3.2%[27]. To examine the differences between private equity and venture capital, regression (1), (2), (3), and (5) in Table 4.2 show regressions that include the sponsored IPOs split out by private equity and venture capital. For all the regressions, PE-backed IPOs are significant at the 5% level, whereas VC-backed are significant for three out of the five regressions at the 10% level. To investigate the difference further, I analyse the groups independently and the results are shown in Table 4.6 below.

[27] 7.4% - 4.2%.

| **PE or VC** | Mean | Median | n | z-value |
|---|---|---|---|---|
| PE or VC | 3.37% | 2.43% | 53 | |
| Non-sponsored | 8.92% | 5.52% | 141 | |
| Diff. | -5.55% | -3.09% | | 2.96*** |
| **PE-backed** | | | | |
| PE-backed | 3.08% | 0.45% | 43 | |
| Non-sponsored | 8.63% | 5.43% | 151 | |
| Diff. | -5.55% | -4.98% | | 3.00*** |
| **VC-backed** | | | | |
| VC-backed | 4.59% | 3.50% | 10 | |
| Non-sponsored | 7.55% | 4.75% | 184 | |
| Diff. | -2.96% | -1.25% | | 0.32 |

*Table 4.6: Sponsored IPOs vs. Non-sponsored IPOs, UK IPOs 2006-2017*

*The table shows summary statistics of sponsored IPOs vs. non-sponsored IPOs. The averages are equally-weighted. The z-value is two sample Wilcoxon rank-sum test. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1.*

When testing the overall group of sponsored IPOs, this shows that on average they have a lower first day return of 5.3%, which is statistically significant at the 1% level. To see what drives this difference, I further split the sample in PE-backed IPOs and VC-backed IPOs. From the results above, it seems that only PE-backed IPOs have statistically significant differences from the Wilcoxon rank-sum test. On the contrary, VC-backed IPOs do not exhibit significantly different first day returns from their non-sponsored counterparts. This is in line with the regressions I analyse, as it varies what variables I include for the VC-backed variable to be significant.

Overall, my results tie well with existing literature on sponsored IPOs. Levis (2011) finds that both PE- and VC-backed IPOs are less underpriced compared to their non-sponsored counterparts. This is likely due to the signalling effect of having PE- or VC-backing in combination with the fact that these investors want to earn the most money for their investors, and thus limit the amount of money they leave on the table (Levis 2011). Furthermore, Levis (2008) shows that PE-backed IPOs have a lower degree of underpricing when compared to VC-backed IPOs, which is consistent with the results I have uncovered.

## 4.3 Methodologies of Aftermarket Performance: CARs, BHARs, and WRs

Measuring aftermarket performance for IPOs has several standards that are used. The most widely used in literature is to compute the cumulative abnormal return (CAR), the buy-and-hold return (BHAR), and the wealth relative (WR). I calculate these measures with five different benchmarks initially to get the breadth and comparison points I want. The five benchmarks are: FTSE ALL Share Index, FTSE 100, FTSE 250, FTSE 350, and FTSE SMALL[28]. For any firms that delist during the period, I set their abnormal returns equal to zero following the delisting when calculating the CAR and BHAR. This is done to avoid survivorship bias[29].

To capture long-term performance, I choose to analyse the IPOs after six months, one year, three years, and five years. I choose the six-month and one-year periods to analyse whether the common lockup periods of 180 days and 365 days have any impact on the regressions. Furthermore, from existing literature three-year and five-year periods are considered long-term[30] which is why I also use these to measure the long-term performance of the UK IPOs.

This section begins by explaining the methodology for CARs, BHARs, WRs before examining the results of aftermarket performance.

The return for each individual IPO company is calculated as shown in Equation 4.7, while the abnormal return (AR) is calculated by taking the return of the IPO company minus the chosen benchmark return for the same time-period, shown in Equation 4.8.

$$r_{it} = \frac{ClosingPrice_t}{ClosingPrice_{t-1}} - 1 \qquad (4.7)$$

$$AR_{it} = r_{it} - r_{bt} \qquad (4.8)$$

Similar to Ritter (1991), I use cumulative abnormal returns to capture monthly portfolio rebalancing. Equation 4.9 shows calculation for the monthly CAR.

[28] See section 3.2 for descriptions of each index.
[29] Follows that of Ritter (1991).
[30] See for example Levis (1993).

$$CAR_{it}^{m} = \sum_{t=1}^{t} AR_{it} \quad (4.9)$$

I compute each CAR excluding and including the first month of returns, denoted as $CAR_{it}^{m1}$ and $CAR_{it}^{m0}$. After calculating each individual IPO CAR, I aggregate into an equally- and a value-weighted average, in order to control for some of the small offer sizes. Equations 4.10 and 4.11 show the formula for the means, with $w_i$ representing the weights based on the adjusted offer size[31]. Each CAR is calculated for each chosen time-period: six months, one year, three years, and five years.

$$CAR_{it}^{m\,EW} = \frac{1}{n_s}\sum_{t=1}^{t} CAR_{it} \quad (4.10)$$

$$CAR_{it}^{m\,VW} = \sum_{t=1}^{t} w_i * CAR_{it} \quad (4.11)$$

Another computation for returns is the BHAR. This is defined as the return an investor receives if he or she holds a stock for a specific period minus the same return for the chosen benchmark. Barber and Lyon (1997) favours BHARs because CARs are biased predictors of BHARs and BHARs are compounded over the chosen time-period. Equation 4.12 shows the calculation for BHAR.

$$BHAR_{it}^{m} = \prod_{t=1}^{T}(1 + r_{it}) - (1 + r_{bt}) \quad (4.12)$$

Similar to the computation of the CARs, I exclude and include the first month of returns for the BHARs, denoted as $BHAR_{it}^{m1}$ and $BHAR_{it}^{m0}$, respectively. Additionally, I also calculate the equally- and value-weighted averages for each chosen period, given by Equations 4.13 and 4.14.

$$BHAR_{it}^{m\,EW} = \frac{1}{n_s}\sum_{t=1}^{t} BHAR_{it} \quad (4.13)$$

$$BHAR_{it}^{m\,VW} = \sum_{t=1}^{t} w_i * BHAR_{it} \quad (4.14)$$

[31] The formula for the weights is the same as Equation 4.4.

Another way of looking at BHARs, is to compute wealth relatives. WR is the ratio of the buy-and-hold returns (BHR) of the IPOs to the BHR of the chosen benchmark, as shown in Equation 4.15.

$$WR = \frac{(1+BHR_{it})}{(1+BHR_{bt})} \quad (4.15)$$

As Ritter (1991) explains a WR greater than one means that the IPO firms outperform the benchmark, while a value less than one means the IPO firms underperform the benchmark in the given period.

## 4.4 Aftermarket Performance in the UK Market: CARs, BHARs, and WRs

Having elaborated on the methods used to measure aftermarket performance, I now present my empirical results. First, I begin with descriptive statistics and analysis of the overall CARs and BHARs, before I explain my regression results. Then an analysis of the wealth relatives follows to complement the BHARs.

Even though I run my analysis on all five benchmarks[32], I choose to highlight two of the benchmarks in the analysis for CARs and BHARs, namely the FTSE All Share Index and the FTSE Small Cap Index. These two are chosen to capture two sides: the universe of shares on the LSE and the smaller firms on LSE[33].

Table 4.7 and Table 4.8 show the equally- and value-weighted CARs and BHARs for the two chosen benchmarks. Additionally, I run statistical tests to see whether any of the CARs or BHARs are significantly different from zero to make inferences.

For the CARs, the six-month return is statistically significant and positive for both the FTSE All Share Index and the FTSE Small Cap Index when I include the first month of returns, but this significance disappears when I exclude the first month return. Looking at the differences of including and excluding the first month of returns, the metrics for excluding the first month

[32] FTSE All, FTSE 100, FTSE 250, FTSE 350, and FTSE Small Cap
[33] The results of the other indices are available upon request.

return are always lower, which makes sense since that is where the first day underpricing occurs.

| | Holding periods | | | |
|---|---|---|---|---|
| **CARs vs. FTSE All** | 6 months | 1 year | 3 years | 5 years |
| EW Mean $CAR^{m0}$ | 4.92% | 2.10% | 4.47% | -3.80% |
| Median $CAR^{m0}$ | 5.09% | 2.61% | 10.77% | 16.54% |
| VW Mean $CAR^{m0}$ | 6.63% | -2.16% | 16.10% | 14.61% |
| EW Mean $CAR^{m1}$ | 2.28% | -0.65% | 2.09% | -6.36% |
| Median $CAR^{m1}$ | 0.62% | 0.82% | 9.78% | 10.31% |
| VW Mean $CAR^{m1}$ | 2.68% | -6.14% | 11.87% | 8.76% |
| Wilcoxon sign-rank z $CAR^{m0}$ | 2.846*** | 1.079 | 1.828* | 0.465 |
| Wilcoxon sign-rank z $CAR^{m1}$ | 1.194 | 0.319 | 1.506 | 0.26 |
| % firms with positive $CAR^{m0}$ | 59.8% | 53.4% | 59.8% | 57.1% |
| % firms with positive $CAR^{m1}$ | 51.9% | 52.2% | 59.8% | 57.1% |
| n | 189 | 178 | 132 | 70 |
| **CARs vs. FTSE Small** | | | | |
| EW Mean $CAR^{m0}$ | 4.35% | 2.01% | 0.68% | -5.14% |
| Median $CAR^{m0}$ | 4.35% | 3.04% | 6.82% | -0.57% |
| VW Mean $CAR^{m0}$ | 6.15% | -1.50% | 14.23% | 13.82% |
| EW Mean $CAR^{m1}$ | 1.73% | -0.74% | -1.73% | -7.63% |
| Median $CAR^{m1}$ | 1.15% | 0.77% | 6.30% | -0.70% |
| VW Mean $CAR^{m1}$ | 2.21% | -5.48% | 9.90% | 7.88% |
| Wilcoxon sign-rank z $CAR^{m0}$ | 2.645*** | 1.038 | 1.052 | 0.29 |
| Wilcoxon sign-rank z $CAR^{m1}$ | 1.036 | 0.336 | 0.788 | 0.056 |
| % firms with positive $CAR^{m0}$ | 59.8% | 54.5% | 55.3% | 48.6% |
| % firms with positive $CAR^{m1}$ | 51.3% | 50.6% | 53.8% | 48.6% |
| n | 189 | 178 | 132 | 70 |

*Table 4.7: Descriptive statistics CARs versus FTSE All and FTSE Small Cap Indices*

*The table shows descriptive statistics for CARs in comparison to the FTSE All Share Index and the FTSE Small Cap Index. The z-value is based on the Wilcoxon rank-sum test. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1. The count of firms is less than the initial sample of 194 because not all firms have returns for the respective periods.*

Moving on to the BHARs, some interesting results emerge. Similar to the CARs, the six-month BHARs are significant for when including the first month return, but this disappears once this is excluded. When I examine the three- and five-year holding period, the results are significant for the BHARs that exclude the first month of returns on both indices. This shows that are is underperformance of the IPOs relative to their benchmarks for the longer period of five years, but an outperformance for the three-year holding period. This is contrary to Levis (1993) and Goergen and Renneboog (2003) who find underperformance equal to -23% and -33% for a three-year holding period.

| | Holding period | | | |
|---|---|---|---|---|
| **BHARs vs. FTSE All** | 6 months | 1 year | 3 years | 5 years |
| EW Mean $BHAR^{m0}$ | 5.79% | 7.41% | 8.45% | -6.96% |
| Median $BHAR^{m0}$ | 3.61% | 0.13% | -9.88% | -26.03% |
| VW Mean $BHAR^{m0}$ | 9.49% | 1.95% | 12.08% | -1.61% |
| EW Mean $BHAR^{m1}$ | 3.28% | 3.89% | 6.08% | -7.37% |
| Median $BHAR^{m1}$ | 0.73% | -1.95% | -20.36% | -24.18% |
| VW Mean $BHAR^{m1}$ | 5.54% | -2.94% | 8.09% | -4.17% |
| Wilcoxon sign-rank z $BHAR^{m0}$ | 2.25** | 0.734 | -1.033 | -1.437 |
| Wilcoxon sign-rank z $BHAR^{m1}$ | 1.149 | -0.499 | -1.725* | -1.656* |
| % firms with positive $BHAR^{m0}$ | 56.6% | 50.6% | 43.9% | 40.0% |
| % firms with positive $BHAR^{m1}$ | 51.9% | 44.9% | 41.7% | 38.6% |
| n | 189 | 178 | 132 | 70 |
| **BHARs vs. FTSE Small** | | | | |
| EW Mean $BHAR^{m0}$ | 5.35% | 6.99% | 5.90% | -9.26% |
| Median $BHAR^{m0}$ | 3.59% | 0.58% | -12.75% | -26.01% |
| VW Mean $BHAR^{m0}$ | 8.72% | 1.25% | 10.45% | -4.04% |
| EW Mean $BHAR^{m1}$ | 2.90% | 3.46% | 3.34% | -9.64% |
| Median $BHAR^{m1}$ | 1.00% | -3.69% | -21.45% | -27.57% |
| VW Mean $BHAR^{m1}$ | 5.21% | -3.30% | 6.32% | -6.34% |
| Wilcoxon sign-rank z $BHAR^{m0}$ | 2.09** | 0.686 | -1.324 | -1.454 |
| Wilcoxon sign-rank z $BHAR^{m1}$ | 1.066 | -0.621 | -2.009** | -1.732* |
| % firms with positive $BHAR^{m0}$ | 57.1% | 50.6% | 41.7% | 40.0% |
| % firms with positive $BHAR^{m1}$ | 51.3% | 43.8% | 37.1% | 38.6% |
| n | 189 | 178 | 132 | 70 |

*Table 4.8: Descriptive statistics BHARs versus FTSE All and FTSE Small Cap Indices*

*The table shows descriptive statistics for CARs in comparison to the FTSE All Share Index and the FTSE Small Cap Index. The z-value is based on the Wilcoxon rank-sum test. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1. The count of firms is less than the initial sample of 194 because not all firms have returns for the respective periods.*

Finally, Figure 4.2, Figure 4.3, Figure 4.4, and Figure 4.5 show the density functions for the three- and five-year CARs and BHARs with the FTSE All Share Index. All four figures show there are severe issues with normality, with the BHARs being more skewed to the left than the CARs. The test for normality of the CARs and BHARs indicates that none of the distributions are normal for either of the two benchmarks[34]. I examine the distributions for the six-month and one-year holding period as well, which shows similar results[35].

[34] Test for normality using Shapiro-Wilk. Results are available upon request for all five benchmarks.
[35] The results of these are available upon request.

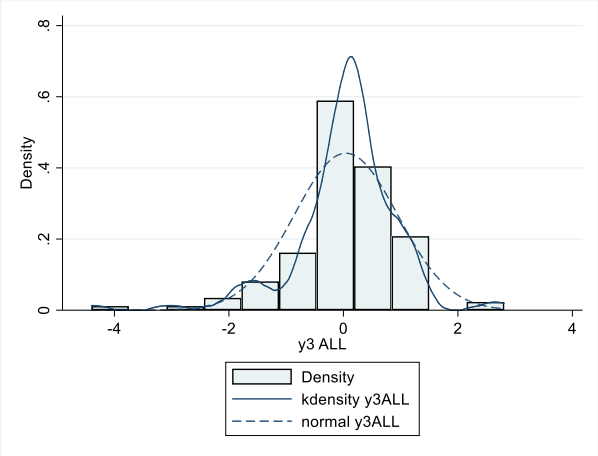


*Figure 4.2: Distribution of three-year CARs against the FTSE All Share Index, 2006-2017*

*The figure shows the density distribution of the three-year CAR. The solid line represents the kernel density, while the solid line shows the normal distribution*

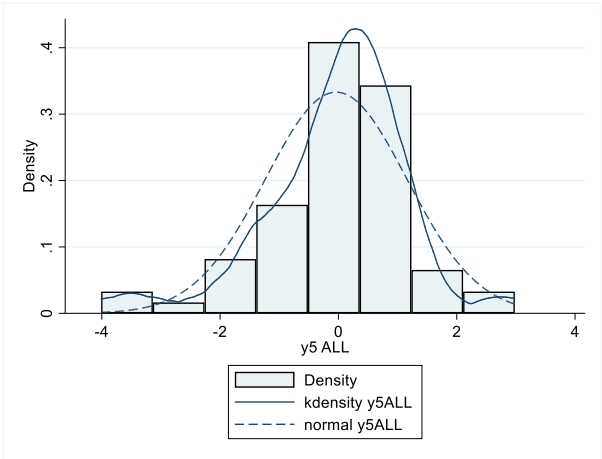


*Figure 4.3: Distribution of five-year CARs against the FTSE All Share Index, 2006-2017*

*The figure shows the density distribution of the five-year CAR. The solid line represents the kernel density, while the solid line shows the normal distribution*

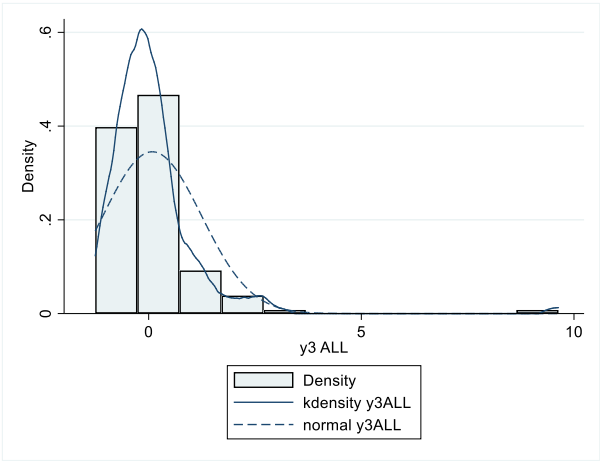


*Figure 4.4: Distribution of three-year BHARs against the FTSE All Share Index, 2006-2017*

*The figure shows the density distribution of the three-year BHAR. The solid line represents the kernel density, while the solid line shows the normal distribution*

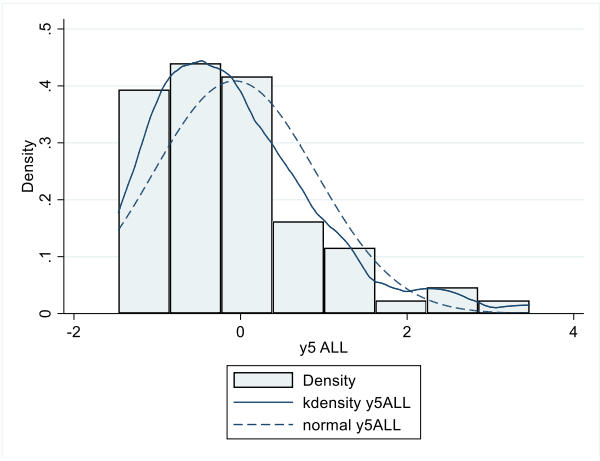


*Figure 4.5: Distribution of five-year BHARs against the FTSE All Share Index, 2006-2017*

*The figure shows the density distribution of the five-year BHAR. The solid line represents the kernel density, while the solid line shows the normal distribution*

Having examined the initial descriptive statistics, I move on to discuss the regression results for the four holding periods.

In order to examine the medium term holding periods, I analyse the returns of the IPO sample over six months and one year in terms of CARs and BHARs. Table 4.9 and Table 4.10 show the six-month and one-year CARs and BHARs, respectively.

| | CARs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | 6mSMALL$^{m0}$ | y1SMALL$^{m0}$ | 6mSMALL$^{m1}$ | y1SMALL$^{m1}$ | 6mALL$^{m0}$ | y1ALL$^{m0}$ | 6mALL$^{m1}$ | y1ALL$^{m1}$ |
| ADJ_Offer_Size | -0.000132* | -0.000232* | -0.00011 | -0.000211 | -0.000124 | -0.000231 | -0.0000949 | -0.000242* |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| lnADJ_Assets | 0.0287* | 0.03 | 0.0232 | 0.0099 | 0.0335* | 0.0228 | 0.0255 | 0.0131 |
| | (0.017) | (0.032) | (0.016) | (0.032) | (0.017) | (0.034) | (0.017) | (0.034) |
| lnADJ_Revenue | 0.0122 | 0.0302 | 0.0158 | 0.0327 | 0.00477 | 0.0304 | 0.00881 | 0.0329 |
| | (0.014) | (0.026) | (0.013) | (0.026) | (0.014) | (0.027) | (0.013) | (0.026) |
| PE_Backed | 0.0917* | 0.160* | 0.075 | 0.163* | 0.0863 | 0.131 | 0.0803 | 0.146 |
| | (0.052) | (0.095) | (0.050) | (0.093) | (0.052) | (0.096) | (0.051) | (0.096) |
| VC_Backed | 0.00163 | | 0.015 | | -0.0215 | | -0.0074 | |
| | (0.091) | | (0.086) | | (0.093) | | (0.088) | |
| Syndicate | -0.105* | -0.208* | -0.0875 | -0.179* | -0.108* | -0.260* | -0.0832 | -0.255* |
| | (0.060) | (0.110) | (0.057) | (0.108) | (0.061) | (0.146) | (0.059) | (0.145) |
| Company_AGE | -0.000732 | 0.000477 | -0.000377 | 0.00129 | -0.000609 | 0.000877 | -0.0003 | 0.00138 |
| | (0.001) | (0.002) | (0.001) | (0.002) | (0.001) | (0.002) | (0.001) | (0.002) |
| HOT_Mkt_Ret | -0.0301 | -0.129 | 0.0292 | -0.12 | -0.0265 | -0.153* | 0.0268 | -0.12 |
| | (0.044) | (0.080) | (0.041) | (0.080) | (0.045) | (0.081) | (0.042) | (0.081) |
| B - Mining and quarrying | 0.603*** | | 0.258 | | 0.603*** | | 0.245 | |
| | (0.202) | | (0.194) | | (0.205) | | (0.200) | |
| y2010 | 0.107 | | | | 0.157 | | | |
| | (0.111) | | | | (0.112) | | | |
| y2011 | 0.084 | 0.232 | | 0.254 | | | | |
| | (0.116) | (0.212) | | (0.208) | | | | |
| Marketing & Sales | -0.452* | | | -0.897* | | | | |
| | (0.272) | | | (0.492) | | | | |
| Lockup180 | 0.00362 | | -0.00688 | | 0.00469 | | -0.00062 | |
| | (0.042) | | (0.041) | | (0.043) | | (0.042) | |
| per50 | 0.0522 | 0.0746 | 0.0278 | 0.0621 | 0.0394 | 0.104 | 0.0162 | 0.0727 |
| | (0.042) | (0.079) | (0.040) | (0.078) | (0.042) | (0.081) | (0.041) | (0.080) |
| y2008 | | 0.722 | -0.537** | 0.68 | | | | |
| | | (0.499) | (0.260) | (0.489) | | | | |
| y2017 | | -0.175 | | -0.212 | | -0.192 | | -0.204 |
| | | (0.208) | | (0.204) | | (0.211) | | (0.210) |
| Restructuring | | -0.983* | | -0.899* | | -1.045** | | -0.938* |
| | | (0.499) | | (0.489) | | (0.516) | | (0.514) |
| Lockup365 | | -0.00549 | | 0.00553 | | 0.0176 | | 0.012 |
| | | (0.078) | | (0.077) | | (0.080) | | (0.080) |
| H - Transportation and storage | | | -0.217 | | | | -0.232* | |
| | | | (0.134) | | | | (0.137) | |
| y2015 | | | 0.0395 | | 0.111* | | 0.0929 | |
| | | | (0.057) | | (0.060) | | (0.059) | |
| y2006 | | | | -0.233* | | -0.336** | | -0.346** |
| | | | | (0.133) | | (0.138) | | (0.138) |
| BULGE_BRACKET | | | | | | 0.0898 | | 0.0955 |
| | | | | | | (0.154) | | (0.153) |
| y2007 | | | | | | -0.206 | | -0.198 |
| | | | | | | (0.126) | | (0.125) |
| Constant | -0.390*** | -0.557* | -0.401*** | -0.387 | -0.371** | -0.434 | -0.357** | -0.384 |
| | (0.148) | (0.284) | (0.140) | (0.283) | (0.149) | (0.296) | (0.144) | (0.295) |
| Observations | 189 | 178 | 189 | 178 | 189 | 178 | 189 | 178 |
| $R^2$ | 0.142 | 0.121 | 0.111 | 0.146 | 0.133 | 0.142 | 0.094 | 0.133 |

*Table 4.9: Regression results of six-month and one-year CARs with FTSE All Share and FTSE Small Cap Indices, UK IPOs 2006-2017*

*This table illustrates the regression results of the final sample of 194 IPOs on the UK market between 2006 and 2017. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01. Observations vary due to the fact that not all companies have returns for the given periods of time.*

| | BHARs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | 6mSMALLm0 | y1SMALLm0 | 6mSMALLm1 | y1SMALLm1 | 6mALLm0 | y1ALLm0 | 6mALLm1 | y1ALLm1 |
| ADJ_Offer_Size | -0.000125 | -0.000248* | -0.0000671 | -0.000279* | -0.000125 | -0.000248* | -0.0000685 | -0.000295** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| lnADJ_Assets | 0.0476** | 0.0594* | 0.0525*** | 0.0531 | 0.0494*** | 0.0435 | 0.0493** | 0.0375 |
| | (0.019) | (0.034) | (0.020) | (0.033) | (0.018) | (0.036) | (0.020) | (0.036) |
| lnADJ_Revenue | -0.0216 | -0.0177 | -0.0314* | -0.0105 | -0.0222 | -0.0131 | -0.0323** | -0.00853 |
| | (0.015) | (0.028) | (0.016) | (0.028) | (0.015) | (0.029) | (0.016) | (0.028) |
| PE_Backed | 0.144** | 0.340*** | 0.178*** | 0.354*** | 0.140** | 0.326*** | 0.191*** | 0.347*** |
| | (0.055) | (0.099) | (0.059) | (0.100) | (0.055) | (0.100) | (0.058) | (0.103) |
| VC_Backed | -0.0657 | | -0.082 | | -0.0838 | | -0.107 | |
| | (0.095) | | (0.102) | | (0.095) | | (0.101) | |
| Syndicate | -0.0803 | -0.244** | -0.0672 | -0.269** | -0.0687 | -0.380** | -0.0507 | -0.356** |
| | (0.065) | (0.115) | (0.069) | (0.113) | (0.064) | (0.152) | (0.068) | (0.153) |
| Company_AGE | -0.000169 | -0.000519 | 0.0000236 | 0.000803 | -0.000298 | -0.0000569 | -0.00000601 | 0.0007 |
| | (0.001) | (0.002) | (0.001) | (0.002) | (0.001) | (0.002) | (0.001) | (0.002) |
| HOT_Mkt_Ret | -0.011 | -0.105 | 0.00153 | -0.107 | -0.022 | -0.182** | -0.0027 | -0.136 |
| | (0.045) | (0.082) | (0.048) | (0.084) | (0.045) | (0.088) | (0.048) | (0.088) |
| G - Wholesale and retail trade; repair of motor vehicles and motorcycles | 0.181*** | 0.182 | 0.137** | 0.245** | 0.180*** | 0.211* | 0.138** | 0.270** |
| | (0.061) | (0.114) | (0.065) | (0.112) | (0.061) | (0.117) | (0.064) | (0.116) |
| N - Administrative and support service activities | 0.0794 | | | | 0.0841 | | | |
| | (0.088) | | | | (0.088) | | | |
| Q - Human health and social work activities | 0.256** | | | | 0.232** | 0.308 | | |
| | (0.114) | | | | (0.114) | (0.207) | | |
| B - Mining and quarrying | 0.765*** | | | | 0.722*** | | | |
| | (0.216) | | | | (0.215) | | | |
| Restructuring | -0.474 | -0.724 | -0.600* | -0.663 | -0.495* | -0.739 | -0.622** | -0.748 |
| | (0.292) | (0.528) | (0.315) | (0.520) | (0.292) | (0.533) | (0.311) | (0.529) |
| Proceed to Sharehlds | 0.279 | | 0.416 | | | | | |
| | (0.292) | | (0.314) | | | | | |
| Marketing & Sales | -0.437 | | -0.523* | | | | -0.540* | |
| | (0.290) | | (0.312) | | | | (0.308) | |
| Lockup365 | -0.104 | | 0.0256 | | | -0.00185 | | 0.00275 |
| | (0.102) | | (0.109) | | | (0.082) | | (0.082) |
| Lockup180 | -0.1 | | -0.024 | | -0.0112 | | -0.0568 | |
| | (0.103) | | (0.110) | | (0.045) | | (0.047) | |
| per50 | 0.119*** | 0.0784 | 0.0979** | 0.0567 | 0.107** | 0.107 | 0.0944** | 0.0509 |
| | (0.046) | (0.083) | (0.048) | (0.082) | (0.046) | (0.085) | (0.048) | (0.084) |
| y2017 | | -0.371* | | -0.252 | | -0.385** | | -0.281 |
| | | (0.192) | | (0.191) | | (0.194) | | (0.196) |
| y2006 | | | | -0.222 | | -0.257* | | -0.274* |
| | | | | (0.140) | | (0.143) | | (0.145) |
| y2012 | | | | 0.369* | | | | 0.417* |
| | | | | (0.215) | | | | (0.219) |
| Reduce Indebtedness | | | | -0.302* | | | | -0.324* |
| | | | | (0.172) | | | | (0.178) |
| BULGE_BRACKET | | | | | | 0.193 | | 0.157 |
| | | | | | | (0.162) | | (0.163) |
| y2010 | | | | | | 0.228 | | 0.0534 |
| | | | | | | (0.210) | | (0.214) |
| y2016 | | | | | | | | -0.155 |
| | | | | | | | | (0.114) |
| Constant | -0.241 | -0.359 | -0.305 | -0.388 | -0.333** | -0.218 | -0.229 | -0.199 |
| | (0.193) | (0.284) | (0.206) | (0.286) | (0.159) | (0.316) | (0.168) | (0.313) |
| Observations | 189 | 178 | 189 | 178 | 189 | 178 | 189 | 178 |
| $R^2$ | 0.211 | 0.143 | 0.159 | 0.184 | 0.188 | 0.183 | 0.158 | 0.213 |

*Table 4.10: Regression results of six-month and one-year BHARs with FTSE All Share and FTSE Small Cap Indices, UK IPOs 2006-2017*

*This table illustrates the regression results of the final sample of 194 IPOs on the UK market between 2006 and 2017. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01. Observations vary due to the fact that not all companies have returns for the given periods of time.*

For the six-month return, PE-backed IPOs are significant at varying degrees for the CARs, but only when comparing the IPO sample to the FTSE Small Cap Index and including the first month return as in regression (1) in Table 4.9. The coefficient is positive indicating that a PE-backed IPO tends to perform better over a six-month period. Furthermore, the PE-backed

variable for the six-month BHARs is significant for all regressions in Table 4.10. For example, regression (3) and (7) show an increase in six month returns equal to 17.3% and 18.6% on average, respectively. The results are even more pronounced for the one-year return, as shown in regression (2), (4), (6), and (8) in Table 4.10. This shows that a PE-backed IPO on average improves the one-year BHAR by around 30%, regardless of the benchmark. On the contrary, there are no significant results for VC-backed IPOs. This supports the findings of Levis (2011) except he looks at a longer time-period of three years.

Furthermore, the Syndicate variable is negative for all regressions for both the CARs and BHARs, indicating that an IPO that was underwritten by a syndicate tend to do worse than those that have a single underwriter. However, whether the syndicate has a lead underwriter that was part of the bulge bracket league is not significant for any of the regressions, as shown by the BULGE_BRACKET variable, in Table 4.9 and Table 4.10.

Moving to IPOs by industry, the Wholesale and Retail Trade industry is positive and significant for all regressions except two in Table 4.10, indicating that IPOs in this industry increase the six-month and one-year BHARs. However, the same is not true for the CARs.

Additionally, the sample IPOs that have first day returns equal to or above the median see positive and significant returns for the six-month BHARs regardless of benchmark. However, the same is not true for the CARs. For example, regression (1) in Table 4.10 shows that the aftermarket performance increases 11.9% on average and is significant at the 1% level.

Finally, I examine different years of going public. The one-year $CAR^{m1}$ in regression (4) and (8) in Table 4.9 show that IPOs issued in 2006 have a significant and negative impact on returns. For one-year $BHAR^{m1}$ regression (8) in Table 4.10 shows a significant and negative coefficient for IPOs in 2017, while IPOs in 2012 have a positive and significant coefficient of 41.9%. This indicates that there is a cyclicality effect in IPOs, meaning that the year of issuance has an impact on the returns.

By having shown the regression results for the six-month and one-year periods, I turn my analysis toward the long-term of three and five years. Table 4.11 and Table 4.12 illustrate the three- and five-year CARs and BHARs, including and excluding the first month of returns.

| | CARs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | y3SMALL$^{m0}$ | y5SMALL$^{m0}$ | y3SMALL$^{m1}$ | y5SMALL$^{m1}$ | y3ALL$^{m0}$ | y5ALL$^{m0}$ | y3ALL$^{m1}$ | y5ALL$^{m1}$ |
| ADJ_Offer_Size | 0.0000178 | 0.000415 | 0.0000864 | 0.000238 | 0.0000511 | 0.000428 | 6.57E-06 | 0.000367 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| lnADJ_Assets | 0.0221 | 0.084 | 0.0233 | 0.0952 | 0.0226 | 0.106 | 0.0175 | 0.098 |
| | (0.070) | (0.131) | (0.068) | (0.132) | (0.069) | (0.128) | (0.068) | (0.130) |
| lnADJ_Revenue | 0.0394 | -0.117 | 0.0313 | -0.0896 | 0.0294 | -0.131 | 0.034 | -0.11 |
| | (0.053) | (0.101) | (0.051) | (0.099) | (0.053) | (0.097) | (0.052) | (0.099) |
| PE_Backed | -0.138 | -0.0367 | -0.15 | -0.0893 | -0.134 | -0.036 | -0.135 | -0.0339 |
| | (0.200) | (0.339) | (0.196) | (0.340) | (0.198) | (0.330) | (0.194) | (0.335) |
| VC_Backed | -0.248 | -0.164 | -0.269 | 0.0936 | -0.378 | -0.217 | -0.297 | -0.17 |
| | (0.332) | (0.534) | (0.322) | (0.523) | (0.336) | (0.520) | (0.323) | (0.525) |
| Syndicate | -0.227 | 1.132 | -0.265 | 1.152* | -0.199 | 1.242* | -0.207 | 1.123 |
| | (0.344) | (0.683) | (0.335) | (0.684) | (0.340) | (0.666) | (0.334) | (0.673) |
| BULGE_BRACKET | 0.17 | -1.014 | 0.193 | -1.055 | 0.119 | -1.100* | 0.139 | -1.03 |
| | (0.339) | (0.647) | (0.330) | (0.648) | (0.335) | (0.630) | (0.330) | (0.637) |
| Company_AGE | 0.000214 | -0.00176 | | | -0.000898 | -0.00202 | -0.000153 | -0.0017 |
| | (0.003) | (0.005) | | | (0.003) | (0.005) | (0.003) | (0.005) |
| HOT_Mkt_Ret | -0.224 | -0.00723 | -0.209 | 0.244 | -0.197 | 0.126 | -0.129 | 0.109 |
| | (0.170) | (0.352) | (0.166) | (0.321) | (0.178) | (0.343) | (0.166) | (0.348) |
| y2011 | 0.556 | 0.809 | 0.558 | 0.609 | 0.700* | 0.872 | 0.692* | 0.979 |
| | (0.401) | (0.615) | (0.389) | (0.594) | (0.401) | (0.585) | (0.390) | (0.591) |
| per50 | 0.292* | 0.255 | 0.277* | 0.236 | 0.177 | 0.179 | 0.167 | 0.144 |
| | (0.170) | (0.322) | (0.164) | (0.317) | (0.170) | (0.313) | (0.167) | (0.321) |
| R - Arts, entertainment and recreation | | -0.667 | | | | | | |
| | | (0.887) | | | | | | |
| Q - Human health and social work activities | | -2.765* | | -3.143** | | -2.758* | | -2.882* |
| | | (1.495) | | (1.486) | | (1.452) | | (1.467) |
| y2010 | | 0.929* | | | 0.334 | 1.080** | | 1.099** |
| | | (0.534) | | | (0.384) | (0.520) | | (0.525) |
| Restructuring | | -2.669** | | -2.706** | -1.993** | -2.676** | -1.902** | -2.531** |
| | | (1.216) | | (1.218) | (0.919) | (1.185) | (0.903) | (1.199) |
| B - Mining and quarrying | | | -0.844 | | | | | |
| | | | (0.664) | | | | | |
| WC | | | -0.762 | | | | | |
| | | | (0.460) | | | | | |
| y2015 | | | | | | | | -0.0451 |
| | | | | | | | | (0.928) |
| Constant | -0.681 | -0.124 | -0.59 | -0.585 | -0.473 | -0.274 | -0.505 | -0.392 |
| | (0.612) | (1.112) | (0.593) | (1.096) | (0.611) | (1.073) | (0.597) | (1.085) |
| Observations | 132 | 70 | 132 | 70 | 132 | 70 | 132 | 70 |
| $R^2$ | 0.076 | 0.272 | 0.103 | 0.208 | 0.113 | 0.310 | 0.100 | 0.298 |

*Table 4.11: Regression results of three-year and five-year CARs for the FTSE All Share and FTSE Small Cap Indices, UK IPOs 2006-2017*

*This table illustrates the regression results of the final sample of 194 IPOs on the UK market between 2006 and 2017. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01. Observations vary due to the fact that not all companies have returns for the given periods of time.*

| | BHARs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | y3SMALLm0 | y5SMALLm0 | y3SMALLm1 | y5SMALLm1 | y3ALLm0 | y5ALLm0 | y3ALLm1 | y5ALLm1 |
| ADJ_Offer_Size | 0.0000763 | -0.0000499 | 0.0000252 | -0.0000639 | -0.0000153 | -0.000105 | -0.0000795 | -0.000117 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| lnADJ_Assets | 0.0588 | 0.0602 | 0.0815 | 0.0261 | 0.0479 | 0.073 | 0.0689 | 0.0412 |
| | (0.090) | (0.107) | (0.101) | (0.111) | (0.089) | (0.114) | (0.101) | (0.120) |
| lnADJ_Revenue | 0.0318 | 0.0558 | 0.0254 | 0.0758 | 0.0637 | 0.0478 | 0.0497 | 0.071 |
| | (0.075) | (0.082) | (0.083) | (0.084) | (0.076) | (0.086) | (0.086) | (0.090) |
| PE_Backed | 0.395 | -0.106 | 0.480* | -0.118 | 0.289 | -0.136 | 0.405 | -0.125 |
| | (0.256) | (0.281) | (0.287) | (0.294) | (0.256) | (0.293) | (0.291) | (0.310) |
| VC_Backed | -0.0148 | -0.17 | -0.0255 | -0.216 | 0.0267 | -0.316 | 0.0236 | -0.367 |
| | (0.445) | (0.415) | (0.498) | (0.432) | (0.442) | (0.430) | (0.503) | (0.455) |
| Syndicate | -0.718* | 0.573 | -0.746 | 0.577 | -1.036** | 0.775 | -1.008** | 0.786 |
| | (0.408) | (0.529) | (0.457) | (0.554) | (0.422) | (0.552) | (0.481) | (0.583) |
| BULGE_BRACKET | 0.0266 | -0.914* | -0.021 | -0.869 | 0.32 | -0.986* | 0.265 | -0.954 |
| | (0.414) | (0.542) | (0.464) | (0.567) | (0.432) | (0.569) | (0.492) | (0.601) |
| Company_AGE | -0.000593 | -0.000767 | | | -0.00216 | -0.0023 | -0.00217 | -0.00272 |
| | (0.004) | (0.004) | | | (0.004) | (0.005) | (0.005) | (0.005) |
| HOT_Mkt_Ret | 0.00345 | -0.401 | 0.0971 | -0.428 | -0.0293 | -0.264 | 0.049 | -0.271 |
| | (0.219) | (0.273) | (0.245) | (0.286) | (0.218) | (0.306) | (0.248) | (0.323) |
| y2007 | -0.257 | | -0.268 | | -0.397 | | -0.404 | |
| | (0.292) | | (0.328) | | (0.290) | | (0.330) | |
| y2011 | 0.643 | 1.660*** | 0.79 | 1.865*** | 0.642 | 1.675*** | 0.799 | 1.917*** |
| | (0.513) | (0.537) | (0.574) | (0.559) | (0.508) | (0.564) | (0.578) | (0.597) |
| per50 | -0.0422 | -0.192 | -0.112 | -0.209 | 0.00205 | -0.221 | -0.052 | -0.257 |
| | (0.217) | (0.261) | (0.242) | (0.267) | (0.218) | (0.274) | (0.248) | (0.289) |
| L - Real estate activities | | -1.298* | | -1.383* | | -0.929 | | -1.008 |
| | | (0.772) | | (0.809) | | (0.804) | | (0.850) |
| Q - Human health and social work activities | | -3.215*** | | -3.349** | | -3.070** | | -3.278** |
| | | (1.201) | | (1.258) | | (1.254) | | (1.326) |
| y2015 | | -0.13 | | -0.164 | | 0.0129 | | -0.000271 |
| | | (0.369) | | (0.386) | | (0.398) | | (0.421) |
| WC | | 0.974 | | 1.063 | | 1.17 | | 1.271 |
| | | (0.797) | | (0.835) | | (0.834) | | (0.882) |
| G - Wholesale and retail trade; repair of motor vehicles and motorcycles | | | | | 0.295 | | 0.472 | |
| | | | | | (0.323) | | (0.367) | |
| y2017 | | | | | -0.994 | | -0.893 | |
| | | | | | (0.606) | | (0.689) | |
| Proceed to Sharehlds | | | | | 2.770** | | 2.017 | |
| | | | | | (1.221) | | (1.389) | |
| y2006 | | | | | | 0.292 | | 0.368 |
| | | | | | | (0.357) | | (0.378) |
| Constant | -0.735 | -1.028 | -0.953 | -0.867 | -0.839 | -1.196 | -0.995 | -1.09 |
| | (0.769) | (0.880) | (0.862) | (0.918) | (0.763) | (0.986) | (0.868) | (1.042) |
| Observations | 132 | 70 | 132 | 70 | 132 | 70 | 132 | 70 |
| $R^2$ | 0.070 | 0.294 | 0.076 | 0.293 | 0.134 | 0.273 | 0.117 | 0.277 |

*Table 4.12: Regression results of three-year and five-year BHARs with the FTSE All Share and FTSE Small Cap Indices, UK IPOs 2006-2017*

*This table illustrates the initial sample of 194 IPOs on the UK market between 2006 and 2017. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01. Observations vary due to the fact that not all companies have returns for the given periods of time.*

Interestingly, PE-backed IPOs are not significant for any regressions except for regression (3) in Table 4.12, which is the three-year $BHAR^{m1}$ with the benchmark of FTSE Small Cap, where the coefficient is equal to 50.3%.

Further, in regression (7) in Table 4.12 shows that those IPOs that are underwritten by a syndicate have a negative and significant coefficient. This means that syndicated IPOs tend to experience lower returns than those that have a single underwriter. However, this trend is more prevalent in the shorter holding periods of six months and one year.

Similar to the six-month and one-year returns, I analyse the industries for the three- and five-year CARs and BHARs for the two chosen benchmarks[36]. The three-year returns do not show any significant results by industry with the multiple regressions[37]. However, five-year CARs and BHARs, regardless of inclusion of the first month and benchmark chosen, shows that Human Health and Social Work Activities is negative and significant at the 1% and 5% level. Those IPOs tend to perform worse on average when compared to firms in other industries.

Additionally, the IPOs that have first day returns equal to or greater than the median experience a bump of 28.5% on average for the three-year CARs when the benchmark is the FTSE Small Cap Index. However, this is significance disappears when moving to the five-year holding period and the BHARs.

Lastly, I examine the year of IPO to explain any possible cyclicality effects. With respect to CARs, 2011 loads positively and is only significant when compared to the FTSE All Share Index as in regression (7) for the three-year return and regression (8) for the five-year return in Table 4.11. Similarly, 2010 is significant only for the five-year CARs, regardless of benchmark and first month inclusion, and is positive. IPOs in 2010 and 2011 therefore increase the CARs for five-year returns. For the BHARs, 2011 also emerges as a positive and significant factor for the five-year return, regardless of benchmark and first month inclusion. However, no other years are significant for the BHARs. Even though the hot market return[38] variable is insignificant, differences among years show the presence of IPO cyclicality.

To complement the results of the BHARs, I use wealth relatives similarly to Ritter (1991) to examine the abnormal returns against the two chosen benchmarks, FTSE All Share Index and FTSE Small Cap[39]. Table 4.13 shows the wealth relatives and the t-statistics for the four

[36] FTSE All Share Index and FTSE Small Cap Index.
[37] Includes regressions not presented in the tables, but that are available upon request.
[38] Defined by level of returns.
[39] The wealth relatives for the other indices are available upon request.

holding periods. The six-month returns are significant, both for the FTSE All Share and FTSE Small Cap indices. The IPO sample outperforms the respective benchmarks, showing that there seems to be evidence for the IPO firms to outperform their benchmarks over a shorter period of six months. The one-year return is also above 1.0, indicating that the IPO firms tend to outperform their benchmark. However, this is only statistically significant for the FTSE All Share Index and disappears when the FTSE Small Cap Index is the benchmark. Finally, the three-year return shows an outperformance, whereas the five-year return indicates an underperformance relative to the two benchmarks. Unfortunately, neither of these returns are significant for either benchmark, hindering any inferences.

| Holding period | FTSE ALL | n | FTSE Small | n |
|---|---|---|---|---|
| 6 months | 1.06 | 189 | 1.05 | 189 |
| t-stat | 2.6397*** | | 2.2949** | |
| 1 year | 1.06 | 178 | 1.05 | 178 |
| t-stat | 1.8211* | | 1.6171 | |
| 3 year | 1.08 | 132 | 1.03 | 132 |
| t-stat | 0.9353 | | 0.3812 | |
| 5 year | 0.98 | 70 | 0.96 | 70 |
| t-stat | -0.1946 | | -0.4201 | |

*Table 4.13: Wealth Relatives for sample of UK IPOs*

*The table shows the wealth relatives for each of the four holding periods, and the two chosen benchmarks. The t-statistics are the results of a two-sample paired t-test with different means. The significance level is given by *** p<0.01, **p<0.05, and *p<0.1.*

## 4.5 Methodologies of Aftermarket Performance: Factor Models

In addition to computing CARs, BHARs, and WRs, I use the Capital Asset Pricing Model (CAPM), Fama-French three-factor model, and the Value and Momentum three-factor model.

To further analyse the long-run performance of the final sample of UK IPOs, I employ various factor models to examine risk-adjusted returns based on alpha. So far, the analysis I have done has been based on the event time approach, which calculates the returns for each IPO from each individual issue date. CAR, BHAR, and WR calculations are done in an event time approach consistent with Ritter (1991). However, an alternative approach to this is the calendar time method, which calculates the returns for each month for each firm. This is repeated for each calendar month I have data for. The factor model regressions are done in a calendar time

approach to be consistent with Fama (1998). Any firm that is delists during my sample period is dropped in the month it is delisted.

The first factor model employed is the CAPM, which only has the market premium as the factor to explain excess returns (Sharpe 1964). Equation 4.16 shows the equation for the standard CAPM. The return for the IPOs, $r_{it}$, are calculated on both an equally- and value-weighted basis. The left side is the monthly return in excess of the risk-free rate represented by the three-month Treasury bills, $r_f$. Alpha, α, represents the excess return when regressing the individual monthly return on the market risk premium, $r_{mt} - r_{ft}$, where the market is represented by the FTSE All Share Index.

$$r_{it} - r_{ft} = \alpha + \beta * (r_{mt} - r_{ft}) + \epsilon_t \qquad (4.16)$$

The second type of model I use is the Fama-French three-factor model (Fama and French 1993). From French's data library, I download the monthly factors for both Europe and the global market (French 2018). However, since this study is done on the UK, I find factors that are constructed on the UK market from Gregory, Tharyan et al. (2013). The general form of the Fama-French three-factor model is show in Equation 4.17. Alpha in this equation is the excess return when the monthly return is regressed on the market premium, $r_{mt} - r_{ft}$, small companies minus big companies, $SMB_t$, and the high book-to-market firms minus the low book-to-market firms, $HML_t$.

$$r_{it} - r_{ft} = \alpha + \beta * (r_{mt} - r_{ft}) + s * SMB_t + h * HML_t + \epsilon \qquad (4.17)$$

Finally, I employ a model developed by Asness, Moskowitz et al. (2013) that finds that value and momentum returns are correlated globally. They construct a three-factor model[40] based on this evidence, which is shown in Equation 4.18. The value effect, $VAL_t$, is the ratio of the long-run book value relative to the firm's market value, and the momentum effect, $MOM_t$, is the relationship between a firm's return to its recent history of performance (Asness, Moskowitz et al. 2013).

[40] A combination of the Fama-French three-factor model and the Carhart momentum model.

$$r_{it} - r_{ft} = \alpha + \beta * (r_{mt} - r_{ft}) + v * VAL_t + m * MOM_t + \epsilon \qquad (4.18)$$

From AQR Capital Management (2018), I download the updated factors from the original paper of Asness, Moskowitz et al. (2013) for my sample period between 2006 and 2017.

By using a variety of factor models, I hope to obtain a consistent result of the excess return in the UK market.

## 4.6 Aftermarket Performance in the UK Market: Factor Models

I finish the aftermarket performance analysis by using various factor models to show whether the IPOs show any risk-adjusted returns based on alpha[41]. I first show the CAPM and Fama-French three-factor models, before examining the results of the Value and Momentum factor model developed by Asness, Moskowitz et al. (2013). All the models have UK factors and European factors[42]. In addition, the Value and Momentum Everywhere model has an "everywhere" factor, as this is the main point of the theory.

Table 4.14 shows the results from the CAPM regressions. I use UK and European factors to find any differences between the two. However, none of the alphas are significant, which indicates that the IPOs may not generate any excess returns. Additionally, the coefficient of determination is very low, indicating that the CAPM model is not a good fit for predicting returns.

| | CAPM | | | |
|---|---|---|---|---|
| | (1) Avg. EW Returns | (2) Avg. VW Returns | (3) Avg. EW Returns | (4) Avg. VW Returns |
| Mkt Prem. UK | 0.103 | 0.116 | | |
| | (0.121) | (0.147) | | |
| Mkt Prem. Europe | | | 0.146* | 0.169* |
| | | | (0.077) | (0.093) |
| Alpha | 0.004 | 0.005 | 0.005 | 0.005 |
| | (0.005) | (0.006) | (0.004) | (0.005) |
| R2 | 0.006 | 0.005 | 0.024 | 0.022 |

[41] Defined as the IPO return minus the risk-free rate on a monthly basis.
[42] I also ran regressions based on global factors, which are available upon request.

*Table 4.14: CAPM Regression Outputs of Monthly Average Returns*

*The table shows the regression output for the CAPM model. Alpha is the excess return above the risk-free rate. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01.*

Secondly, Table 4.15 shows the regression output from applying the Fama-French three-factor model. Like the CAPM results, none of the alphas are significant at any level. The IPO sample loads positively and is significant for SMB, both for the UK and European factors, indicating that the sample takes a long position in small firms and a short position in large firms. No other factors have significant results. However, compared with the CAPM, the explanatory power of the Fama-French three-factor model is higher.

| | Fama-French Three-Factor Models | | | | | |
|---|---|---|---|---|---|---|
| | (1) Avg. EW Returns | (2) Avg. VW Returns | (3) Avg. EW Returns | (4) Avg. VW Returns | (5) Avg. EW Returns | (6) Avg. VW Returns |
| Mkt. Prem. UK | 0.0744 | 0.104 | 0.075 | 0.102 | | |
| | (0.142) | (0.169) | (0.143) | (0.170) | | |
| SMB UK | 0.438*** | 0.653*** | 0.434*** | 0.666*** | | |
| | (0.138) | (0.164) | (0.145) | (0.173) | | |
| HML UK | 0.00114 | -0.086 | -0.00869 | -0.0556 | | |
| | (0.236) | (0.281) | (0.259) | (0.308) | | |
| MOM UK | | | -0.0113 | 0.0351 | | |
| | | | (0.119) | (0.142) | | |
| Mkt. Prem. Europe | | | | | 0.14 | 0.184* |
| | | | | | (0.089) | (0.104) |
| SMB Europe | | | | | 0.704*** | 1.048*** |
| | | | | | (0.222) | (0.262) |
| HML Europe | | | | | 0.0677 | -0.0116 |
| | | | | | (0.216) | (0.254) |
| Alpha | 0.004 | 0.005 | 0.004 | 0.005 | 0.004 | 0.003 |
| | (0.005) | (0.006) | (0.005) | (0.006) | (0.004) | (0.005) |
| R2 | 0.085 | 0.122 | 0.085 | 0.122 | 0.089 | 0.122 |

*Table 4.15: Fama-French Three-Factor Regression Outputs of Monthly Average Returns*

*The table shows the regression output for the Fama-French three-factor model. Alpha is the excess return above the risk-free rate. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01.*

Finally, Table 4.16 shows the regression output of the model developed by Asness, Moskowitz et al. (2013). They have factor loadings for the UK, globally (everywhere), and just for equities (Asness, Moskowitz et al. 2013). Therefore, I employ the factors that are available to me by using UK, globally, and for only equities in my regressions. Unfortunately, none of the alphas are significant for any of the regressions, implying that no inferences can be made on the

excess return of the IPO sample. From the UK factors, the IPO sample loads positively on the value factor, meaning that the sample goes long on value stocks and short on growth stocks, but is only significant for the value-weighted returns. This also occurs for the European value factor, but not for value Everywhere and value Equities. Moreover, the momentum Everywhere factor is significant as shown in regression (3) and (4) in Table 4.16, but the loading sign switches from the equally-weighted to the value-weighted. The explanatory power of this model is better overall than for the Fama-French three-factor model.

| | Value and Momentum Everywhere | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Avg. EW Returns | (2) Avg. VW Returns | (3) Avg. EW Returns | (4) Avg. VW Returns | (5) Avg. EW Returns | (6) Avg. VW Returns | (7) Avg. EW Returns | (8) Avg. VW Returns |
| Mkt. Prem. UK | 0.051 | 0.0431 | | | | | | |
| | (0.121) | (0.144) | | | | | | |
| VAL UK | 0.244 | 0.700*** | | | | | | |
| | (0.206) | (0.244) | | | | | | |
| MOM UK | -0.0808 | 0.14 | | | | | | |
| | (0.159) | (0.188) | | | | | | |
| Mkt. Prem. Everywhere | | | 0.122 | 0.123 | 0.104 | 0.102 | | |
| | | | (0.096) | (0.114) | (0.095) | (0.112) | | |
| VAL Everywhere | | | -0.286 | 0.283 | | | | |
| | | | (0.453) | (0.539) | | | | |
| MOM Everywhere | | | -0.651** | -0.634* | | | | |
| | | | (0.308) | (0.366) | | | | |
| VAL Equities | | | | | 0.0488 | 0.571 | | |
| | | | | | (0.307) | (0.360) | | |
| MOM Equities | | | | | -0.346* | -0.256 | | |
| | | | | | (0.199) | (0.233) | | |
| Mkt. Prem. Europe | | | | | | | 0.0901 | 0.0975 |
| | | | | | | | (0.077) | (0.091) |
| VAL Europe | | | | | | | 0.345 | 0.554* |
| | | | | | | | (0.245) | (0.293) |
| MOM Europe | | | | | | | -0.164 | -0.142 |
| | | | | | | | (0.162) | (0.193) |
| Alpha | 0.006 | 0.007 | 0.005 | 0.006 | 0.005 | 0.006 | 0.006 | 0.007 |
| | (0.005) | (0.006) | (0.004) | (0.005) | (0.004) | (0.005) | (0.004) | (0.005) |
| R2 | 0.049 | 0.097 | 0.059 | 0.075 | 0.079 | 0.123 | 0.100 | 0.112 |

*Table 4.16: Value and Momentum Everywhere Regressions Outputs of Monthly Average Returns*

*The table shows the regression output for the Value and Momentum Everywhere model. Alpha is the excess return above the risk-free rate. Standard errors are in parentheses and significance levels are represented by* $^{*}$ *p < 0.10,* $^{**}$ *p < 0.05,* $^{***}$ *p < 0.01.*

Despite showing several regressions for various factor models, I cannot make any inferences for the excess return of my IPO sample based on this. Interestingly, the lowest coefficients of determination are from the UK factors, which intuitively should show the highest explanatory power due to the geographical area.

# 5. Conclusion

By writing this thesis, I have tried to answer whether underpricing initially exists and whether it is followed by an underperformance in the aftermarket for UK IPOs between 2006 and 2017, in addition to explaining the results by running regressions. My sample size is a significant limitation of this study. This could be lessened by employing a wider time frame. Furthermore, linear regressions rely on several assumptions, mainly that the distributions that you are predicting are normally distributed. As I show, several of the distributions are non-normal which may skew my regression results. To further enhance my thesis, I use a newer three-factor model made by Asness, Moskowitz et al. (2013).

First by examining underpricing, I find statistically significant evidence that UK IPOs are underpriced based on first day returns. Through my analysis, underpricing is equal to 7.4% and 6.5%, on an equally- and value-weighted basis, respectively. Furthermore, underpricing seems to be a consistent phenomenon throughout all the years that I analyse.

Variables that contribute negatively to first day returns are the adjusted asset size and PE- or VC-backed IPOs. Of specific interest is the fact that PE-backed IPOs and not VC-backed IPOs show a statistically significant difference from their non-sponsored counterparts. The IPOs issued in hot markets, as defined by initial return, exhibit higher first day returns compared with those that are not. Additionally, there is evidence that the size of the offer and the size of the IPO firm in terms of assets play a role in the degree of underpricing. Moreover, those firms that have a higher profit margin before going public, exhibit a higher degree of underpricing. This is on average equal to 0.2% bump on the first day return. Finally, and perhaps surprisingly, my regressions show that neither the type of underwriter nor the number of underwriters increase or decrease the first day return. However, when comparing the groups individually through the Wilcoxon rank-sum test, differences emerge.

With regards to the aftermarket performance, I find underperformance and outperformance of the UK IPOs, but it depends on the method, benchmark, and holding period I examine. Firstly, the overall CARs and BHARs show varying statistical significance. The explanatory variables show that the year of the IPO matter, along with the industry variables. However, even though individual years matter, the hot market volume and return variables do not from the regressions. The most interesting I find is that PE-backed IPOs seem to have a large and

significant impact on the shorter periods of aftermarket performance, namely the six -month and one-year periods but not for the longer periods of three- and five-years. A further study of this could be to analyse why the PE-backed IPOs perform the way they do and compare them to their VC-backed and non-sponsored counterparts in the UK.

Furthermore, the wealth relatives indicate that the six-month holding period is the only significant result, with the IPO firms outperforming the respective benchmarks. However, this significance disappears when applying the longer holding periods of one-, three-, and five years.

Finally, applying the CAPM, the Fama-French three-factor model, and the three-factor model developed by Asness, Moskowitz et al. (2013), I am unable to uncover any significant excess returns in the form of alpha generated from my sample.

I hope that my research has provided an update to the UK IPO environment and some valuable insights.

# Appendix

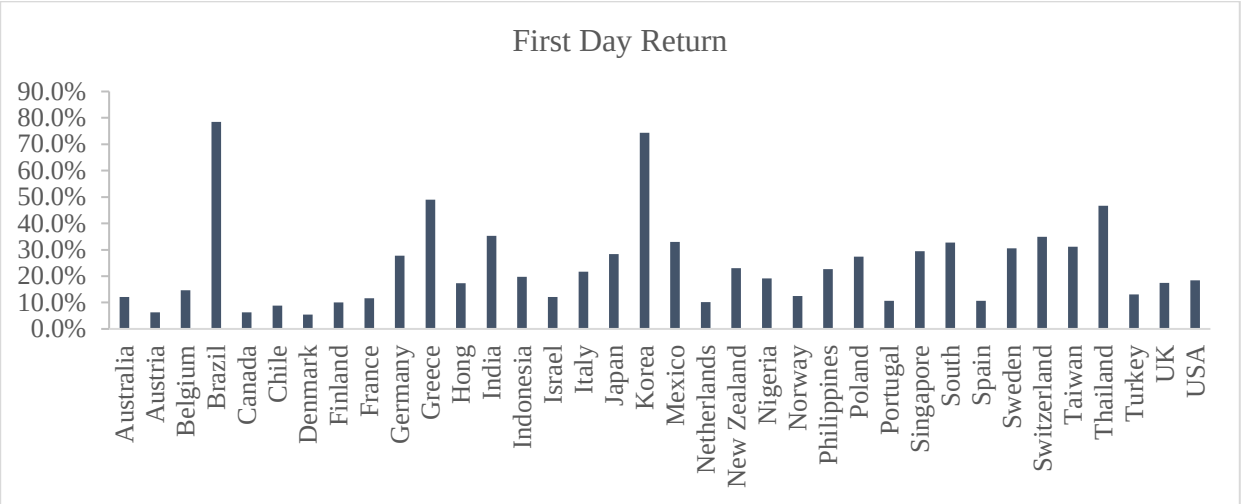


*Figure A1: First Day Returns by country. Source: Ritter (2003)*

*This graph illustrates the average first day return from a number of different papers, all accumulated in Ritter (2003). This provides a good way to show the differences between countries and how there are significant variations.*

| NACE | Count of IPOs | Average First Day Return | Average ADJ_Offer_Size | Average Company Age |
|---|---|---|---|---|
| C - Manufacturing | 45 | 7.89% | 87.7 | 18.3 |
| G - Wholesale and retail trade | 31 | 4.92% | 271.0 | 27.8 |
| K - Financial and insurance activities | 28 | 5.38% | 147.9 | 16.5 |
| M - Professional, scientific and tech. | 22 | 7.63% | 165.0 | 23.8 |
| J - Information and communication | 14 | 9.48% | 29.3 | 11.5 |
| N - Administrative and support service | 12 | 4.67% | 190.4 | 14.2 |
| Q - Human health and social work act. | 7 | 1.38% | 94.2 | 6.8 |
| R - Arts, entertainment and recreation | 7 | 17.24% | 67.3 | 40.8 |
| I - Accommodation and food service | 6 | 15.21% | 13.9 | 9.0 |
| F - Construction | 4 | 6.10% | 75.7 | 22.0 |
| H - Transportation and storage | 4 | 16.20% | 539.4 | 16.1 |
| L - Real estate activities | 4 | 4.64% | 120.4 | 10.9 |
| S - Other service activities | 4 | 5.86% | 94.0 | 3.5 |
| D - Electricity, gas, steam and air cond. | 3 | 2.25% | 195.5 | 0.5 |
| B - Mining and quarrying | 2 | 5.73% | 949.2 | 9.5 |
| P - Education | 1 | 50.00% | 0.7 | 0.9 |

*Table A1: UK IPO Sample by Industry, UK IPO sample 2006-2017*

*This table shows the 194 sample IPOs classified by NACE Rev. 2 Main Section industries by volume, average first day return, average inflation-adjusted offer size by 2017 as a base year, and average company age before the IPO. It is sorted in descending order by count of IPOs.*

| Use of Proceeds | Count of IPOs |
|---|---|
| General Corp. Purp. | 94 |
| Investment / Loan | 17 |
| Secondary | 17 |
| Capital Expenditures | 12 |
| Reduce Indebtedness | 11 |
| Industrial Developmt | 10 |
| Working Capital | 9 |
| Paymnt on Borrowings | 7 |
| Future Acquisitions | 6 |
| Improve Balance Sht | 3 |
| Acquisition Fin. | 1 |
| Marketing & Sales | 1 |
| Other | 1 |
| Pay Fees & Expenses | 1 |
| Pay on LT Borrowings | 1 |
| Proceed to Sharehlds | 1 |
| Project Finance | 1 |
| Restructuring | 1 |

*Table A2: Use of Proceeds for sample of 194 UK IPOs, 2006-2017*

*This table illustrates the use of proceeds by the sample of UK IPO firms from 2006 to 2017. It is sorted in descending order.*

# Bibliography

AQR Capital Management (2018). "Data Sets." Retrieved 1/5/18, from https://www.aqr.com/Insights/Datasets?&page=2#filtered-list.

Asness, C. S., et al. (2013). "Value and Momentum Everywhere." The Journal of Finance **LXVIIII**: 929-985.

Ball, R. and L. Shivakumar (2008). "Earnings quality at initial public offerings." Journal of Accounting and Economics **45**: 324-349.

Barber, B. M. and J. D. Lyon (1997). "Detecting long-run abnormal stock returns: The empirical power and specification of test statistics." Journal of Financial Economics **43**: 341-372.

Beatty, R. P. and J. R. Ritter (1986). "Investment Banking, Reputation, and the Underpricing of Initial Public Offerings." Journal of Financial Economics: 213-232.

Berk, J. and P. Demarzo (2014). Corporate Finance. Essex, Pearson Education.

Bloomberg L.P. (2018).

Brennan, M. J. and J. Franks (1997). "Underpricing, ownership, and control in initial public offerings of equity securities in the UK." Journal of Financial Economics: 391-413.

Burrowes, A. and K. Jones (2004). "Initial public offerings: evidence from the UK." Managerial Finance: 46-62.

Carter, R. and S. Manaster (1990). "Initial Public Offerings and Underwriter Reputation." The Journal of Finance: 1045-1067.

Datastream (2018). Thomson Reuters Datastream.

Dell'Acqua, A., et al. (2015). "IPO Underpricing and aftermarket performance in Italy." Journal of Economic & Financial Studies: 1-14.

Espenlaub, S., et al. (2000). "Re-assessing the long-term underperformance of UK Initial Public Offerings." European Financial Management: 319-342.

Fama, E. F. (1998). "Market efficiency, long-term returns, and behavioral finance." Journal of Financial Economics **49**: 283-306.

Fama, E. F. and K. R. French (1993). "Common risk factors in the returns on stocks and bonds." Journal of Financial Economics **33**: 3-56.

Field, L. C. and G. Hanka (2001). "The Expiration of IPO Share Lockups." The Journal of Finance **2**: 471-500.

Filatotchev, I. and K. Bishop (2002). "Board composition, share ownership, and 'Underpricing' of U.K. IPO Firms." Strategic Management Journal **23**: 941-955.

Financial Times (2018). "League Tables." Retrieved 1/5/2018, from https://markets.ft.com/data/league-tables/tables-and-trends.

French, K. R. (2018). "Data Library." Retrieved 4/4/18, from http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

FTSE Russell (2017). FTSE UK Index Series: An accurate and consistent measurement of the UK equity market.

Goergen, M. and L. Renneboog (2003). Insider Retention and Long-Run Performance in German and UK IPOs, Tilburg University.

Gregory, A., et al. (2013). "Constructing and Testing Alternative Versions of the Fama-French and Carhart Models in the UK." Journal of Business Finance & Accounting **40**: 172-214.

Jenkinson, T. J. (1990). "Initial Public Offerings in the United Kingdom, the United States, and Japan." Journal of the Japanese and International Economies: 428-449.

Levis, M. (1990). "The Winner's Curse Problem, Interest Costs and the Underpricing of Initial Public Offerings." The Economic Journal: 76-89.

Levis, M. (1993). "The Long-Run Performance of Initial Public Offerings: The UK Experience 1980-1988." Financial Management: 28-41.

Levis, M. (2008). The London Markets and Private Equity-backed IPOs, Cass Business School.

Levis, M. (2011). "The Performance of Private Equity-Backed IPOs." Financial Management: 253-277.

London Stock Exchange plc (2018). "Choosing A Market." from http://www.londonstockexchange.com/companies-and-advisors/listing/markets/markets.htm.

London Stock Exchange plc (2018). "History of the London Stock Exchange Group." Retrieved 30/4/2018, 2018, from https://www.lseg.com/about-london-stock-exchange-group/history.

London Stock Exchange plc (2018). "Main Market and AIM for Private Investors." Retrieved 16/5/2018, from http://www.londonstockexchange.com/traders-and-brokers/private-investors/private-investors/stock-markets/main-market-and-aim/main-market-and-aim.htm.

London Stock Exchange plc (2018). "New and Further Issues." Retrieved 5/2/2018.

Loughran, T. and J. R. Ritter (2004). "Why Has IPO Underpricing Changed over Time?" Financial Management: 5-37.

Loughran, T., et al. (1994). "Initial public offerings: International Insights." Pacific-Basin Finance Journal: 165-199.

Miller, R. E. and F. K. Reilly (1987). "An Examination of Mispricing, Returns, and Uncertainty for Initial Public Offerings." Financial Management: 33-38.

Morningstar (2015). "Investing in Small, Mid, and Large-Cap Stocks." Retrieved 1/5/2018, from http://www.morningstar.co.uk/uk/news/105769/investing-in-small-mid-and-large-cap-stocks.aspx.

Orbis (2018). Bureau van Dijk.

Ritter, J. R. (1984). "The "Hot Issue" Market of 1980." The Journal of Business: 215-240.

Ritter, J. R. (1991). "The Long-Run Performance of Initial Public Offerings." The Journal of Finance.

Ritter, J. R. (2003). "Differences between European and American IPO Markets." European Financial Management: 421-434.

Ritter, J. R. and I. Welch (2002). "A Review of IPO Activity, Pricing, and Allocations." The Journal of Finance: 1795-1828.

Santos, F. (2017). "IPO market timing with uncertain aftermarket retail demand." Journal of Corporate Finance **42**: 247-266.

SDC Platinum (2018). Thomson Reuters.

Sharpe, W. F. (1964). "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." The Journal of Finance **XIX**: 425-442.

The World Bank (2018, 8/4/2018). "CPI Index." Retrieved 4/5/2018, from https://data.worldbank.org/indicator/FP.CPI.TOTL?end=2017&locations=GB&name_desc=false&start=1988&view=chart.

Tinic, S. M. (1988). "Anatomy of Initial Public Offerings of Common Stock." The Journal of Finance: 789-822.

Turner, M. (2018). "Spotify's using a 'novel method' to go public, and it means the stock price could 'decline significantly and rapidly'." Retrieved 28/4/2018, from http://www.businessinsider.com/spotifys-using-a-novel-method-to-go-public-and-it-means-the-stock-price-could-decline-significantly-and-rapidly-2018-2?r=US&IR=T&IR=T.

Unlu, E., et al. (2004). "IPO Underpricing over time: evidence from the UK." Applied Economics Letters: 5-9.

Yahoo Finance (2018). Retrieved 28/4/2018, from https://finance.yahoo.com/.