LONG-TERM PERFORMANCE OF UK IPOs

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ABSTRACT

This thesis investigates the long-term post-issue performance using a sample of 1,953 UK non-financial IPOs for the period of 1982-2004. Data is obtained from the LSPD. The main measure of performance includes buy-and-hold abnormal returns, cumulative abnormal returns, and calendar time regression intercepts.

Our results indicate the mixed evidence on the long-term post-IPO stock performance. Event time analysis produce significant underperformance at five-year horizon while calendar time regression results show that IPOs perform as good as benchmarks. In conclusion, the relative long-term performance depends on the method and benchmark of examining performance. For example, most results based on BHAR measure suggest that the sample underperforms.

Additionally, we assess the choice of data set on the conclusion of long-term post-IPO performance. We find that Datastream (DS) produces similar results as London Share Price Database (LSPD) if equal weight scheme is adopted. Additionally, there is insignificant discrepancy for the value weighted returns.

Finally, the thesis reveals that two-stage IPOs do not underperform the benchmarks. Furthermore, two-stage IPOs have similar long-term performance compared to that of regular IPOs listed in AIM. Also, the underpricing for two-stage IPOs is less severe than regular IPOs.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1 Introduction

In the past decade, the topic of initial public offering (IPO) has been of great interest to investors and academics. Investors are interested at the tremendous profit that IPOs often offer to them. In academia, studies find significant underpricing in the primary market and consequently substantial initial returns in the secondary market. Most IPOs left money on the table.[1] However, after short-run outperformance of IPOs, there is on average breathtaking underperformance over longer period.

Although the poor long-run post-IPO performance is well documented, the determinant of this phenomenon is not well sustained. From market efficiency hypothesis, there should be no abnormal returns as long as the event fully completed. Therefore, another relevant research area considers the metric to measure firms' long-term performance. Recent studies provide through evidence about various methods of measuring abnormal performance[2]. The conclusion is that none of extant methods is always preferred.

Nonetheless, due to availability of data and size of the market, most studies tend to focus on US market and few researches are on UK IPOs. In spite of small coverage of IPOs in UK, IPO market in UK has grown rapidly over the past decade at a quicker pace than the counterparts in continental European markets. In 1995, Gajewski and Gresse (2006, table 1) report 285 IPOs in UK market and this number increases to 413

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[1] Ritter (1991) defines money left on the table in an IPO as the number of shares offered multiplied by the first day capital gain, measured from the offer price to the closing price.

[2] See Barber and Lyon, 1997; Lyon et al., 1999; Mitchell and Stafford, 2000

until 2004. The capital raised during that period even tripled. Other European countries have less IPOs in 2004 compared to that in 1995. The buoyant UK IPO market is related to the success of Alternative Investment Market (AIM). There is no requirement on size, floating capitalization, age, sector, growth if private firm choose to goes public through AIM. Admission is only subject to the approval of the nominated adviser in charge of the IPO. Therefore, we need updated empirical evidence about long-term post-issue stock performance of UK IPOs.

Furthermore, nearly all previous UK studies (Levis, 1993; Espenlaub et al., 2000; Gregory et al., 2010) use London Share Price Data (LSPD) as data source. However, the return and market value information could also be found from DataStream (DS) and there's no assessment between two databases concerning the impact on conclusions caused by data source.

Additionally, even the long-term post-issue poor performance from UK IPOs is well documented in previous literature, the determinant is not been found yet. One purpose of the study is to shed some light on the potential determinants of long-term IPOs performance.

Last but not least, UK IPO market displays some different characteristics which cannot be shared by US market. For instance, firms are permitted to be listed first in the secondary market and then issue new equity sometime after the listing. The IPOs adopting two-stage strategy potentially have different underpricing and long-term post-offering performance pattern from regular IPOs.

Our thesis aims to address the problems mentioned above. Chapter 2 reviews the literature on theoretical determinants of long-term IPO stock performance and associated empirical work. We also survey some econometric issues that likely contribute to the mixed empirical results.

Our first empirical study covers Chapter 3, examines the long-term post-issue UK IPO performance using two datasets. We assess the impact of using different data sources on conclusion, which is never performed in prior studies. In this chapter, we also try to test the hot market hypothesis by dividing the sample into several groups based on annual IPO activity.

Our second empirical study re-examines the long-term post-issue performance using an updated and more comprehensive sample. Consistent with prior UK studies, we focus our study on non-financial firms. Our major measure of performance includes buy-and-hold abnormal returns and cumulative abnormal returns. We conduct robustness check using calendar time portfolio approach. The intercepts of each time series OLS regression is indicator of average abnormal returns. We also use GLS to control for the well-known problem of heteroscedasticity (Mitchell and Stafford, 2000). For finding the determinants of long-term performance, we focus whether there is difference if IPO is listed in different market or using different listing method.

Our last empirical study (chapter 5) investigates the underpricing and long-term post-offering stock performance for two-stage firms. We are not aware of any UK study that analyzes the long-run performance for this special group of IPOs. We first compare the initial returns of two-stage firms with that from regular IPOs. We also apply the standard methodology in our analysis and demonstrate how benchmarks are chosen to make sure the validity of the conclusion.

This research contributes to the extant literature on long-term IPO post-issue performance in the following ways. Firstly, this research provides additional UK evidence on the long-term post-issue stock performance with a more recent and carefully constructed dataset. Additionally, prior UK studies either use BHAR or CAR to measure the performance. We demonstrate the both two measures have exclusive advantages and can supplement each other. In terms of benchmark, we apply Carhart (1997) four-factor model to the expected return, which has not been conducted before. Secondly, our research provides valuable insight about impact of data set choice on conclusion. Most previous UK studies only collect first trading day close price from DS as underpricing dataset, while we collect monthly stock price and market value from DS. Thirdly, we conduct an experimental study using a sub-group of IPOs to investigate the effect of two-stage strategy on long-term post-offering stock performance. Besides, we test and confirm the notion of Derrien and Kecskes (2007) that two-stage strategy will reduce underpricing relative to regular IPOs.

The remainder of the thesis is organized as follows. Chapter 2 contains a review of theoretical and empirical literature on long-term post-issue IPO performance. Chapter 3 documents the long-term UK IPOs performance using two datasets. Chapter 4 re-examine the post-issue performance of UK IPOs with an extended sample period and size. Chapter 5 investigates the underpricing and post-offering stock performance in the long-run for two-stage firms. Chapter 6 concludes, summarizing the major empirical findings, limitations, and further research.

Chapter 2 Literature Review

2.1 Long-run underperformance international evidence

2.1.1 US evidence on IPO long-term performance

There is ongoing debate on whether the IPOs firms underperform in the long-run. Ritter (1991) documents that initial public offerings underperform significantly relative to comparable firms in terms of size and industry. With a sample of 1526 US IPOs from 1975 to 1984, he finds sample firms significantly underperform the benchmark about 34.47 percent in the post-issue three year period.

Work earlier conducted by Aggarwal and Rivoli (1990) yield underperformance based on post issue 250 trading days (one year) period as well. Although one year cannot be defined as a long-term basis now, it is comparatively long for studies before 1990 which usually target on price behavior of days and weeks after IPO. Their sample includes 1598 offerings over the years 1977-1987. They find that adjusted return compared to NASDAQ index is -13.73 percent during one year post-issue horizon. This underperformance is highly significant. Furthermore, the conclusion is conservative for two reasons. First, the adjusted returns present a positive skewed distribution, with median much lower than mean. Second, because the IPOs have higher systematic risk, the adjusted return based on risk would have been more negative.

The two papers above are the most influential in the early research stage of long-term performance of IPOs. The underperformance conclusion is backed by more papers with increasingly focus on this topic. Loughran and Ritter (1995) analyze post-issue five year stock performance of issuing firms during 1970 and 1990, and find IPOs are poor long-term investments for investors. 4753 stocks on average show significant underperformances relative to non-issuing firms. The magnitude of underperformance is huge, with 44 percent more money being invested in issuers than in non-issuers to reach same wealth relative five years later. The conclusion is more persuasive than previous studies because they adopt different benchmarks including matching firms and five market indices[3]. Loughran and Ritter (2000) re-examine the new issues puzzle using three-factor regressions with factors purged of new issues, and find new issuers reliably underperform. Brav and Gompers (1997) use a sample of 934 venture-backed IPOs from 1972-92 and 3407 non-venture IPOs from 1975-92 and analyze their stock behavior in the long run. Their result is that nonventure-backed small IPOs perform worst. The underperformance of IPOs substantially reduces when the weight scheme is switched from equal to value.

In Ritter and Welch (2002), they review stock price performance of IPOs in the three years after the offering. They find that over three years, an average IPO underperforms market-adjusted (CRSP value weighted index) by 23.4 percent, underperforms style-adjusted companies (non-IPO matching firms with closest market capitalization and book-to-market ratio) only by 5.1 percent. Seasoned firms matched by market capitalization and book-to-market ratio fare as bad as IPOs do. Their results

[3] Nasdaq equally weighted index, Nasdaq value weighted index, Amex-NYSE value weighted index, Amex-NYSE equally weighted index, and S&P 500 index

support the implication from Brav and Gompers (1997) that underperformance is not due to the IPO status but possibly subject to certain firm characteristics. Brav and Gompers (1997) suggest that we should look more broadly at the types of firms that underperform and not consider IPO firms as a distinct group. Brav et al. (2000) also examine whether a distinct equity issuer underperformance anomaly exists. In a sample including IPOs from 1975 to 1992, they find underperformance concentrated among small issuing firms with low book-to-market ratio. They indicate the poor long-term performance is not exclusive to firms as IPOs but also shared by other non-issuing firms with similar firm characteristics. Gompers and Learner (2003) participate in the debate of whether a distinct IPO underperformance exists by testing out-of-sample data. They collect information of firm-commitment IPOs in the US from 1935 to 1972 before the formation of Nasdaq and measure their returns for up to five years after listing. The failure to detect a consistent price pattern put more doubts on whether a unique IPO effect exists.

In summary, the empirical evidence of long-term underperformance of IPO in U.S. reaches a consensus. However, it is still not sure whether IPOs long-term underperformance is one market anomaly against market efficiency hypothesis or a phenomenon shared by some other non-issuing firms.

2.1.2 International evidence on IPO long-term stock performance

The international evidence on the long-run performance of IPOs is less conclusive compared to those found in US. At least, the consistent finding in US IPOs is that they fare poorly, regardless of the different explanations. IPOs in some countries other than US cannot find evidence of long-term underperformance. Sometimes, even the conclusions for the same country but in different papers are opposite. In the following, I will demonstrate the empirical evidence of underperformance first and then some refuting this statement.

Leleux and Muzyka (1997) investigate the post-issue performance of IPOs issued in Belgium and France from 1988-1992. They find negative cumulative abnormal returns for the French IPOs, but not for the Belgian ones. For German capital market, Uhlir (1989) shows that IPOs underperform the market by 7.41 percent (excluding first day returns). Stehle et al. (2000) find that the German IPOs from 1960 to 1992 on average will produce -6 percent adjusted returns relative to matching portfolio with similar market capitalization by three years after listing which is much smaller than the counterparts in US. Furthermore, Finnish IPO research by Keloharju (1993) proves -26.4 percent long-run cumulative market-adjusted returns for 79 new offerings from 1984 to 1989. In Jakobsen and Sorensen's (2001) study on Danish IPOs from 1984 to 1992, it also finds the underperformance of IPOs compared to the market (Danish Total Stock Index) by -30.4 percent, and by -13.1 percent compared to matching firms after 5 years. Studies have also been conducted for other European countries, such as Italy and Spain. Arosi et al. (2000) report adjusted return of -11.53 percent for 108 Italian IPOs during 1985-1997. Alvarez and Gonzalez (2005) find that the Spanish IPOs after five years of listing underperform by -37.05 percent.

Kooli and Suret (2004) fulfill the gap of evidence on Canadian market by examining the performance of over 445 Canadian IPOs from 1991 to 1998 up to five years. They find long-term underperformance, however not always statistically significant, is contingent on methodology and weighting scheme. In Australia, Mustow (1992) document significant long-run underperformance and 36-month post-listing adjusted returns of -112.8 percent is reported. In addition, results from Lee et al. (1996) show that Australian IPOs significantly underperform market in the three-year period subsequent to listing. Another study on Australia by Allen and Patrick (1996) also proves significant aftermarket underperformance of -25.38 percent.

Emerging capital markets also provide some evidence of poor long-run post-issue stock performance. Aggarwal et al. (1993) conduct analysis on three Latin America stock markets. 62 Brazilian IPOs are found to underperform -47 percent; 6 Chilean IPOs at three-year horizon underperform by -23.7 percent; 44 Mexican IPOs at one-year horizon underperform by -19.6 percent. Chan et al. (2004) explore the long-run stock performance of IPOs in China allowing for specific characteristics (A and B shares). They find A-share IPOs underperform their non-IPO benchmarks while B-share IPOs outperform the similar non-IPO firms in terms of size and/or book-to-market ratio. Cheng and Shiu (2005) demonstrate that IPOs in Taiwan during 1988-2002 underperform the market by -22.73 percent, contradicting results presented by Chen (2001) who conclude that Taiwanese IPOs do not underperform in the long-run.

We also find some evidence that IPOs do not perform poorly or even outperform the benchmark. For example, Brounen and Eichlolz (2002) find that IPOs in Sweden have long-run outperformance by 18.89 percent. Similarly, study by Drobetz et al. (2005) indicates that Swiss IPOs listed from 1983 to 2000 don't demonstrate evidence of long-run underperformance if small capitalization index as a benchmark is applied. Schuster (2003) focuses the returns of all IPOs in the six largest continental European markets and Sweden as a whole during the period 1988-1998. He finds evidence of short-term outperformance and no long-term underperformance.

Paudyal et al. (1998) report that no performance difference could be detected between Malaysia IPOs and market portfolio. Ahmad-Zaluki et al. (2007) even find that IPOs listed on the KLSE (Kuala-Lumpur Stock Exchange) during the period 1990 to 2000 outperform their market benchmarks by 32.63 percent in the post-issue three years. The Thai IPOs listed during 1985-92, undertaken by Allen et al. (1999), show insignificant underperformance during two years after going public. Kim et al. (1995) find that Korean IPOs outperform seasoned firms with similar characteristics. Kiymaz (2000) find outperformance (44.1 percent at the end of 36 months) of Turkish IPOs for the period 1990-1995.

2.1.3 UK evidence on IPO long-term performance

The research for UK is tilted towards finding underperformance. Levis (1993) adopts methods similar to Ritter's (1991) and finds that 712 UK floated during 1980-88 underperform the HGSC index (Hoare Govett Smaller Companies Index) over a three year period by 8.31 percent. Using data of UK firms that go public during 1985-92, another influential paper by Espenlaub et al. (2000) find in event-time framework, there is a substantial amount of negative abnormal returns after the first 3 years compared to different benchmarks. However, over further two years, IPOs on average exhibit less dramatic underperformance, and the conclusion depends on the benchmark used. In calendar time framework, the statistical significance of underperformance is even less marked. Goergen et al. (2007) also confirm the statically and economically significant underperformance. Gregory et al. (2010) provide the UK evidence using 2499 non-financial firms spanning from 1975 to 2004. They find underperformance of -12.6 percent after three years and -31.6 by 5th anniversary. The conclusion holds for various benchmarks.

In short, there is still international variation in observed performances and thus further research warranted. Most evidence in developed markets indicate negative long run IPO performance, although notable exceptions are also observed. The researches on emerging markets are even less conclusive compared to ones found in emerged markets. It is more likely to observe outperformance in emerging capital markets.

2.2 Determinants of long-run underperformance

2.2.1 Windows of opportunity

The windows opportunity hypothesis indicates that firms take advantage of time when stock prices are overpriced to sell newly listed stocks to overly optimistic investors. These are periods of market buoyancy during which companies have an incentive to issue new shares in that they have an over-valuation compared to other companies in their industry. These IPOs have the worst post-issue performance among all IPOs, which contribute to long-term underperformance of IPOs. This hypothesis is supported by Ritter (1991), Lerner (1994), Loughran and Ritter (1995), and Baker and Wurgler (2000). Ritter (1991) finds that volume of IPO activity is associated with taking advantage of "windows of opportunity". Lerner (1994) confirms finding by Ritter (1991). He suggests that in IPO peak periods, investors are willing to pay higher price for issuers. Loughran and Ritter (1995) have the evidence consistent with theory above. The substantial overvalued issuers are followed by a poor market performance could be justified. Results from Hoechle and Schmid (2009) also indicate IPOs with optimistic growth prospects and going public in hot issue period tend to underperform over the long-run. Baker and Wurgler (2000) suggest that windows opportunity is evidence of market inefficiency. Modigliani and Miller (1958) imply the irrelevance of financing policy in efficient market. However, the financing decision does matter in inefficient market. If that's the case, firms will issue equity when equity prices are higher which will benefit the existing shareholders.

More firms will choose to be public listed when the market price is high if windows opportunity hypothesis holds. The market could be divided into hot and cold depending on the volume of public offering in a certain period. However, conclusion about the quality of IPOs issuing in hot market is mixed. Hot market is a good chance to take advantage of window opportunity to undertake an IPO. Loughran and Ritter

(1995) suggest firms issuing stocks in hot markets to be lower quality compared to those in cold markets because they tend to experience worse long-run stock returns. However, Helwege and Liang (2004) show that there is no difference in quality between firms going public in hot or cold markets. Hot market (high volume) IPOs have higher market-to-book ratios, are smaller, and have lower earnings than cold market IPOs, but as long as these characteristics are adjusted for macroeconomic and industry conditions, these differences vanish.

2.2.2 Earnings management

Rangan (1998), Teoh et al. (1998a), and Teoh et al. (1998b) document that issuers with high discretionary accruals before they go public experience significantly negative long-run abnormal returns and poor earnings in the post-issue period.[4] The proponent of market efficiency illustrates that benchmarks have specification error which is related to past accruals. Earnings management hypothesis tries to interpret by exploring whether high accruals is associated with biases in expectation, as reflected in analyst forecasts. It avoids concerns about appropriate expected returns benchmark, and focuses on the problem that whether adjustment of accounting information is efficient. Because the timing of cash transaction sometimes cannot match with economic transactions, the stated regulatory purpose for accruals is to make reported earnings more accurately reflect the economic performance of the firm. Accruals contain important information for the future earnings of the firm. Firms are allowed boost their earnings relative to actual cash flow by making accounting adjustments

[4] See also Dechow and Sloan (1997) and Chan et al. (2001)

(accrual) before they go public, allowed by financial reporting rules. Also, entrepreneurs have motivations and opportunities to manage earnings. There is high information asymmetry between investors and issuers at the time of the offering. Rao (1993) reports that there is almost no news coverage of firm in the years before the IPO. High reported earnings would increase the probability of successful IPOs and the likelihood of higher offer proceeds. While entrepreneurs have discretion over accrual adjustments to make the firms look better before public offering, it is difficult for investors to assess the appropriate extent to the adjustments given the relatively limited amount of information about issuing firms prior to going public. Therefore, an important role for analysts is to evaluate whether high reported net income caused by large positive accruals or by earnings management by the firm. Teoh and Wong (2002) demonstrate that probably because of agency incentives to bias forecasts in favor of the firms, analysts do not discount adequately for firms with high discretionary accruals in their forecasts of subsequent earnings. Investors who rely on analysts' forecast will overvalue the new issue firms with high accruals. When they are surprised at the actual reported earnings after issue and overvaluation is corrected, they will find poor abnormal returns of the issuing firms. In other words, analysts systematically misuse the accounting information and contribute to long-term event abnormal returns. The information asymmetry can keep the new issue stock price relatively high, even extending to 3 to 6 months after IPO. All parties involved are under pressure to justify the high stock prices to preclude unpleasant results from taking place, such as lawsuits, loss of reputation, loss of goodwill of investors etc. However, the issuers with aggressive discretionary accruals should pay the price during long post-IPO period. This result is robust with respect to different benchmarks, abnormal performance measurement and test specifications. That's why greater earnings management in IPOs is associated with more optimistic errors in analyst earnings forecast, and with more adverse subsequent long-run abnormal stock returns.[5] Besides the financial analyst's role in earnings forecasting, Lee and Masulis (2008) investigate the role of financial institutions that are involved in the IPO process. They provide additional evidence that more reputable underwriter less likely support earnings management. The earnings management explanation has a bearing on the windows opportunity explanation of the new issues puzzle by Loughran and Ritter (1995). According to windows opportunity hypothesis, firms will conduct new issues when firms are overvalued. The market fails to discount fully for this timing, and therefore continues to overvalue new issue firms in the short run until it is eventually revised. Either timing or manipulation alone can explain the puzzle. In reality, it is likely that their effects are both present.

2.2.3 Pseudo market timing

Schultz (2003) use pseudo market timing hypothesis to explain poor performance of firms issuing equity (IPOs and SEOs). It's a complete different explanation from those either based on mis-measurement of risk and statistical significance or methodological concerns raised by Kothari and Warner (1997), Barber and Lyon

[5] See Teoh et al. (1998a, 1998b), and Teoh and Wong (2002)

(1997), and Lyon et al. (1999). “The pseudo market timing hypothesis says that, ex-post, the poor performance of equity issuers is real and significant. That is, IPOs have underperformed relative to their ex-ante expected return.” (Schultz, 2003, p 490) The pseudo market timing relies on two assumptions. First, more firms issue equity as stock prices increase. Manager’s decision when to go public is justified by this rationale. Secondly, abnormal returns are cross-sectional positively correlated. Nevertheless, those are not contradictory to an efficient market. Since even if ex-ante expected abnormal return is zero, the positive covariance between abnormal returns and the number of future offerings will cause probability to find negative abnormal return exceeding fifty percent. Schultz emphasize that managers have no timing ability which is opposite to opinion in windows opportunity hypothesis. Via a simulation, long-run event returns are downward biased when returns predict events. To mitigate the effects of cross-section in event-time excess returns, he recommends benchmarks that are “as highly correlated with the firms being studied as possible”. (Schultz, 2003, p 515) The limitation of pseudo market timing is that negative expected abnormal returns only could be realized in in event-period which weights each issuer equally. The calendar-time abnormal returns are not affected.

Viswanathan and Wei (2008) reexamine the conclusion from Schultz (2003) and find their negative expected long-term event abnormal is caused by small-sample bias. The traditional assumption (see Campbell et al., 1997, p157) about event studies is that “the event is exogenous with respect to the change in the market value of the security.”

Both Schultz (2003) and Viswanathan and Wei (2008) consider event-generating process depends on past returns and thus the events are endogenous. They justify the event endogeneity assumption with some theoretical models in corporate finance. For example, Pastor and Veronesi (2005) predict that managers will time IPOs when the stock market is doing well. Lucas and McDonald (1990) show that seasoned equity issues are more likely to be preceded by stock price increase. All those models show that events occur more often when event returns are higher. Their small-sample theory shows that when returns predict events, the long-run abnormal returns will be negative, which is consistent with findings in Schultz (2003). However, Schultz's results are from simulation and the condition under which the results could be obtained is unclear. Viswanathan and Wei fill in the gap by illustrating post event returns converge to zero under the condition that the process of number of events is stationary. The negative expected long-term event abnormal return is a small-sample problem. In a large sample, long-run average number of events is not affected by the shocks to the number of events today. In fixed samples, expected abnormal returns are negative and become more negative when holding period longer. Asymptotically, the bias will disappear when the process of number of events is stationary.

2.2.4 Firm characteristics

In this section, three various interpretations concerning long-term post-issue IPO underperformance are provided. They are all relevant to firm characteristics. First explanation (Brav and Gompers, 1997; Brav et al., 2000) argues that long-term underperformance is not an IPO effect, and is shared by some other non-issuing firms.

When issuing firms are matched to size and book-to-market portfolios excluding recent issuing firms, IPOs do not underperform. Second explanation (Eckbo and Norli, 2005) states IPOs have higher turnover and lower leverage. Those stocks are exposed to smaller risk related to those factors and have smaller expected return. Third interpretation points out none of single firm characteristic can explain the long poor performance of IPO. A set of firm characteristics including IPO market environment, leverage and liquidity, firm valuation, corporate diversification strategies, and investments are control variables that make stock performance no different between IPOs and non-issuing companies.

Brav and Gompers (1997), Brav et al. (2000), and Ritter and Welch (2002) show that long-term IPO underperformance is not unique to firms issuing equity. Similar size and book-to-market firms that have not issued equity perform as poorly as IPOs. Furthermore, both papers find that small growth companies perform worst, regardless of IPOs or non-issuing firms. Brav and Gompers (1997) propose various explanations for concentration of underperformance among small, low book-to-market companies. First, unexpected shocks may have hit small growth companies in the early and middle 1980s. Fama and French (1995) show that earnings of small firms decline in the early 1980s and have not recovered when those of large firms do. Secondly, institutional investors prevent from investing in small growth firms for regulatory reasons. Securities and Exchange Commission (SEC) restricts trading if shareholding exceeds 5 percent, and institutions may want to avoid this level of ownership.

Therefore, these firms are held primarily by individuals. Field (1997) documents that long-run IPO performance is positively related to institutional holdings. Field's effects may similarly extend to non-issuing small growth companies. Furthermore, information asymmetry and investor sentiment is likely to be more prevalent for small growth firms because individuals spend considerably less time tracking information regarding returns than institutional investors do and they are less rational in decision making. Finally, individuals might derive utility from buying the shares of small, low book-to-market firms because they value them like a lottery ticket. Black (1986) argues that many finance anomalies may only be explained by this type of utility-based theory. In a nutshell, long-term underperformance is not due the IPOs status.

Eckbo and Norli (2005) present new evidence on potential risk-based explanations for poor IPO stock performance. The new discovery that IPOs exhibit relatively higher stock turnover and lower leverage, compared to non-issuing firms matched on stock exchange, equity size and book-to-market ratio indicates lower risk exposure to factors which have links to stock liquidity and leverage. The resulting hypothesis is that IPOs have lower expected return due to lower exposure to these and other risk factors. They explore this possibility by adding liquidity factor into Fama-French (1993) model. Liquidity factor is a portfolio that is long in low-turnover stocks and short in high-turnover stocks. When applied to IPO portfolios, the liquidity reduces expected portfolio return. The liquidity-based factor model prices IPO portfolios more comprehensively in that the intercept terms become smaller. Switching to leverage characteristic, declining leverage will reduce the exposure to leverage-related risk factors. In a factor model with macroeconomic risks, lower leverage-related factor betas for IPO portfolios also imply a lower expected return. They conclude that higher liquidity and lower leverage both contribute to lower expected return on IPO shares. Therefore, the negative abnormal returns of IPOs relative to seasoned firms matched on size and book-to-market could be justified since their risks are lower than their counterparts.

Hoechle and Schmid (2009) find size and book-to-market ratio are not able to fully explain IPO underperformance because a standard Carhart (1997) model cannot explain a significant part of IPO underperformance. They use the multivariate BHAR-analysis to explore which of the firm characteristics known by the time of IPO are good predictors for new offerings' subsequent performance. The key results are that controlling for single firm characteristic such as issue period, leverage, cannot find performance difference between IPOs and non-issuing firms. Only by controlling for a sufficient number of firms characteristics, can they explain why IPO firms underperform. Specifically, controlling for IPO market environment, leverage and liquidity, firm valuation, corporate diversification strategies, and investments, no differences can be found between IPO firms with non-issuing firms sharing same firm fundamentals. Therefore, Hoechle and Schmid (2009) conclude that differences in firm characteristics between IPO and more seasoned non-issuing firms result in IPO underperformance. With IPO firms' characteristics converging to those of more seasoned companies, apparent underperformance of IPO firms will vanish.

2.2.5 Venture capitalists

The involvement of venture capital will make a difference to the long-term IPO stock performance. If the market underestimates the importance of venture capitalists in the pricing of new issues, the long-term performance will differ for two groups. The IPOs backed by venture capital tend to perform better than their counterparts without venture capital support. Paper by Brav and Gompers (1997) examines whether difference exists between venture-backed IPOs and nonventure-backed IPOs. They find the underperformance comes mainly from small, non-venture backed IPOs. Venture-backed IPOs are found indeed to outperform nonventure-backed IPOs over a five-year period, but only on an equally weighted basis. There are two possible reasons for this finding posited by Brav and Gompers (1997). Gompers (1996) shows that venture capital firms specialize in collecting and evaluating information on startup and growth companies. The involvement of venture capitalists will partly overcome the information asymmetry and capital constraints suffered mostly by these types of companies. Venture capitalists may have an impact on the compositions of shareholders of new offerings. Participation of venture capitalists attracts more analysts to follow the firm which in turn reduce the problem of information asymmetries because venture capitalists have more contacts with top-tier investment banks. Similarly, institutional investors are main capital source of venture fund and therefore more willing to take part in IPOs holding. The availability of information and higher institutional ownership constitutes the first reason for better long-term performance for venture-backed IPOs. Furthermore, Gompers (1996) demonstrates that reputational concerns affect the decisions venture capitalist made to bring the firms public. If venture capitalists are associated with underperformance of newly issued firms, their reputations will be effected and consequently less willing to overprice IPOs. Brav and Gompers (1997) confirm that underperformance of IPO is concentrated among ones without venture capital backing. The results shed some doubt on whether long-horizon poor performance is due to the status as issuance using calendar time.

2.3 Methodology Literature on long-run IPO performance analysis

Two main changes take place in methodology about event studies. First, use of daily stock return rather than monthly stock return becomes more prevalent. It allows more precise measure of abnormal return and more informative studies of announcement effects. Second, the methods to calculate abnormal returns and calibrate their statistical significance become more sophisticated. The second change is more important for long-horizon event studies. The change in measurement and statistics reflects the new findings in the statistical properties of long-horizon security returns. (Kothari and Warner, 2007)

While long-horizon methods improve, serious limitations and problems still remain. Kothari and Warner (2007) indicate that "horizon length has a big impact on event study test properties." Short-horizon event study methods are well-specified and powerful, while it's different for long-horizon event study. In fact, long-term tests are much more troublesome due to uncertainty and accumulation effect. Although much has been done to improve power and reduce misspecification, none of existing procedures can completely eliminate these inherent drawbacks.

In the event study tests for long-horizon performance of IPOs, economic interpretation is more changeling than statistical specification, because performance tests are joint tests of whether abnormal returns are zero, of whether the assumed model of expected return is correct. The explicit and implicit assumptions made in long-horizon stock performance should be understood before interpretation. For example, the use of normative capital asset pricing model such as CAPM indicates that security returns is normally distributed. The validity of these assumptions is questioned in small samples. However, in large samples, we can rely on asymptotic results or central limit theorem to overcome this problem.

2.3.1 Expected return

2.3.1.1 Characteristic-based matching approach

Numerous literatures[6] use market index as benchmark for calculating abnormal returns of firms undergoing corporate event. It is most straightforward since it assumes that sample firms have same systematic risk with market portfolio. However, in most cases, the composition of market portfolio is different from that of sample firms. Therefore, some papers[7] adopt matching non-issuing firms with similar

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[6] See Ritter, 1991

[7] See Ritter, 1991; Loughran and Ritter, 1995; Eckbo and Norli, 2005;

characteristics as alternative benchmarks. Their matching is based on firm characteristics which are related to expected return of stocks. These firm characteristics include firm size and book-to-market ratio. The use of this approach is based on two assumptions. First, the characteristics-based matching approach assumes that equity risk is captured by an observable set of firm-specific characteristics such as size, book-to-market, and stock price momentum. Second, IPOs differ from other similar matching firms only in that they experience IPO. The researches implicitly assume that matching firms perfectly proxy for the expected return on an offering. However, IPOs are unlikely to be random event, there is possibility that IPO and non-issuing firms differ systematically in their expected return despite of the matching on certain firm characteristics. This makes matching on expected returns susceptible to joint test problem. Even if abnormal returns are found, we cannot make sure the source is from the status as IPOs.

2.3.1.2 Multi-factor model

Capital Asset pricing model (CAPM) is widely used as a typical benchmarki to argue against market efficiency in many empirical studies. It is developed by Sharpe (1964), Lintner (1965), and Mossin (1966). CAPM shows a linear relation between systematic risk and expected return. The compensation over risk-free return is only from extra systematic risk, expressed by beta:

$$r_{pt} - r_{ft} = a + b(r_{mt} - r_{ft}) + e_{pt} \qquad \text{(Equation 2.1)}$$

Nevertheless, normative asset pricing models such as CAPM suffer from incompetence in little ability to explain the cross-section of stock returns. The deficiency of this problem is confirmed by Brav et al. (2000) in tests of long-run performance of equity issuers. The search for a better model is always under the way and culminates in Fama-French (1993) three-factor model, further modified by Carhart (1997) to incorporate the momentum factor. Recent work by Fama and French (1992, 1993, 1995, and 1996) indicates that a three-factor model may explain the time series of stock returns. Fama and French (1993) three-factor model is a parsimonious model for sock returns taking the form

$$r_{pt} - r_{ft} = a + b(r_{mt} - r_{ft}) + cSMB_t + dHML_t + e_{pt} \quad \text{(Equation 2.2)}$$

where (r_{mt}-r_{ft}) is the market factor, constructed by subtracting the T-bill return from the value-weighted market return. SMB (small minus big) is the size factor, the return on a zero investment portfolio formed by subtracting the return on a large firm portfolio from the return on a small firm portfolio. HML (value minus growth) is the book-to-market factor, the return on a zero investment portfolio calculated as the return on a portfolio of high book-to-market stocks minus the return on a portfolio of low book-to-market stocks. Intercept *a* is indicator of average monthly adjusted performance of IPOs. The intercepts in these regressions have an interpretation analogous to Jensen's alpha in the CAPM framework. Chan et al. (1996) suggest momentum anomaly[8] is market efficiency due to slow reaction to information and this effect is robust to time-periods and countries. Corresponding to the argument, Carhart (1997) add the momentum factor which is supposed to be related to expected return of firms.

$$r_{pt} - r_{ft} = a + b(r_{mt} - r_{ft}) + sSMB_t + hHML_t + mUMD_t + e_{pt} \quad \text{(Equation 2.3)}$$

where *UMD* is momentum factor, constructed as equal weight average of firms with the highest thirty percent eleven-month returns lagged one month minus the equal weight average of firms with the lowest thirty percent eleven-month returns lagged one month. However, since asset pricing theory provides little guidance on how to construct factors that price the systematic risk, model misspecification problem remains. Model misspecification refers to the problem that measured underperformance is likely driven by benchmark models that misprice certain classes of stocks including IPOs. Fama (1998) states that all models of expected returns are incomplete descriptions of systematic variations of expected returns across firms. For example, CAPM is incompetent in capturing the expected return for small stocks (Banz, 1981). If the IPO firms are titled towards small size, it is more likely to produce spurious abnormal returns. Brav et al. (2000) provide the new evidence on model misspecification. They take the alternative approach that examines robustness of IPO underperformance, permitting directly showing the existence of model

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8 Refer to the finding that persistence in mutual fund performance over short-term horizons of one to three years

misspecification. Specifically, they replace the book-to-market mimicking portfolio HML with an alternative zero investment portfolio HML*. The construction of HML* guarantees a focus on book-to-market effect while excluding any other exposure by subtracting the average return from two tails of the book-to-market distribution of stocks in Amex and Nasdaq. Although same factor regression analyses are conducted as previous one with original HML, the intercept for IPO portfolios becomes insignificant economically and statistically. In other words, alternative model to Fama-French's (1993) three factor model substantially increases the pricing ability and eliminate underperformance to some extent. The new factor model supports the hypothesis that model misspecification causes measured underperformance. The knotty aspect of model misspecification is that it cannot be rejected unless a clear alternative hypothesis is available. Hence, our ability to detect true underlying pricing errors is limited.

One approach to limit model misspecification is to adopt firm-specific models for expected return instead of formal asset pricing models. Market model used by Fama et al. (1969) and Masulis's (1980) comparison period approach are such examples of which expected return is estimated without constraining the cross-section of expected return.

In the analysis of long-term performance of IPOs, an appropriate risk adjustment is critical for calculating accurate abnormal return. Unlike short-horizon tests, in which risk adjustment is straightforward and unimportant, small errors in risk adjustment can result in a different picture within long-horizon. IPO tends to be found smaller and lower book-to-market compared to average firms in stock exchange. Furthermore, it is found that the event sample firms with extreme characteristics (e.g., small market capitalization stocks, or low book-to-market stocks) suffer more from the risk adjustment errors in long horizon study. The historical risk estimate is severally biased and therefore risk should be estimated in post-event period (Ball and Kothari, 1989; Chan, 1988; Ball et al., 1995; Chopra et al., 1992). "However, how the post-event risk should be estimated is itself a subject of considerable debate …" (Kothari and Warner, 2007)

Brav et al. (2000) state post issue long-run poor stock returns are not unique. Non-issuing firms with similar size and book-to-market ratio share similar returns. The general solution researchers take in is to adopt various benchmarks with respect to the robustness of IPOs long-term performance. However, Hirshleifer (2001) document that the argument that post-IPO underperformance is eliminated by an appropriate benchmark is counterintuitive, because it emerges that IPO firms have usually low risk.

2.3.1.3 Propensity score matching approach

The standard approach to construct a model of benchmark return is to match offering firms with a non-offering firm several characteristics including size, book-to-market, past returns, and perhaps industry. Nevertheless, issuing stocks is an endogenous choice for the firm. There are important factors, other than the factors mentioned above. This will fall into difficulties when we find more dimensions that are concerned with expected return of firms. Propensity score (PS) based matching methods are potentially useful alternatives in this scenario. Firms are matched based on the probability of issuing stocks. Two recent papers, Cheng (2003) and Li and Zhao (2006), use PS methods to reexamine the long-term performance of SEOs. Both papers find that while characteristic-based matching yield significant long-term abnormal returns after SEOs, abnormal returns are insignificant if propensity score based matching method is adopted.

Cheng (2003) investigates US SEOs offered between 1970 and 1997 for which necessary COMPUSTAT data are available on firm characteristics. She finds significant buy-and-hold abnormal returns ranging from -6 percent to -14 percent over three to five years in full sample and sub-samples when matches are based on size, industry and book-to-market. She then uses three logit models, one for each decade, to predict the probability of issuance. Several firm characteristics such as size, book-to-market, industry, R&D, exchange, and 11-month past returns are used to predict the issuance decision. Cheng matches each issuer with a non-issuer in the SEO year with the closest propensity score (i.e., predicted probability). She finds little evidence of significant abnormal returns expect for one sub-sample in the 1970s and conclude that sufficient matching can explain away the underperformance of equity issuers.

Li and Zhao (2006) undertake a research similar to that in Cheng (2003) for issuers from 1986 to 1997. They show that characteristic-based matching is inadequate match between issuers and non-issuers in terms of average size. They estimate propensity scores with size, book-to-market, and past returns in three quarters prior to issuance, one model per year, and add interaction terms for better predictions and delete firms as necessary to have a common support. In their final sample, conventional matching results in average three-year buy-and-hold abnormal returns of -16 percent, but this drops to an insignificant -4 percent with PS matching.

Cheng (2003) and Li and Zhao (2006) emphasize that PS methods are merely substitutes for characteristic-based approach. The main issue of PS application is the data driven nature of the confirmation in fitting probit models. Characteristics and interaction terms are added to achieve balance in characteristics and propensity scores. While we recognize that a reasonable probit model seems necessary to place faith in treatment effect estimates, the search required to achieve balance, however transparent, nevertheless raises data dredging concerns and even inconsistency of estimates (Heckman and Navarro-Lozano, 2004). The general use of PS methods in studies of long-term stock return as an alternative to methods studies in Barber and Lyon (1997), Lyon et al. (1999), and Kothari and Warner (1997) remains an open question.

2.3.2 Abnormal performance measurement

Barber and Lyon (1997), Lyon et al. (1999), and Kothari and Warner (1997) provide comprehensive evidence on various methods of measuring abnormal returns. There is no consensus on which method is always preferred. Measurements could be divided into two groups based on event-time framework or calendar-time framework (Fama, 1998; Eckbo, Masulio, and Norli, 2000; Mitchell and Stafford, 2000). The two most frequently used measurements in event-time framework are buy-and-hold abnormal returns and cumulative abnormal returns. In calendar time framework, the intercepts of the benchmark model is indictor of average abnormal returns.

2.3.2.1 Buy-and-hold average abnormal returns (BHARs)

Beginning with Ritter (1991), the most popular estimator of long-term abnormal performance is the mean buy-and-hold abnormal return, BHAR. Mitchell and Stafford (2000, p 296) describe BHAR returns as "the average multiyear return from a strategy of investing in all firms that complete an event and selling at the end of a pre-specified holding period versus a comparable strategy using otherwise similar nonevent firms". There are two methods to estimate the buy-and-hold returns for benchmark (matching firms, reference portfolio, or market index). First, in each month we can calculate the mean return for each portfolio and then compound this mean return over t month, which could be expressed as follows:

$$BHR = \prod_{t=s}^{s+T}\left[1+\frac{\sum_{i=1}^{n_t} R_{it}}{n_t}\right]-1 \qquad \text{(Equation 2.4)}$$

where s is the beginning period, T is the holding period, R_{it} is the return of stock i in month t, and n_t is the number of observations in month t.

The second method of calculating buy-and-hold returns involves first compounding the returns on individual stocks constituting the portfolio and then summing across securities:

$$BHR = \sum_{i=1}^{n_s} \frac{\left[\prod_{t=s}^{s+T}(1+R_{it})\right]-1}{n_s} \qquad \text{(Equation 2.5)}$$

where n_s is the number of observations in month s, the beginning month for return calculation. Lyon et al. (1999) prefer the second method. First method changes portfolio composition each month. The rebalancing could lead to upward biased long-run returns[9]. Additionally, if first method is used on benchmark returns, benchmark will include firms that being listed after the portfolio formation. Since Brav and Gompers (1997) document the poor performance mainly comes from small and high-growth firms and IPOs are found to have these characteristics compared to average stocks, inclusion of IPOs in the benchmark returns will lead to downward biased estimate of long-term returns.

Barber and Lyon (1997) support for BHAR in that it preciously measures investor experience. However, Barber and Lyon (1997) and Kothari and Warner (1997) also show that commonly used methods of calculating long-run abnormal return are

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[9] See Blume and Stambaugh, 1983; Roll, 1983; Conrad and Kaul, 1993; and Ball et al., 1995

subject to misspecified test statistics. These biases mainly arise from new listing, rebalancing of benchmark portfolios, and skewness of multiyear abnormal returns. The solutions include carefully constructing reference portfolio so as to make sure population mean abnormal return zero and conducting inference via either a bootstrapped skewness-adjusted t-statistic or the empirically generated distribution of mean long-run abnormal stock returns from pseudo-portfolios (Lyon et al., 1999). Nevertheless, BHAR is unable to control for cross-section among sample firms and poorly specified asset pricing model. Furthermore, because of its compounding effect for return error in shorter time intervals, it is more sensitive to model misspecification problem. Fama (1998) argue against the BHAR methodology partly because of that. He also points out methodology that neglects the cross-sectional dependence of abnormal returns that has overlapping in time series is likely to overestimate test statistics. Based on this, he strongly advocates a monthly calendar time portfolio approach for measuring long-term abnormal returns.

2.3.2.2 Cumulative average abnormal return (CAARs)

Buy-and-hold abnormal returns are included if researchers' interest is on whether sample firms earn an abnormal return over the concerned horizon. But when the question comes to whether sample firms persistently earn abnormal monthly returns, we use cumulative abnormal returns. The *T* month cumulative abnormal return from firm *i* beginning in period *s* is calculated as:

$$CAR_{iT} = \sum_{t=s}^{s+T} (R_{it} - R_{Bt}) \qquad \text{(Equation 2.6)}$$

where R_{it} is the simple monthly return for sample firm i, R_{Bt} is the monthly return of benchmark. Cumulative monthly abnormal returns are less skewed and therefore less problematic statistically. A greater knowledge of the distribution properties and statistical tests are known for this metric. Unlike buy and hold abnormal returns, cumulative abnormal returns have well specified conventional t-statistics as long as reference portfolios are free of new listing and survivor bias since cumulative abnormal returns are less skewed. Fama (1998) recommends using cumulative abnormal return (CAR) as well since it less likely rejects the hypothesis of market efficient compared to BHAR. A criticism of the AAR or CAR approach is that an average monthly return does not accurately measure the return to an investor holding a security for a long post-IPO period. Long-term investor experience is better captured by compounding short-term returns.

2.3.2.3 Calendar time portfolio approach

To address the problem of cross-sectional correlation suffered by BHAR and CAR in event time framework, calendar time portfolio approach is examined. Average abnormal return of an event portfolio calculated each calendar month tracks the performance relative to an explicit asset pricing model or benchmark portfolio. The event portfolio is updated each period to include all companies that have completed the event within the prior n periods. Fama (1998) recommends using calendar-time portfolio techniques initiated by Jaffe (1974) and Mandelker (1974) and developed by Fama and French (1993). Firstly, shorter intervals return is less vulnerable to model misspecification problem, imperfect expected return proxies. Secondly, cross-section among sample firms can be accounted for in the portfolio variance. Thirdly, the distribution of this estimator is better approximated by the normal distribution, allowing for classical statistical inference. Fama (1998) and Mitchell and Stafford (2000) also provide the argument that measures of abnormal performance such as cumulative abnormal returns (CARs) and intercepts of time-series regressions are less likely to get spurious abnormal return than measures by buy-and-hold abnormal returns (BHARs) because they eliminate the compounding effect of a single month's poor performance. However, Loughran and Ritter (2000) argue against using the calendar-time portfolio approach because they allege it might be biased toward finding results consistent with market efficiency and lacked power to detect abnormal performance. Loughran and Ritter (2000, p 362) dictate: "If there are time-varying misevaluations that firms capitalize on by taking some action (a supply response), there will be more events involving larger misevaluations in some periods than in others… In general, test that weighs firms equally should have more power than tests that weigh each time period equally". Intercept is the indicator of abnormal return in calendar time portfolio approach which weighs each time period equally and is hard to notice abnormal returns when heavy IPO activities occurred in certain period.

Lyon et al. (1999) adopt and suggest using both approaches (BHAR and calendar time portfolio) in analyzing long-term abnormal returns because both offer advantages and disadvantages that supplement each other. The innovation in buy-and-hold abnormal returns approach lays in the new test statistics which can eliminate skewness bias in random samples. Through careful constructing reference portfolio, the new listing and rebalancing biases can also be expunged. Furthermore, abnormal return measure accurately captures experience of investors. However, they don't work well in non-random samples and cannot address cross-sectional dependence and bad model problem. The calendar time portfolio approach controls well for the cross-sectional dependence but is still sensitive to the bad model problem. Their drawback is that it cannot precisely measure investor experience. Their main conclusion is that "analysis of long-run abnormal returns is treacherous".

The traditional calendar time portfolio approach constitutes two-step procedure. The first step is to calculate the average return for the cross-section of firms and the second step then measures the risk-adjusted performance by estimating a multi-factor time series regression model. Because the traditional calendar time portfolio approach cannot capture the continuous and multi-factor firm characteristics, researches have been improved to switch to cross-section regressions on the firm level. The ordering of this alternative approach is reversed. Thus, the first step involves the estimating a Fama and French (1993) type multifactor model for each single firm and second step then decomposes the risk-adjusted performance of each IPO by regressing alphas from the parameters obtained from the first step. However, the second procedure of the cross-sectional regression approach implicitly assumes that individual firms are cross-sectionally uncorrelated. This assumption cannot be validated given the hot market hypothesis. There is a danger of producing severely biased statistical results because of ignoring cross-sectional dependence in the data. The alternative model can substitute the dichotomous variable for a continuous variable and also possibly add control variables to the regression and to perform robustness checks. Under the theoretical framework, Hoechle et al. (2009) propose Generalization Calendar Time (GCT) regression model which condenses two steps into one. They rely on a linear regression model with Driscoll and Kraay (1998) standard errors. Although coefficient estimates of cross regression methodology is identical to that of GCT-regression model, the standard errors and t-statistics of the cross regression methodology cannot be adjusted such that they are robust to cross-sectional dependence in the data. The standard errors and t-statistics of the cross regression approach are different from those of the GCT-regression model. By separating estimating procedure into two steps, the cross regression approach abandons valuable information which guarantees the validity of statistical results. To the country, the information advantage enables the GCT-regression model to produce standard error estimates that are robust to very general forms of cross-sectional and temporal dependence. GCT-regression model resolves or at least mitigates several weakness of the calendar time portfolio methodology. By estimating the model with ordinary least squares (OLS), all observations are equally weighted. By describing firm characteristics with continuous and multivariate variables the GCT-model regression model also provides a potential solution to the misspecification issue in non-random sample.

2.3.3 Biases and solutions for testing long-run abnormal returns

Although the magnitude of underperformance found in IPO literature is non-trivial, more recent long-term event-study empirical papers evaluate methodologies for evaluating long-run abnormal performance. Barber and Lyon (1997), Kothari and Warner (1997) and others doubt on the reliability of test statistics used in previous papers. Unbiased standard errors for the distribution of IPO long-term abnormal returns are not easy to estimate. Inferences on long-term abnormal returns are difficult to obtain. Lyon et al. (1999) summarize misspecification of test statistics to five sources: "(1) the new listing or survivor bias, inclusion of new firms in the reference portfolio subject to event month will make the benchmark not reliable adequate enough to compare to sample firms, (2) the rebalancing bias, caused by the fact that reference portfolio rebalancing periodically (generally monthly) while sample firms compounding without rebalancing, (3) the skewness bias, a result of positively skewed distribution of long-run abnormal returns, (4) cross-sectional dependence due to overlapping returns on sample firms in calculation, (5) a bad model of asset pricing. Additionally, there are another two causes. Firstly, long-horizon abnormal returns depart from the normality assumption that underlies conventional t statistical test. Secondly, volatility of the IPO offerings will exceed that of matched firms because of event-induced volatility. (Kothari and Warner, 2007) Therefore, remedy for misspecified test statistics is used to overcome the problems mentioned above.

2.3.3.1 Benchmark Portfolio bias

Loughran and Ritter (2000) argue that if benchmarks are used that contains many sample firms, the test is biased towards high explanatory power and no abnormal returns. The most powerful test should use a benchmark that is constructed to have none of the sample firms as part of benchmark. An unbiased reference portfolio is of great importance as sources of misspecification are mostly related to benchmark. To avoid or alleviate new listing bias and rebalancing biases, Lyon et al. (1999) not only choose correct method to calculate buy-and-hold returns, but also recommend carefully constructed reference portfolios. Their reference portfolios are formed based on firm size and book-to-market ratios in July of each year. This method could be extended to construction of reference portfolios based on other firm characteristics (e.g., prior return performance, sales growth, industry, earnings yields).

2.3.3.2 Skewness bias

For mean buy-and-hold abnormal return as measurement, concern arises from right skewness of individual-firm long-horizon returns (even after adjusting for the performance of a matched firm/portfolio) which restrains the use of standard statistical function. The source of skewness is not difficult to understand as the lower bound of abnormal returns is -100 percent and upper bound is unlimited. Papers documented by Brav et al. (2000) and Mitchell and Stafford (2000) find skewness distribution appears to be due to lack of independence by overlapping return observations. From this perspective, the right skewness abnormal return distribution is partly a byproduct of cross-section, not consequence of skewed individual firm's return. Fortunately, problems caused by skewness bias in test statistics decline with increase in sample size which often can be satisfied. The sample size in post-IPO long-horizon abnormal return is often several hundred or thousand. If BHAR observations are truly independent, the central limit theorem's implication that "the sum of a large number of independent random variables has a distribution that is approximately normal" could apply. Even so, Ikenberry et al. (1995) introduced a bootstrapping procedure for addressing skewness problem. They generate empirical distribution of mean long-run abnormal stock returns by creating a pseudo-portfolio with similar event time, size and book-to-market characteristics and then calculate buy-and-hold abnormal return for one pseudo-portfolio. This randomly selecting procedure will be repeated many times (1000, 5000) and their average abnormal return will proxy empirical distribution of mean long-term abnormal return. That's the solution for portfolio benchmark approach. If the benchmark is matching firm based on size and book-to-market, skewness can be eliminated (Barber and Lyon, 1997).

2.3.3.3 Cross-correlation bias

Lyon et al. (1999) evaluate various statistical tests for long-term performance. They recommend using either a bootstrapped skewness-adjusted t-statistic or the empirically generated distribution of mean long abnormal returns from pseudo-portfolios. The former statistic adjusts the usual t-static by two terms that are a function of the skewness of the distribution of abnormal returns. Despite of skewness adjustment, the skewness-adjusted t-statistic still indicates over-rejection of null hypothesis. Both Sutton (1993) and Lyon et al. (1999) think they need bootstrapped application of this skewness-adjusted test statistic. Bootstrapping the test statistic involves drawing voluminous resample from the original sample. The skewness-adjusted t-statistic is calculated from each of resamples and the critical value is obtained from empirical distribution of transformed t-statistic. Many recent papers on long-term stock performance follow their suggestions. The pseudo-portfolio-based statistical tests generate the empirical distribution of long-run abnormal stock returns. These abnormal returns are constructed using repeatedly-sampled pseudo-portfolios. Samples are based on characteristics thought to be correlated with the expected rate of return. Following Fama and French (1993) three-factor model, matching on size and book-to-market as expected return determinants is quite common. For each matched-sample portfolio, an average buy-and-hold abnormal return is calculated as the raw return minus the benchmark portfolio returns. This distribution yields empirical 5 and 95 percent cur-off probabilities against which the event-firm sample's performance is calibrated to infer whether or not the event-time portfolio buy-and-hold abnormal return is statistically significant. Paper by Lyon et al. (1999) is flawed by incompetent statistical inference in non-random samples and where cross-correlation is severe. This problem is put forward by Mitchell and Stafford (2000) who account for positive cross-correlations of event-firm abnormal return and produce little evidence of long-term abnormal return. Although their samples are restricted to SEO, mergers and share repurchases, the dependence of major corporate events, including IPOs, is prevalent. For example, IPO offerings are concentrated on hot issue period when offerings are more likely to be overvalued.

Bayeasian approach advocated by Brav (2000) does not suffer from the problems of non-normality and cross-correlation of abnormal returns among sample firms. This model begins with a subjective prior belief regarding model parameters. These beliefs reflect researchers' knowledge about parameters of interest conditional on model and the data. The methodology takes as given an asset-pricing model and distribution for firm residual variation and uses these to simulate the predictive distribution of the long-horizon average abnormal return. Using a large sample of 1521 companies, the distribution of average abnormal returns is proved to be non-normal. Moreover, residual variability and cross-correlation make a great difference on the inference. This also indicates that methods which do not control for these statistical characteristics yield erroneous statistics. This method could be extended to allow for time variation in factor loadings (e.g., Shanken, 1990) and also for various forms of heteroskedasticity and time variation in the common correlation of the assets under study.

Lyon et al.'s (1999) recommendation is misspecified in nonrandom samples. An important reason for misspecification is that approach by Lyon et al. (1999) assumes that sample returns are cross-sectional uncorrelated, which is violated in non-random samples such as IPOs. In fact, because of positive correlation, the variability of test statistics is larger than in random samples. Using critical value by simulation, the tests will reject the null hypothesis of no abnormal returns too often (type I error). Furthermore, the replacement of original sample firms implies an assumption that two samples are similar in every dimension, but not limited to, expected returns. This is unlikely because if two samples have systematically different residual variations, resulting empirical distribution will be biased (Brav, 2000). Jegadeesh and Karceski (2004) propose t-statistics that are well-specified in nonrandom samples. Their nonrandom samples refer to industry-clustered observations or returns are overlapping. They make some adjustments based on Hansen and Hodrick (1980) standard error, allowing for heteroskedasticity, autocorrelation, and different weights across observations. They evaluate the performance of tests in both scenarios (samples with concentrated industry distribution and overlapping returns). Their empirical results demonstrate the level of misspecification is fairly small. The improved specification of the tests with less restrictive assumption comes at a cost – loss of power. One shortcoming is that the approach proposed is less powerful than the conventional t-statistic in nonrandom samples. Since many characteristics shared by different stocks are not readily observable, it is hard to assume major corporate events, such as IPOs, random selected. Therefore, in future work, they recommend their proposed test methodologies when assessing long-run performance.

2.3.4 Weighting scheme

Loughran and Ritter (2000) argue that the calendar time portfolio approach has low power to detect abnormal returns for events that occur because of behavioral timing (windows of opportunity). The power refers to the probability of rejecting null hypothesis when the hypothesis is false. The inability of finding abnormal returns is more severe when value weighted portfolio return is used. Loughran and Ritter provide two reasons associated with weighting scheme to explain the pattern[10].

If there is time-varying misevaluation of going public, there would be more new issuing with larger misevaluation in some periods than others. Their evidences (Loughran and Ritter, 2000, table 5-7) display abnormal returns difference between periods of high activity and periods of low activity. The regression will average these and tend to less likely to find abnormal performance. The abnormal return in hot period is hardly to be detected by calendar time portfolio approach. In general, tests that weight firms equally should have more power than tests that weight each time period equally[11]. Also, we have a weight choice on portfolio return. If underperformance is more concentrated on small firms than big firms, tests that weight firms equally should find greater abnormal returns than tests that weight firms by market capitalization[12]. Value-weighted portfolios can also have larger variance of returns because in some periods a single firm is a large proportion of the portfolio and therefore the unique risk cannot be diversified away. The lower power of detecting

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10 The third reason is related to benchmark contamination.

11 For example, in Loughran and Ritter (1995, Table I and II), the five-year wealth relative for initial public offerings is 0.70 when each firm is weighted equally, but 0.79 when each of the 21 cohort years are weighted equally. For seasoned equity offerings, the five-year wealth relative is 0.69 weighting each firm equally, but 0.76 when each of the 21 cohort year is weighted equally. A wealth relative of 1.00 represents no abnormal performance.

12 See Grav and Gompers, 1997; Brav et al., 2000; Mitchell and Stafford, 2000

abnormal returns from value weight is also demonstrated in large standard errors and low t-statistics.

However, the less likelihood underperformance from value weight does not indicate we should always adopt equal weight scheme. If one is trying to measure abnormal returns on a value-weighted portfolio with equal amount of money invested in each time period, it is appropriate to value weight returns and equally weight time periods. But if the purpose is to measure abnormal returns on the average firm undergoing some event, each firm should be weighted equally. In other words, the traditional event study approach in which all observations are equally weighted will produce exact estimate that are relevant from different perspectives. Fama (1998) points out that weighted scheme should be determined by the economic hypothesis of interest.

Chapter 3 Long-term UK IPOs performance test, evidence from two Databases

3.1 Introduction

The chapter investigates the long-run performance of UK Initial Public Offerings (IPOs). We use two databases to assess the performance over three- and five-years after listing. Although long-term underperformance of IPOs is prevalent in US (Ritter, 1991; Loughran and Ritter), the international evidence is still controversial. Our paper aims to provide additional evidence using a recent UK sample. There is another reason motivating us to undertake the research. Access to both DataStream (DS) and London Share Price Data (LSPD) enables us to have alternative data source instead of one. Although most prior UK studies (Levis, 1993; Espenlaub et al., 2000) use the LSPD, DS also provides stock and market price information. There's no previous UK study indicating which database tends to produce long-run underperformance results. We are also interested to test whether post-issue long-term underperformance is sample specific phenomenon since no evidence showing our sample is comprehensive in the study period.

With the success of AIM introduced in 1995, more attention has been paid to the UK equity market again. More companies choose to be listed via AIM rather than official list (OL). The most influential papers in UK include Levis (1993) and Espenlaub et al. (2000). However, their samples (IPOs) terminate at 1988 and 1992 respectively, by which time AIM has not set up yet. Whether the establishment of this fast growing listing market impacts the long-term performance in general is a question that has not yet been fully explored.

Both Levis[13] (1993) and Espenlaub et al. (2000) use LSPD as their data sources in the analysis of long-term performance. The advantage of using LSPD over DS is that monthly equity returns include dividend going ex during certain month and are adjusted for rights and scrip issues. Additionally, monthly market value is readily available from LSPD. However, DS can also provide returns and market value information. The frequency could even be daily. This is of great importance for studies on short-term analysis. Use of DS information can provide us a new perspective of importance of dividend adjustment in calculating returns.

The remaining of the chapter is organized as follows. Section 3.2 presents more literature on the long-term IPO stock performance. Section 3.3 describes data and methodology. Section 3.4 presents the results and Section 3.5 concludes.

3.2 Relevant literature and hypotheses

Studies for the US such as Ritter (1991) and Loughran and Ritter (1995), report that IPOs experience significant poor performance in the first three to five years after listing. They also illustrate that value-weighted event-time buy-and-hold abnormal returns are prone to produce underperformance. On the other hand, either equal-weighted buy-and-hold returns or cumulative abnormal returns tend to reduce the magnitude of underperformance. We are also interested in the international evidence of IPOs anomaly. The international evidence on the long-term post-issue IPO stock performance has mixed results. Lee et al. (1996) find that Australian IPOs

[13] Levis collects the end of first trading day price and last first trading month price. However, it is not used in calculating long-term performance.

exhibit severe underperformance in the long run, while Da Silva Rosa et al. (2003) find no evidence of underperformance in the post-issue two years in Australia. Paudyal et al. (1998) also cannot find evidence of differential performance between IPOs and the market portfolio in Malaysia. Kiymaz (2000) even report Turkish IPOs outperform the market in the long-run during the 1990-1995. Therefore, the international evidence of long-run IPO performance is far from a consensus.

On the other hand, various methods of measuring abnormal performance have been discussed in the literature (Barber and Lyon, 1997; Kothari and Warner, 1997; and Lyon et al., 1999). Parametric test statistics are found to be subject to misspecification because they do not satisfy the assumptions of zero mean and unit normality. They recommend nonparametric or bootstrapping procedures as a means of reducing misspecification. As noted by Loughran and Ritter (1995), Eckbo et al. (2000) and Gompers and Lerner (2003), among others, the results of long run performance studies may differ as a result of differences in the method used to measure abnormal returns. For example, Gompers and Lerner (2003) find underperformance when event time buy-and-hold abnormal returns are used. The underperformance disappears when cumulative abnormal returns are used. The intercepts in CAPM and Fama-French three-factor regressions even suggest outperformance.

Levis (1993) first reports UK IPOs from 1980 to 1988 underperform a number of relevant benchmarks in the 36 months following the first day of trading. Espenlaub et al. (2000) add further evidence on the of long run performance in UK. Using data on

588 IPO companies over the period 1985 to 1992, they document abnormal performance based on five alternative benchmarks using both an event-time approach and a calendar-time approach. They find substantial negative abnormal returns three years after the offerings irrespective of the benchmark employed in their event-time approach. However, over a five year period the underperformance is less dramatic and depends upon the benchmark applied; when returns are measured in calendar time there is even less evidence of underperformance. Goergen et al. (2007) also conduct research on long-run performance of UK IPOs. They also find IPOs underperform similar non-issuing firms. Additionally, quality of the firm is found to have significantly positive influence on its performance after the IPO. The cross-sectional and time-series pattern of long run IPO performance has been examined by several researchers. Loughran and Ritter (1995) report the degree of underperformance by issuing companies varies over time. They find that IPOs occurring in years when there are little issuing activities do not exhibit significant underperformance, while companies being listed during high volume periods of selling new issues severely underperform. In their analysis of Japanese IPOs, Hwang and Jayaraman (1995) observe no differences in abnormal returns across industries for their IPO and non-IPO groups. However, Cai and Wei (1997) find that Japanese issuing companies underperform size-matched non-issuing companies in most industries. Ritter (1991) finds that US IPOs display long run underperformance, with a tendency for the smaller offers to have the worst aftermarket performance. He also reports that

companies which have the highest mean initial returns also have the poorest long run returns, consistent with the “fad” hypothesis of Aggarwal and Rivoli (1990) or the “over reaction” hypothesis from De Bondt and Thaler (1985).

Thus, based on foregoing theoretical and empirical literature concerning long-term post-IPO stock performance, our study proposes three promising research ideas. First, there is need to add another empirical evidence on UK IPO market since the establishment and success of AIM. Second, determinants of long-term performance should be examined as well. We try to test different hypothesis in explaining the found pattern. Thirdly, two-stage strategy is fresh; especially its effect on long-term performance has not been examined before.

3.3 Data and Methodology

3.3.1 Data description

In this section, we outline our sample selection procedure and describe out data sources. Our sample consists of IPOs on the LSE between January 1981 and December 2000. The original IPO list is provided by my supervisor Professor Ranko Jelic. The other information including sample monthly returns, initial market capitalization are collected from both databases (DS and LSPD). LSPD is set up in October 1972 and has developed into the most comprehensive share price database for UK market. DS is more comprehensive in terms of geographical coverage, with covering over 64 markets. However, in terms of UK market, there’s no comparison about which provides more accurate and comprehensive information. Table 3-1 provides us more detailed information of variables which are used in this paper. Return file from LSPD includes dividend, which is adjusted to a month-end basis. The return data from DS is calculated from price data provided by DS. Additionally, both adjusted (dividend included) and unadjusted (dividend excluded) prices are available in DS. In terms of market value, the two datasets have same definition, representing the market value of ordinary shares. For the companies having more than one class of equity capital, the market value only includes ordinary shares.

Before commencing sample description, it is important that we have a general picture about two datasets. Therefore, we compare the coverage and related information between LSPD and DS.

[Insert table 3-1about here]

Table 3-1 compares DS with LSPD in terms of coverage and key variables. LSPD is the most comprehensive database focusing on UK equity market. Before 1974, it covers a random of 33 percent of companies quoted in LSE. Since 1975, it includes complete history of all UK companies. On the other hand, DS includes 1832 companies, with price history starting from 1965. Next, their data resources are different as well. LSPD obtains the information from stock exchange daily official list, the financial times, and Extel's EXSHARE service. DS indicates that data is from exchanges, leading international and local supplies, and published reports. On the return information, DS appears to be more flexible, with both unadjusted and adjusted price available. LSPD provides the adjusted price and returns. The last key variable is market value, with both dataset having ready information about ordinary shares' capitalization. The advantage of DS over LSPD is that the return and market value information is available at daily frequency. The corresponding information is available at monthly frequency in LSPD. However, we use monthly return information which makes two datasets comparable in the aspect.

[Insert table 3-2 about here]

Table 3-2 displays the procedure from original population to the final sample. We hand collect the mnemonic from DS, based on which sample price and market value is collected. In this procedure, 25 firms have been excluded because issuance date is beyond the sample period. These firms are distributed either before 1981 or after 2000, with only one or two observations one year. Furthermore, 80 companies are removed since corresponding mnemonic could not be found. In addition, we try to find corresponding identification (G1). G1 is the company number in LSPD, a unique identification number, allocated in a sequence from 1, for all British registered companies quoted on London Stock Exchange since 1955. This number was allocated to overcome the problem of changing SEDOL numbers. 58 IPOs are eliminated due to either one IPO takes place at different months between DS and LSPD or the company names could not be found from LSPD. Furthermore, we require that market capitalisation data of issue month must be available in both databases which results in a further loss of 99 IPOs. The requirement for initial market value is for a comparable value weight scheme. We are left with a sample of 819 IPOs from 1981 to 2000.

We collect daily price and market value from DS. These data provides monthly returns and initial market value. DS provides adjusted (dividend included) and unadjusted (dividend excluded) price history, which enables us to assess the impact of dividend on IPO returns. Monthly returns are calculated as the difference of share price between two consecutive month ends divided by last month end price. Monthly return and market value information is readily available from LSPD at monthly frequency. Return file in LSPD provides natural logarithmic returns for each sample. However, discrete returns are used throughout the paper to avoid any downward bias in returns caused by Jensen's inequality[14]. Furthermore, the conversion is to be consistent with counterparts in DS. 336 IPOs have 2578 missing monthly returns in LSPD due to short trading suspension or unavailable beginning trading data. We replace all these missing data with zero because there is no trading activity in suspension period. Also, investors could not be able to sell such stocks just before a suspension, which is likely to be unexpected. The return measurement starts from the beginning of the second post-issue month (first complete trading month). The first partial issuance month is excluded to allow for underpricing and possibility of price support in the first few trading days. Table 3-3 shows year distribution of sample IPOs, with mean and median initial market capitalisation attached as well. The p-value of the difference between two datasets is also displayed each year. The table reveals that there is a time varying pattern in the number of IPOs. The increase of numbers since 1995 coincides with the opening of the AIM market. There is small

[14] The convex transformation of a mean is less than or equal to the mean after convex transformation.

discrepancy between two groups on mean and median initial market capitalisation. We conduct t-test to compare the mean and median of initial market value from two groups year by year and display p-value on the 5^{th} and 8^{th} columns. As we could see, mean and median difference in 1985 is significant at 95% and 99% confidence level. In general, the average initial market capitalisation of our sample IPOs is very close, with 125 million sterling from LSPD and 117 million sterling from DS.

[Insert table 3-3 about here]

We further find that two databases have various treatments on return histories. In DS, the price remains for the firm that has been delisted, reflected by monthly returns zero for last few consecutive event months. There are 356 IPOs with 8323 observations having zero returns in last consecutive months. The situation is much less severe in LSPD. The price usually terminate as long as the firm is delisted. There are only 240 IPOs with 801 such observations in LSPD. We drop all these observations. Otherwise, there would be spurious returns since the benchmark return are not zero in periods which the firm has been delisted. After this treatment, the total monthly return observations difference between two databases is only 716, smaller than 1 percent of total monthly observations.

From papers by Barber and Lyon (1997), Kothari and Warner (1997), Fama (1998), and Lyon et al. (1999), we learn that all methods calculating long-term abnormal return present some inconveniences. All methodologies are subject to different biases[15]. Therefore, we intend to use both cumulative average abnormal returns (CAAR) and buy-and-hold abnormal returns (BHAR) to evaluate the long-run performance in the event time framework. The cumulative abnormal return for a holding period of m month is computed by summing average monthly abnormal returns from the first complete trading month to the m month. The typical buy-and-hold strategy involves buying the stock in certain month, and holding for a time period. Therefore, returns will be compounded at regular intervals. In our case, abnormal buy-and-hold returns are buy-and-hold return difference between sample firms and benchmarks at monthly interval. If stocks are delisted before the post-issue 60 month, returns of those companies are supposed to be the average monthly return of the remaining sample. Liu and Strong (2008) replace the returns on de-listed firms by either zero or the risk-free rate. They find similar results in both cases. Lyon et al. (1999) and Mitchell and Stafford (2000) replace all de-listed firms returns with the benchmark returns, making their abnormal returns zero. In our paper, we adopt both replacements. For those firms which have been delisted but still remain in the databases, the return afterwards is calculated as zero since there is no price change. For those firms which have been delisted and removed from the sample, the company return is supposed to be the same as the benchmark return. It indicates investment strategy that allocates the proceeds average to the surviving firms.

[15] New listing bias, rebalancing bias, skewness bias, cross-sectional correlation, and bad model problem

3.3.2 Methodology

Three benchmarks will be used in this paper. These are the FTSE all share index (FTSE), the Capital Asset Pricing Model (CAPM), and the Fama-French three factor model (FF). Levis (1993) use FTA[16] as benchmark and Espenlaub et al. (2000) use the latter two models. The benchmark choice is restricted by limit of other information. FTSE all share index represents 98-99 percent of UK market capitalisation, and is the aggregation of the FTSE 100, FTSE 250 and FTSE Small Cap indices. [17] Therefore, FTSE all share index can generally indicate the performance of average stocks. However, Dimson and March (1986) state that if the composition of the sample firms differs from FTA in terms of company size, the adjusted returns based on market index will lead to misleading conclusion. That's the reason why we supplement with additional benchmarks. The Capital Asset Pricing Model is used as a standard measurement to quantify adjusted returns. Fama and French (1992) add that not only beta has an effect in explaining expected returns, but also size and book-to-market ratios have a role. The Fama-French three factor model has been developed by them in 1996 to capture these additional effects and is applied in our research. ε_{it} represents the abnormal return for company i at time t for each benchmarks.

Model 1: FTSE All Share Index

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[16] Financial Times Actuaries All Share Index (FTA), capitalization weighted index, representing about 650 stocks and embracing 90 percent of the UK stock market by value.

[17] The information is available from http://www.ftse.com/Indices/UK_Indices/index.jsp .

$$\varepsilon_{it} = R_{it} - R_{FTSE} \qquad \text{(Equation 3-1)}$$

where R_{it} is the return on company i in event month t, R_{FTSE} is the return on the FTSE All Share Index in corresponding month.

Model 2: CAPM

$$\varepsilon_{it} = R_{it} - [R_{ft} + \beta_i(R_{mt} - R_{ft})] \qquad \text{(Equation 3-2)}$$

where R_{it} is the return on company i in event month t, R_{mt} is the return on the market in event month t, measured by FTSE All share index monthly return, R_{ft} is the treasury bill return in event month t, β_i is the beta of company i, estimated by an OLS regression up to 60 months after the IPO.

Model 3: Fama-French three factor model

$$\varepsilon_{it} = R_{it} - [R_{ft} + \beta_i\left(R_{mt} - R_{ft}\right) + \gamma_i SMB_{it} + \delta_i HML_{it}] \qquad \text{(Equation 3-3)}$$

where R_{it} is return on company i in event month t, R_{mt} is the return on the market in event month t measured by FTSE All Share Index monthly return, β_i, γ_i, and δ_i are the coefficients of the factors (R_{mt}-R_{ft}), SMB and HML respectively. Those three coefficients are estimated using OLS regressions from the first full trading month to the post-issue 60th month or the delisting date, which takes place first. Fama-French factor model allows companies without size and/or book-to-market ratio in the sample. The inclusion could not be realized if benchmark is a matching firm based on size and/or book-to-market ratio.

The average benchmark-adjusted return on a portfolio of n stocks for specified time intervals is the arithmetic average (depending on the weighting scheme) of benchmark-adjusted returns. w_i is the weight of the company i and ar_{it} is the monthly abnormal returns for company i within t month:

$$AR_t = \sum_{i=1}^{n} w_i ar_{it} \quad \text{(Equation 3-4)}$$

The cumulative average abnormal return (CAAR) from event month 1 to event month s is the summation of the average benchmark-adjusted returns:

$$CAAR_s = \sum_{t=1}^{s} AR_t \quad \text{(Equation 3-5)}$$

When a firm in portfolio p is delisted before the 5^{th} year anniversary, the portfolio return from the next month is an equally-weighted average of the remaining firms in the portfolio. For the month in which the IPO firm is delisted, the return for that individual firm is vacant. We employ the method by Ritter (1991) to test the statistical significance of the calculated CAAR. The t-statistic for the CAAR in month t, $CAAR_t$ is computed as:

$$t(CAAR) = CAAR_t * \sqrt{n_t}/csd_t \quad \text{(Equation 3-6)}$$

where n_t is the number of companies trading in each month, and csd_t is computed as:

$$csd_t = [t * var + 2 * (t-1) * cov]^{1/2} \quad \text{(Equation 3-7)}$$

where t is the event month, var is the mean cross-sectional variance over 60 months, and cov is the first-order autocovariance of the AR_t series.

One problem with CAAR is that they do not represent an ex ante applicable investment (trading) strategy. In other words, they do not accurately measure the return to an investor who holds a security for a long post–event period. Buy-and-hold abnormal return which can capture investor experience by compounding short-term returns is reported by most empirical studies.

For the calculation of buy-and-hold average abnormal returns, the first step is to estimate the buy-and-hold abnormal return for individual IPO. A T-month buy-and-hold return (BHR) could be in the expression of:

$$BHR_i = \prod_{t=1}^{T}(1 + R_{it}) - 1 \quad \text{(Equation 3-8)}$$

where R_{it} denotes the monthly return of IPO i or benchmark over month t. The holding period for stock i is either five years or the time until delisting, whichever comes first.

The abnormal or unexpected BHR (BHAR) is return difference between two:

$$BHAR = BHR_{IPO} - BHR_{Benchmark} \quad \text{(Equation 3-9)}$$

Where BHR_{IPO} is buy-and-hold returns for individual company and $BHR_{Benchmark}$ is corresponding returns for its benchmark.

Finally, the average BHAR over T-month for a sample of N IPOs could be expressed as:

$$\overline{BHAR}_T = \frac{1}{w_i}\sum_{i=1}^{N} BHAR_{iT} \quad \text{(Equation 3-10)}$$

w_i is IPO i's weight in forming the average holding-period return (w_i =1/N when equal-weighting). In short, our procedure to obtain average BHAR is first to estimate the individual BHAR and then average them at same time interval.

Besides estimating the magnitude of mean BHARs, we also need to test the statistical significance of the abnormal returns. To test the null hypotheses that the mean abnormal return is equal to zero for the sample of IPO firms, we employ the bootstrapped skewness-adjusted t-statistic, which is computed as:

$$t_{sa} = \sqrt{n}\left(S + \frac{1}{3}\hat{\gamma}S^2 + \frac{1}{6n}\hat{\gamma}\right) \qquad \text{(Equation 3-11)}$$

Where

$$S = \frac{\overline{BHAR}}{\sigma(BHAR_t)}, \quad \text{and } \hat{\gamma} = \frac{\sum_{i=1}^{n}(BHAR_{it} - \overline{BHAR_t})^3}{n\sigma(BHAR_t)^3}$$

where $\hat{\gamma}$ is the estimate of the coefficient of skewness and $\sqrt{n}S$ is the conventional t-statistic. The critical values applied to conventional t-statistics are not appropriate when the bootstrapped skewness-adjusted t-statistics are used. We draw 1000 resamples of size n (1/4 of original sample size), with replacement, from each return series and calculate a skewness-adjusted t –statistic for each sample. Critical values are rearranged and provide the cut offs at which a null hypothesis that average buy-and-hold abnormal returns are zero can be rejected for a significance level. These critical values are obtained by solving:

$$\Pr[t_{sa}^{b} \le x_{l}^{*}] = \Pr[t_{sa}^{b} \ge x_{u}^{*}] = \frac{\alpha}{2} \qquad \text{(Equation 3-12)}$$

where x_l is the critical lower value and x_u is the critical upper value for the bootstrapped t-test at the α percent significant level. The skewness-adjusted t-statistic calculated for each of the actual buy-and-hold return series is then compared to these bootstrapped critical values to determine whether any abnormal performance is found significant. The procedure for creating bootstrapped skewness-adjusted t-statistics is similar in the equal weight and value weight cases, with the exception that in the latter analysis, we employ the weighted average returns based on market value.

Loughran and Ritter (1999) stipulate that the choice of weighting scheme is important for power consideration. Brav et al. (2000) illustrate this point by a simple example. Consider a sample consisting of 1000 firms, 999 of which have a capitalisation of 1 million (the “small” firms) and the rest one has a market capitalisation of 1001 million (the “big” firm). Assume all small firms have underperformed an equal 50 percent relative to a benchmark while the large firm over performed by 50 percent. An equal weight measure will imply severe mispricing (-50 percent), while value weighting will lead to a conclusion of no abnormal return. The use of a weighting scheme is dependent on our research motivation. We are interested in impact of weighting scheme on the results as well as comparison between results from DataStream and LSPD. Therefore, we include results using both value and equal weighting to address it.

3.4 Empirical Results

3.4.1 Performance using both measurements

We compute the three- and five-year buy-and-hold returns of the IPOs and benchmarks respectively. The benchmarks include FTSE All Share Index (FASI), Capital Asset Pricing Model (CAPM), and Fama-French (1993) three factor model (FF). Our purpose is to first evaluate the long-term performance using buy-and-hold measure independently. Additionally, we are keen to assess the different results from two datasets. The results of evaluating long-term performance from two datasets are presented in table 3-4.

[Insert table 3-4 about here]

Panels A and C of table 3-4 demonstrates the equal and value weight results during post-IPOs 5-year periods. Panels B and D include corresponding information at 3-year interval. The layout of each panel is the same. The raw returns of IPOs from DS and LSPD are displayed in columns 2 and 3, while the adjusted returns relative to benchmarks are presented in columns 5 and 6. The differences between two datasets in terms of raw returns and BHAR are shown in columns 4 and 7. The t-statistics are presented below the BHAR and difference between two datasets, displayed in parentheses. We use the market value of firm at the end of issue month as weight in value weight scheme. We follow the procedure for handling zero returns in last consecutive months mentioned above. The results in panels A and C show that returns to IPOs outperform the market on equal weighted basis. In DS, equal weighted raw return on sample IPOs is 38.5 percent over three years and 61.3 percent over five years. The corresponding figures in LSPD are 51.4 percent and 95 percent. However, none of differences (-12.9 percent and -33.7 percent) at two time intervals is significant. When performance measured based on benchmarks, there is outperformance of 11.1 percent over three years and 22.6 percent over five years. The magnitude of counterparts from LSPD is quite close, with 8.9 percent and 26.5 percent respectively. The outperformance based on other two benchmarks (CAPM and FF) is larger in terms of magnitude, which holds in both datasets. For each benchmark at same time interval, none of the difference of BHAR between DS and LSPD is statistically significant. In our sample of IPOs, we find consistent evidence of outperformance based on equal weight either in three- or five-year holding period. Both DS and LSPD produce same qualitative conclusion, which is superior performance over benchmark.

Panels C and D illustrate results from value weight scheme. Although weight allocation for the same company between DS and LSPD is different due to different initial market value, we cannot find significantly different performance from two datasets. In value weight scheme, IPOs are also found to outperform the corresponding benchmarks both at three-year and five-year intervals. However, compared to equal weight counterparts, we find small performance reduction both on raw and adjusted returns. At five-year horizon, there is nearly no performance difference between equal weight and value weight scheme. The raw performance difference is 9.5 percent at three-year and 26.7 percent at five-year horizon, with later figure significant at 5% level. When measured with adjusted returns, the results from two datasets are even closer, with largest difference smaller than 6 percent. Therefore, panels C and D also present consistent conclusion as equal weight scheme. DS and LSPD are providing evidence arguging outperformance in the long-run post-IPO period.

We also measure IPOs' performance using the cumulative abnormal return. Fama and Mitchell and Stafford (2000) propose that CARs is possibly a better, less biased method to calculate long-term returns because they eliminate the compounding effect of single year's poor performance. However, they are still subject to cross-sectional correlation. We calculate CARs by summing monthly average abnormal returns over three or five years. Due to this procedure, the standard deviation of CAR at specific time interval is zero and we cannot conduct t-test to compare the CAR difference between two samples as in buy-and-hold measure.

[Insert table 3-5 about here]

In panels A and B, returns are calculated for five years and three years respectively. IPO and benchmark returns terminate in month following a firm's acquisition or delisting. The left hand side displays equal weight results while right hand side demonstrates value weight results. Once performance is measured using CARs, we get a different picture of long-run performance. The significant outperformance from BHAR cannot be detected from CAR. On the contrast, the significant underperformance at three-year horizon relative to FASI is presented. Even at five-year horizon, the outperformance is not universal. When measured at three-year horizon, equal weighted CARs display negative performance from DS. While Espenlaub et al. (2000) show significant underperformance relative to CAPM and FF using CARs, we could only find the underperformance relative to FASI is significant. Impact of value weight on results cannot be detected, since results from equal weight and value weight quite close for both datasets. Similar to finding in table 3-4, we also find there is no significant difference in terms of performance between two datasets. In other words, both datasets produce close results in this measurement. The difference in the results between CARs and BHARs is due to the large positive skewness of the individual IPO firm return.

Besides the adjusted price from DS used in tables above, we also collect the IPOs price without dividend. It is interesting to explore the impact of dividend in IPOs returns. We compare the IPOs performance using both prices with and without dividend. The result is presented in table 3-6.

[Insert table 3-6 about here]

The focus is the impact of dividend on IPOs raw and adjusted return. Therefore, we only calculate the equal weight returns. Panels A and B reveal results for five-year and three-year respectively. As expected, the raw and relative IPOs returns from unadjusted price are lower than counterparts with dividend included. The discrepancy between adjusted and unadjusted return is more prominent at five-year horizon. The buy-and-hold abnormal returns difference is as large as 20 percent. When dividend is included in the price, we find significant outperformance both at five-year and three-year interval for every benchmark. If dividend is not included in the price, we cannot find evidence of outperformance from BHAR measure at five-year horizon. Therefore, it again confirms the importance of dividend in calculating performance of IPOs.

3.4.2 Performance by size

Ritter (1991) states that IPOs with poorest performance usually have small size measured by initial market value. We are interested to explore the relationship of performance with size in both datasets. Although we do not find buy-and-hold abnormal returns decrease when switching from equal weight scheme to value weight scheme, we find raw IPOs returns reduction. Our hypothesis is that performance will deteriorate as size decreases. To confirm the hypothesis, we divide the samples into five groups based on size, which is market value of ordinary shares at the end of first trading month. Our first attempt is that the range of group is constant. However, there is severe positive skewness in the initial market value distribution. The skewness is 16.64 and 7.75 for DS and LSPD respectively. We try data transformation, including taking logarithms on different bases, box-cox transformation, and taking reciprocal. However, the observations are still be clustered in one or two group size. Therefore, the new rule is that we allocate observations in each quintile to make sure there is same number of IPOs. This is both applied to DS and LSPD. We term groups from smallest to biggest as small, 2, 3, 4, and Big. The composition of samples forming same quintile is different between DS and LSPD, however. The results are presented in table 3-7.

[Insert table 3-7 about here]

We look at the pattern of performance across various sizes. Our goal in table 3-7 is to discover whether performance deteriorates as size increases. Using FASI as benchmark, Panel A calculates the three- and five-year equal weight BHARs and panel B produce the three- and five-year equal weight CARs. Espenlaub et al. (2000, table 2) find underperformance is concentrated in the low deciles. However, our result is inconsistent with that hypothesis. On the contrast, we find IPOs in the smallest size quintile performs best among all groups, except BHAR over post-issue five-years in DS. With size quintile increasing, there's no predictable trend for performance variation. For example, the performance of IPOs in 4^{th} quintile is better than other quintiles. Panel B yields the qualitative same results. With notable superior performance form smallest size quintile for both datasets, we could not detect other valuable information regarding performance change.

3.4.3 Sub-period performance analysis

We also test some of the hot market hypothesis proposed by Ljungqvist et al. (2006). They predict that firms issued in a hot market underperform in the long run while there is no long-run underperformance in a cold market. Hot IPO markets could be defined based on several criteria. These criteria include above-average number of IPOs, momentum in IPO issue numbers and abnormal initial returns. The most commonly used criteria are periods of either high IPO volume or high level of initial returns. However, Lowry and Schwert (2002) find that periods of high initial returns are typically followed by high IPO volume. Our classification of hot markets follows Helwege and Liang (2004) and Coakley et al. (2008). They use the top quartile of a three-month centred moving average of the number of IPOs to define hot period. Apply the criterion to our sample, we find 63 out of total 240 months are treated as hot markets. 528 (65.7%) out of 819 IPOs are hot issues. The average number of IPOs per month over the full month was 3.4. IPO issue numbers peak from 1993 till 2000 where hot markets cluster. Although Helwege and Liang (2004) differentiate between cold and normal markets, we follow Coakley et al. (2008) to combine these two markets into one called normal markets. On the one hand, there are only 819 observations and we do not want to discard any useful information. On the other hand, the performance between hot markets and normal markets is more conservative than tests between hot markets and cold markets. The results are presented in table 3-8.

[Insert table 3-8 about here]

We only present equal weight results because as shown in the previous, two databases have qualitative same and quantitative similar results if equal weight case is adopted. Additionally, the performance difference, if measured with cumulatiave average abnormal return, between hot and normal markets cannot be detected using t-stat. Therefore, only buy-and-hold abnormal returns are presented. The panel A displays the five-year results. We find that at five year horizon, performance from normal markets is always superior to that from hot markets, with all markets in the middle. The trend remains at three year horizon, but with much less dramatic extent. However, all differences are insignificant reflected by the t-stat in the last row. The hot market hypothesis does not hold in our sample.

3.5 Conclusion and limitation

In this chapter, we study the long-run performance of 819 UK IPOs listed from 1981-2000 using two data sources (DS and LSPD). We cannot find long-term underperformance up to 60 months after being public. On the contrast, we document the abnormal returns at five-year horizon vary from 22.6 percent to 49.7 percent, all of which are significant. The third anniversary also experience outperformance, ranging from 8.9 percent to 25.8 percent, some of which are not significant. We also confirm the importance of inclusion of dividend. This holds most prominent in value weight results. However, the returns difference won't impact conclusions in equal weight results. The market value difference between DS and LSPD is insignificant. The delicate difference in market value does not cause the results of value weight various between DS and LSPD. Value weight results remains outperformance from both datasets if measured using BHAR. Fama (1998) and Mitchell and Stafford (1998) argue that measures such as cumulative abnormal returns are less likely to generate results against market efficiency compared to buy-and-hold abnormal return measures, indicating less abnormal returns. We find supporting evidence in this chapter. CAR measure yields performance closer to zero than BHAR. We also test whether the poorest performance comes from IPOs with small size. Our results show that IPOs in smallest quintile perform best. We finally examine whether performance from heavy IPO activity will be better than that from light IPO activity. The evidence is not statistically significant. However, firms listed in 1999 and 2000 perform rather poorly.

Nevertheless, the paper still has some limitations. Firstly, we have no information about the representativeness of our sample. The underperformance is probably due to the sample choice. Secondly, we have not included the calendar time approach in this paper, which could be a robustness check.

Table 3-1 Comparison between DS and LSPD

The table displays the difference between LSPD and DS in various aspects, including coverage, data resources, returns, and market value. The compared items are listed in the first column.

Items	LSPD	DS
Coverage	A random sample of 33 percent of the companies quoted on the LSE between 1955 and 1974, complete history for all UK companies quoted in London since 1975	1832 equities included, price starting from 1965
Data	Stock Exchange Daily Official List, the Financial Times, and Extel's EXSHARE service	Exchanges, leading international and local supplies, and published reports
Return	dividend included, log return	capital changes adjusted or not, simple returns
Market value	Market value of company's ordinary shares, readily available	Market value of company's ordinary shares, readily available
Return and market value frequency	Monthly	Daily

Table 3-2 Sample selection

This table describes the filters we use to construct our sample for comparing results based on two different databases (DataStream and London Share Price Data). We begin with an original sample (1084) provided by Professor Ranko Jelic. We eliminate firms which go public before 1981 or after 2000. We also exclude firms which could not be identified either by DS or LSPD. Furthermore, companies whose issuance months have discrepancies between the two databases are eliminated. Finally, companies which do not have market value information are excluded. We are left with a sample of 819 IPOs.

Original Sample		1084
Less: Firms being listed before 1981 (from DataStream)	11	
Less: Firms being listed after 2000 (from DataStream)	14	
Less: Firms which could not be identified by DataStream	80	
Equals: IPOs identified from DataStream		979
Less: Firms which could not be identified by LSPD	31	
Less: Firms with different issue months (DataStream vs. LSPD)	27	
Equals: IPOs identified both by DataStream and LSPD		921
Less: Firms which have missing market value information (DataStream)	4	
Less: Firms which have missing market value information (LSPD)	4	
Less: Firms without initial market value information	91	
Equals: Final Sample		819

Table 3-3 Univariate analysis of IPO size

The table presents the mean and median initial market value of IPOs by calendar year, denoted by millions of pounds. Market value is measured as the market capitalization of stock's ordinary shares' at the end of their issue month. The p-values for two sample t-test (difference in mean =0 vs. difference in means ≠ 0) and two sample Wilcoxon rank-sum (Mann-Whitney) test (difference in medians =0 vs. difference in medians ≠ 0) are presented in the 5th and 8th columns. The number of observations by calendar year is presented in 2nd columns. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		Mean			Median		
year	Observations	DS	LSPD	p-value	DS	LSPD	p-value
1981	3	25.21	1.67	0.420	2.09	2.00	0.268
1982	1	8.14	7.00		8.14	7.00	0.317
1983	9	42.96	39.11	0.203	20.80	20.00	0.691
1984	10	13.67	13.80	0.401	11.48	11.50	0.821
1985	41	34.09	23.71	0.008***	14.51	9.00	0.037**
1986	19	426.76	378.00	0.234	11.00	9.00	0.261
1987	16	112.04	109.50	0.502	20.10	13.50	0.327
1988	37	21.20	107.43	0.182	13.98	13.00	0.619
1989	41	146.95	142.61	0.272	10.57	11.00	0.945
1990	11	393.21	394.36	0.403	362.17	362.00	0.922
1991	4	484.14	476.00	0.384	156.25	140.00	0.773
1992	13	254.60	247.92	0.303	30.01	30.00	0.939
1993	43	80.58	77.49	0.071	59.47	54.00	0.672
1994	80	81.34	85.44	0.156	40.82	41.00	0.819
1995	84	45.46	45.56	0.784	17.59	16.00	0.980
1996	131	72.27	70.76	0.253	27.44	26.00	0.728
1997	91	178.25	227.70	0.325	24.43	24.00	0.984
1998	40	124.46	132.70	0.416	37.64	39.00	0.690
1999	40	248.29	247.20	0.482	33.88	34.00	0.943
2000	105	128.76	125.34	0.243	29.79	29.79	0.935
Total	819	117.46	124.59	0.264	25.01	24.00	0.487

Table 3-4 Three- and Five-Year Post-IPO Buy-and-Hold Returns Versus Various Benchmarks

The sample includes 819 identified IPOs from 1981 through 2000. Panels A and C display results at five-year horizon in equal and value weight scheme respectively. Panels B and D show results at three-year horizon in equal and value weight scheme correspondly. Three- and five-year buy-and-hold raw and abnormal returns (both equal-weighted and value-weighted) are presented. In the first row of each panel, we employ the FTSE All Share Index (FASI). Row 2 of each panel presents abnormal performance measured relative to Capital Asset Pricing Model (CAPM). Row 3 of each panel presents adjusted returns relative to Fama-French (1993) three factor model (FF). Columns 2 and 3 are buy-and-hold raw returns from DS and LSPD respectively. Column 4 displays the difference of raw returns between DS and LSPD. Buy-and-hold abnormal returns are presented in column 5 and 6. Column 7 displays the difference between result from column 5 and 6. Buy-and-hold returns are generated by compounding monthly returns beginning from the first complete trading month that could be found either in DS or LSPD. In all panels, we drop the zero returns if occurring in last consecutive months. T-stats for the buy-and-hold abnormal returns are computed according the skewness-adjusted t by Lyon et al. (1999) and in parentheses ( ). T-stats for the difference are standard t and in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Five year equal weighted raw and buy-and-hold abnormal return

	Raw IPO Return			BHAR		
Benchmarks	DS	LSPD	Difference	DS	LSPD	Difference
FASI	0.613	0.950	-0.337	0.226**	0.265**	-0.039
(t-statistic)			(-1.643)	(2.082)	(2.153)	(-0.197)
CAPM	0.613	0.950	-0.337	0.277**	0.372***	-0.095
(t-statistic)			(-1.643)	(2.633)	(3.160)	(-0.473)
Fama-French	0.613	0.950	-0.337	0.345***	0.497***	-0.152
(t-statistic)			(-1.643)	(3.150)	(4.381)	(-0.750)

Panel B: Three year equal weighted raw and buy-and-hold abnormal return

	Raw IPO Return			BHAR		
Benchmarks	DS	LSPD	Difference	DS	LSPD	Difference
FASI	0.385	0.514	-0.129	0.111*	0.089	0.022
(t-statistic)			(-1.194)	(1.748)	(1.295)	(0.212)
CAPM	0.385	0.514	-0.129	0.169***	0.192***	-0.024
(t-statistic)			(-1.194)	(2.803)	(3.019)	(-0.178)
Fama-French	0.385	0.514	-0.129	0.252***	0.258***	-0.006
(t-statistic)			(-1.194)	(4.413)	(4.165)	(-0.061)

Panel C: Five year value weighted raw and buy-and-hold abnormal return

	Raw IPO Return			BHAR		
Benchmarks	DS	LSPD	Difference	DS	LSPD	Difference
FASI	0.567	0.834	-0.267**	0.266***	0.274***	-0.008
(t-statistic)			(-2.264)	(5.888)	(4.751)	(0.073)
CAPM	0.567	0.834	-0.267**	0.323***	0.365***	-0.042
(t-statistic)			(-2.264)	(7.980)	(7.108)	(0.374)
Fama-French	0.567	0.834	-0.267**	0.255***	0.269***	-0.014
(t-statistic)			(-2.264)	(4.249)	(4.324)	(0.116)

Panel D: Three year value weighted raw and buy-and-hold abnormal return

	Raw IPO Return			BHAR		
Benchmarks	DS	LSPD	Difference	DS	LSPD	Difference
FASI	0.274	0.369	-0.095	0.060	0.016	0.044
(t-statistic)			(-1.318)	(1.545)	(0.370)	(0.656)
CAPM	0.274	0.369	-0.095	0.152***	0.123***	0.029
(t-statistic)			(-1.318)	(4.612)	(3.003)	(0.443)
Fama-French	0.274	0.369	-0.095	0.177***	0.120***	0.056
(t-statistic)			(-1.318)	(5.191)	(2.782)	(0.838)

Table 3-5 Three- and Five-Year Post-IPO Cumulative Abnormal Returns versus Various Benchmarks

The sample includes 819 identified IPOs from 1981 through 2000. Panels A and B show results at five-year and three-year horizon. In each panel, equal weight results are presented on the left hand side and value weight results are presented on the right hand side. The measurement of performance in the table is cumulative average abnormal return. In the first row of each panel, we employ the FTSE All Share Index (FASI). Row 2 of each panel presents abnormal performance measured relative to Capital Asset Pricing Model (CAPM). Row 3 of each panel presents adjusted returns relative to Fama-French (1993) three factor model (FF). Columns 2 and 4 are results from DS. Columns 3 and 5 are results from LSPD. Cumulative abnormal returns are generated by cumulating monthly returns starting in the first complete trading month that could be found either in DS or LSPD. In all panels, we drop the zero returns if occurring in last consecutive months. The calculation of T-statistics follows Ritter (1991) and is in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Five year CAR

	EW CAR		VW CAR	
Benchmarks	DS	LSPD	DS	LSPD
FASI	-0.047	0.016	0.071	0.063
(t-statistic)	(-0.489)	(0.152)	(1.057)	(0.958)
CAPM	0.019	0.115	0.185***	0.160**
(t-statistic)	(0.199)	(1.165)	(3.007)	(2.607)
Fama-French	0.089	0.194**	0.104	0.056
(t-statistic)	(1.165)	(2.399)	(1.927)	(1.029)

Panel B: Three year CAR

	EW CAR		VW CAR	
Benchmarks	DS	LSPD	DS	LSPD
FASI	-0.150**	-0.123*	-0.108***	-0.126***
(t-statistic)	(-2.379)	(-1.879)	(-2.460)	(-2.983)
CAPM	-0.074	-0.020	0.050	0.014
(t-statistic)	(-1.217)	(-0.320)	(1.255)	(0.353)
Fama-French	-0.001	0.040	0.039	-0.036
(t-statistic)	(-0.021)	(0.780)	(1.106)	(-1.052)

Table 3-6 Three- and Five-Year Post-IPO Buy-and-Hold Returns with and without dividend

The sample is 819 identified IPOs from 1981 through 2000. Three- and five-year buy-and-hold abnormal returns (both equal-weighted and value-weighted) are compared with alternative benchmarks. In the first row of each panel, we employ the FTSE All Share Index (FASI). Row 2 of each panel presents abnormal performance measured relative to Capital Asset Pricing Model (CAPM). Row 3 of each panel presents adjusted returns relative to Fama-French (1993) three factor model (FF). All IPOs returns data are from DS. Column 2 and 3 is buy-and-hold returns from adjusted and unadjusted prices respectively. Column 4 displays the difference between result from column 2 and 3. Buy-and-hold abnormal returns are presented in column 5 and 6. Column 7 displays the difference between result from column 5 and 6. Buy-and-hold returns are generated by compounding monthly returns beginning from the first complete trading month. In all panels, we drop the zero returns if occurring in last consecutive months. T-stats for the buy-and-hold abnormal returns are computed according the skewness-adjusted t by Lyon et al. (1999) and in parentheses ( ). T-stats for the difference are standard t and in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Five year equal weighted raw and buy-and-hold abnormal returns

	Raw IPO Return			BHAR		
Benchmarks	Dividend included	Dividend excluded	Difference	Dividend included	Dividend excluded	Difference
FASI	0.613	0.351	0.262	0.226**	-0.037	0.262
(t-statistic)			(1.458)	(2.082)	(-0.231)	(1.489)
CAPM	0.613	0.351	0.262	0.277***	0.010	0.267
(t-statistic)			(1.458)	(2.633)	(0.165)	(1.523)
Fama-French	0.613	0.351	0.262	0.345***	0.130	0.215
(t-statistic)			(1.458)	(3.150)	(1.308)	(1.175)

Panel B: Three year equal weighted raw and buy-and-hold abnormal returns

	Raw IPO Return			BHAR		
Benchmarks	Dividend included	Dividend excluded	Difference	Dividend included	Dividend excluded	Difference
FASI	0.567	0.447	0.120	0.266***	0.146***	0.120
(t-statistic)			(1.262)	(5.888)	(3.510)	(1.314)
CAPM	0.567	0.447	0.120	0.323***	0.203***	0.120
(t-statistic)			(1.262)	(7.980)	(5.476)	(1.339)
Fama-French	0.567	0.447	0.120	0.255***	0.161***	0.094
(t-statistic)			(1.262)	(4.249)	(3.654)	(0.951)

Table 3-7 Equal weight Three- and Five-year buy-and-hold abnormal returns, and cumulative abnormal returns by size

The sample includes 819 identified IPOs from 1981 through 2000. Three- and five-year buy-and-hold abnormal returns (both equal-weighted and value-weighted) are based on FASI. IPOs are divided into five groups based on its size, which is measured at the end of its first trading month. Size represents the market value of ordinary shares at that time. Panel A uses buy-and-hold abnormal returns measurement. Buy-and-hold returns are generated by compounding monthly returns beginning from the first complete trading month that could be found either in DS or LSPD. The buy-and-hold Size portfolios are generated by forming size quintile breakpoints so that the number of IPOs in each portfolio is same. Panel B adopts cumulative abnormal returns measurement. Cumulative abnormal returns are generated by cumulating monthly returns starting in the first complete trading month that could be found either in DS or LSPD. Rows 2 and 3 present post-issue performance from DS at three-year and five-year horizon respectively. Rows 4 and 5 provide counterparts from LSPD. In all panels, we drop the zero returns if occurring in last consecutive months. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Equally weight Three- and Five-year Buy-and-hold abnormal returns

Size	DS		LSPD	
	3-Year	5-Year	3-Year	5-Year
Small	0.219	0.320	0.273	0.229
2	0.021	0.435	0.104	0.805
3	0.139	0.161	-0.075	-0.203
4	0.277	0.233	0.231	0.388
Big	-0.091	0.051	-0.104	0.133

Panel B: Equal weight Three- and Five-year cumulative abnormal returns

Size	DS		LSPD	
	3-Year	5-Year	3-Year	5-Year
Small	0.002	0.197	0.159	0.352
2	-0.302	-0.109	-0.268	-0.016
3	-0.142	-0.189	-0.243	-0.141
4	-0.116	-0.142	-0.105	-0.110
Big	-0.188	-0.002	-0.170	-0.001

Table 3-8 Sub-period return analysis

The sample includes 819 identified IPOs from 1981 through 2000. Three- and five-year buy-and-hold abnormal returns (equal-weighted) are based on different benchmarks. These benchmarks include FTSE All Share Index (FASI), capital asset pricing model (CAPM), and Fama-French (1993) three-factor model. The hot periods are months within top quartile of three-month centered moving average of monthly IPOs number. The remaining periods are defined as normal markets. The buy-and-hold abnormal return is the simple difference between IPO three-year average return and the corresponding benchmark. Skewness-adjusted t-statistics from Lyon et al. (1999) are presented in parentheses below the buy-and-hold abnormal returns. The last row shows the t-stat of difference between hot and normal markets. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Five-year buy-and-hold abnormal returns

Dataset	DS			LSPD		
Benchmark	FASI	CAPM	FF	FASI	CAPM	FF
All markets	0.226*	0.277***	0.345***	0.265*	0.372***	0.497***
(skewness-adjusted t-statistic)	(2.082)	(2.633)	(3.150)	(2.153)	(3.160)	(4.381)
Hot	0.126	0.182	0.257**	0.208	0.321**	0.420***
(skewness-adjusted t-statistic)	(0.971)	(1.429)	(2.051)	(1.400)	(2.261)	(3.009)
Normal	0.403**	0.447**	0.502**	0.351	0.450*	0.614***
(skewness-adjusted t-statistic)	(2.152)	(2.417)	(2.365)	(1.699)	(2.229)	(3.193)
t-stat for hot vs. normal	0.999	0.954	0.857	0.473	0.427	0.636

Panel B: Three-year buy-and-hold abnormal returns

Dataset	DS			LSPD		
Benchmark	FASI	CAPM	FF	FASI	CAPM	FF
All markets	0.111	0.169***	0.252***	0.089	0.192***	0.258***
(skewness-adjusted t-statistic)	(1.748)	(2.803)	(4.413)	(1.295)	(3.019)	(4.165)
Hot	0.101	0.171**	0.253***	0.088	0.202***	0.264***
(skewness-adjusted t-statistic)	(1.229)	(2.220)	(3.452)	(1.004)	(2.511)	(3.383)
Normal	0.129	0.165	0.251***	0.091	0.175	0.248**
(skewness-adjusted t-statistic)	(1.363)	(1.767)	(2.811)	(0.874)	(1.726)	(2.469)
t-stat for hot vs. normal	0.190	0.039	0.012	-0.022	0.179	0.102

Chapter 4 Re-examination of long-term UK IPO performance

4.1 Introduction

The study of the long-run performance of firms after their flotation is of interest for issuers as well as for investors. Issuers wonder whether it is right time to issue stock by examining whether stock market is at peak. Investors wonder whether IPOs are attractive investments compared to other mature firms. Long-run horizon is often defined from one year to five years after the IPO. Numerous studies find that IPOs perform poorly in the long-run (Ritter, 1991; and Loughran and Ritter, 1995 and 2000). However, the findings are not homogenous and depend on methodologies and benchmarks. A long-run underperformance after IPOs is also reported by several studies in UK capital market, including Levis (1993), Espenlaub et al. (2000), Goergen et al. (2007), and Gregory et al. (2010).

There are several reasons motivating us to conduct another study evaluating long-term performance, despite the vast literature. First, most previous UK studies (Levis, 1993; Espenlaub et al., 2000; Gregory et al., 2010) present measurement based either on cumulative average abnormal returns (CARs) or buy-and-hold average abnormal returns (BHARs). None of the papers mentioned above adopts both measures. Second, the datasets used in most prior studies are dated. Except Gregory et al. (2010), the most recent concerning paper (Espenlaub et al., 2000) uses sample terminating at 1992. Ritter and Welch (2002) state that long-run performance of IPOs is not only sensitive to econometric methodology, but also to the choice of sample period. The more recent data could be used to test the validity of underperformance in different time period. Even in Gregory et al. (2010), they do not adopt cumulative average abnormal returns. Third, some of the benchmarks such as Carhart four factor model and control portfolios based on firm's certain characteristics have not been applied in UK literature. We could have a more comprehensive picture if those benchmarks are included.

Our paper aims to provide updated evidence on long-run stock performance of IPOs in UK using extended time period and more benchmarks. Our sample period spans from 1982 until 2004 and we adopt five different benchmarks to check our conclusion. The rest of paper is organized as follows. In section 4.2, we will review the international literature on long-term IPOs financial performance. In section 4.3, we will discuss our data set and methodology. Section 4.4 provides the empirical results. Section 4.5 presents the robustness check with calendar time work. Section 4.6 concludes with a summary of the major results.

4.2 Literature Review

Efficient market hypothesis indicates no abnormal return caused by firm-specific events as long as event-related activities are fully completed. However, beginning from Ritter (1991), numerous literature find negative adjusted returns from IPOs in the long post-issue period. The documented long-term underperformance not only takes place in USA, but also in many other capital markets. However, the underperformance found in European countries is generally lower than that discovered in US stock market. For example, Stehle et al. (2000)

study 187 IPOs from 1960-1992 in Germany using various benchmarks. They find IPOs only underperform a size control portfolio by 6 percent in the three-year post-issue horizon. Furthermore, Stehle et al. (2000) demonstrate that size portfolio adjusted return give a more accurate estimate of long-term abnormal returns because IPO stocks in Germany usually have a small or medium market capitalization and market portfolio used as a benchmark is not appropriate. Alvarez and Gonzalez (2005) provide additional evidence in Spanish market, confirming the negative long-run abnormal stock returns, in line with international literature. In some other European stock markets, the long-term underperformance is challenged (France, Switzerland). For example, Drobetz et al. (2005) estimate the long-run performance of Swiss Initial public offerings (IPOs) from 1983 to 2000. They do not find strong evidence of underperformance. They contribute the found underperformance in other markets to the fact that benchmarks have not taken size into account. Similarly, Nounis (2003) reports average over-performance of 14.68 percent during the first year of listing on a sample of Greek IPOs.

Some similar studies have also been conducted in UK. Levis (1993) shows IPOs in UK from 1980 to 1988 underperform three relevant benchmarks in the full 36 months of trading following the first day of trading. The cumulative average abnormal return, excluding first month returns, falls to -11.38 percent, -8.31 percent, and -22.96 percent relative to Financial Times Actuaries All Share Index (FTA), Hoare Govett Smaller Companies Index (HGSC) and All Share Equally Weighted Index (ASEW) respectively. The magnitude of underperformance is supposed to be conservative given the performance of small companies during the period 1984-1987 is especially superior to that of large firms. Espenlaub et al. (2000) re-examine the evidence from Levis (1993) by updating the sample and including calendar-time approach. Similar to Levis' (1993) findings, the first three years after IPOs exhibit a dramatic underperformance regardless of benchmark choice. The subsequent two years, however, show different pattern depending on benchmarks. By the end of 5th anniversary, CAARs based on Capital Asset Pricing Model, simple size adjustment, multi-index model and Fama-French (1993) three-factor model yield -28.67 percent, -21.32 percent, -4.3 percent, and -42.77 percent respectively. To control for cross-sectional correlation, they also include calendar time analysis in the paper. Intercepts of regressions indicate negative average monthly abnormal return, with less magnitude than that in event time framework. Goergen et al. (2007) study the long-run stock performance of UK IPOs by relating it to the pre-IPO financial performance of the firm as well as the managerial decision taken pre-IPO. They confirm the underperformance of UK IPOs and find that quality, pre-IPO accounting performance, and degree of multi-nationality are determinants of long-term IPOs performance. Gregory et al. (2010) analyse the long run stock returns of UK IPOs using a set of 2,499 UK IPOs between mid-1975 and the end of 2004. They show the compelling evidence of long run underperformance from size decile control portfolio and control firm. Additionally, performance by listing market differs, with results in AIM and USM much worse than those from official list (OL).

Methodology to measure abnormal returns, especially over long-term, always receives criticisms since none existing method can avoid all weaknesses. Lyon et al. (1999, p165) describe “even using the best methods, the analysis of long-run abnormal returns is treacherous”. Firstly, among a variety of expected returns, we cannot conclude which one is most accurate. Secondly, how to aggregate average abnormal returns over time is inconclusive as well. Both cumulative average abnormal returns and buy-and-hold abnormal returns presents some conveniences and inconveniences. Thirdly, test statistic to determine the significance of abnormal return is not standard since the distribution of abnormal return is not normal. We have to make some adjustments to allow for the deviation from normal distribution. Therefore, measured performance to a large extent depends on benchmark and methodology selected (Brav et al. 2000, Gompers and Lerner, 2003; Drobetz et al. 2005, Alvarez and Gonzalez, 2005). Brav et al. (2000) state that underperformance from traditional index disappears when the benchmark matched on size and book-to-market ratios. Gompers and Lerner (2003) find that while IPOs underperform when event-time buy-and-hold abnormal returns are used, they do not in cumulative abnormal returns. Additionally, intercepts in time series regression are insignificantly different from or even positive. The relative performance of an IPO sample depends on the method of examining performance.

Barber and Lyon (1997), Kothari and Warner (1997) and Lyon et al. (1999) point out commonly used methods for testing long-run abnormal returns yield misspecified test statistics. These papers underline three main causes for the misspecifications. They solve the problem by calculating skewness-adjusted t-statistic or the empirically generally distribution of long-run abnormal returns in event time framework and using buy-and-hold abnormal return measurement. Gajewski and Gresse (2006) confirm positive skewness of long-term abnormal return by analysing long-term performance of IPOs across 15 European countries. The positive skewness of performance is reflected by the fact that median returns are lower than mean returns. Stehle et al. (2000) also mention the strongly skewed distribution of abnormal returns from all benchmarks. Their remedies include reporting skewness-adjusted t-statistics and bootstrapping procedure to evaluating the t-statistics.

4.3 Data and Methodology

4.3.1 Data Description

The data in this paper is from London Share Price Database (LSPD). LSPD is a unique, comprehensive database of UK stock returns covering some 9,000 UK shares from 1955 to 2007. In last chapter, we use DS as one source and compare the results with those from LSPD. In this paper, we expand our sample size and period. Our IPO sample is identified by four steps. First, birth date[18] spans from 1982 to 2004, covering 23 years. Year 2004 is chosen as

[18] The first date the security was offered for sale or for tender, introduced to the Stock Exchange, placed, issued, acquired in the case of a merger, or first quoted.

last sample year because 5 year subsequent to IPOs, excluding first trading month, is our analysis horizon and the latest available return data in LSPD terminates at December 2009. The first trading month is excluded from the study because of initial underpricing and possibility of price support in the first few trading days. Second, there's type of birth information in LSPD and we pick all methods categorizing as IPOs, including placing, offers for sale, offers for sale by tender, subscription, and mixed of any two. Third, financial companies are excluded from our sample. Finance firms are different in that their accounting treatment on book value is different from firms in other industries. This filter follows Espenlaub et al. (2000), Goergen et al. (2007) and Gregory et al. (2010). Fourth, in order to compare the value effect on IPO performance, we drop all samples without first month market value information. We do this to make sure that the sample in equal weighted and value weight scheme is exactly same so that results from two schemes could be comparable. We are left with a sample size of 1,953 firms from 1982 to 2004.

[Table 4-1 about here]

Panel A of table 4-1 shows the distribution by listing method and calendar year respectively. The mean and median market value is presented in the last two rows of table. Market value refers to market capitalization of ordinary shares, measured at the end of first trading month. The volume in terms of IPOs number in each year is time varying. Time between 1985 and

1988 witness the first hot time period, with number of IPOs exceeding 100 in each year. Afterwards, there's a temporary cold period before it boost again to 141 in 1996. The number culminates with 238 in 2004, which is a huge increase compared to figures in last three years. Although the number of IPOs in each calendar year is different from figures presented in Gregory et al. (2010) who also use LSPD, the time series trend of number is similar. Their first hot issue period also occurs between 1985 and 1988 and follows a cold period before jumping in 1996. In terms of listing method, placement dominates public offer through the entire sample period, with 84 percent IPOs choosing placement as their method of raising capital. The similar situation is also found in Gregory et al. (2010). They document that placements take 81.3 percent. Birth type such as introduction, re-introduction, IPO spinoff is not categorized into IPOs because they do not issue new stocks. We also find after 1986 that the number of public offer decrease gradually. We argue that choice of listing method depends mainly on the stock exchange's listing rules. The big bang which refers to the deregulation of fixed brokerage commissions and the termination of restrictions on membership on LSE takes place on October 27, 1986. Before big bang iss introduced, public offer is the only choice for issues larger than 3 million pounds. On the date of big bang, LSE changes its rules to allow placements to be used for larger issues up to 15 million pounds in the listed market and up to 5 million pounds in the unlisted markets. We show that average market value IPOs choosing placing is much smaller than firms choosing offer for sale. This finding supports Goergen et al. (2007) who suggest that UK public offers are mainly used by larger firms and placing are usually used by smaller firms. Within public offers, there are a number of variations. In an offer for sale, underwriter offers shares at a fixed price to individual and institutional investors. In an offer for sale by tender, the investors are invited to state a price at which they are willing to buy. An offer for subscription is similar to an offer for sale but it is only partially underwritten and is mainly used by investment trusts.

Panel B displays distribution by industry[19] and calendar year. In LSPD, each sample firm is given a digit code representing its specific industry. The industry classification code rules change three times during the sample period. We make some adjustments to match each firm to ICB industry code taking effect from 2006. The results show an industry clustering phenomenon. There are 648 and 471 companies in general industries and consumer services. On the other hand, telecommunications and utilities only bring about 37 and 34 public companies respectively. It seems there is negative relationship between the number of IPOs and market value if compared from industry level. IPOs in telecommunications, utilities, and oil & gas (with top 3 smallest observations, 37, 34, and 58) occupy the largest market value (1280 million, 651 million, and 154 million).

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[19] Industry Classification Benchmark (ICB), which is used by FTSE group and Dow Jones Indexes in 2005 for identifying industry

Panel C displays the distribution by listing market and calendar time. Before 1996, UK firms going to public can be listed either in Official List (OL) or Unlisted Securities Market (USM). Since the establishment of Alternative Investment Market (AIM) in June 1996, private firms have choice between OL and AIM. AIM replaces the function of USM. We notice that although AIM is not established until 1996, the IPOs appearing in AIM begins from 1983. Those AIM securities with issuing year before 1996 are transferred from other markets (OL or USM). Before 1996, most IPOs choose OL as their listing market. However, IPOs listed in AIM dominates after 1996, which is consistent with establishment of AIM. In summary, 928 firms choose OL, 804 companies pick AIM, and 223 stocks go to USM. The last two rows show the mean and median size of firms in each market. The average market value for IPOs in OL is 197 million; the corresponding figures for IPOs in AIM and USM are 30.4 and 10.4 million. The difference of median figure is smaller, indicating the severe skewness of distribution of market value.

4.3.2 Methodology

Monthly returns, including both capital gains and dividend payments, are collected from return file of LSPD. We follow Levis (1993) to make some adjustments on returns, converting monthly log return provided to simple arithmetic returns. Some monthly data are missing due to short suspension of trading or unavailable early trading months data. We substitute all missing returns of this kind with zero because it is unlikely that investors could be able to sell such stocks just before a suspension that is likely to be unexpected by investors. The treatment of missing returns has rarely been mentioned in other papers. Monthly returns of zero indicates no trading activities in the time period. The returns on the FTSE All Share Index (FASI) are measured as total returns including dividends and capital gains. The data of risk-free rate needs to be adjusted to be used since we refer this to monthly return of 90 day Treasury bill while LSPD provides the annual log return in each month. Therefore, we divide the annual figures by 12 and then convert to simple monthly return by taking exponential transformation. Our transformation is correct, confirmed by same figure from dataset from Gregory et al. (2010).

Various benchmarks are utilized to calculate the abnormal returns. Barber and Lyon (1997) categorize three approaches for developing a benchmark for long-run stock returns. The first approach employs the reference portfolio to calculate abnormal returns. The second approach matches sample firms to control on specified firm characteristics. The third approach is an application of Fama-French (1993) three-factor model. We include both the first and third approach. The first two benchmarks use reference portfolios, which are FASI and size control portfolios. Fama and French (1992) document that not only beta effects expected return, but also size and book-to-market ratio make a difference on returns. Dimson and Marsh (1986) take the size effect into consideration by using size decile control portfolios as benchmarks. The latter three belong to asset pricing model, including capital asset pricing model (CAPM), Fama-French (1993) three-factor model, and Carhart (1997) four-factor model. Fama-French three factor model and Carhart model are recent popular benchmarks in calculating expected returns. IPOs without size and book-to-market information can also use Fama-French model to estimate the expected returns. We achieve this by using readily available three factors downloaded from Gregory et al. (2010). Therefore, IPOs do not need size and book value information to enter the sample. Additionally, three-factor model allows for the possibility for firms with large size or high book-to-market ratio mimicking return pattern of small firm or low book-to-market ratio. It is pattern of returns, not explicit measurement of size and book-to-market ratio, determines whether a firm's common stock more closely mimic the returns of small firms and/or high book-to-market firms. The disadvantage of the three-factor model is that it equal weight each month in minimizing the sum of squares. If underperformance is correlated with the number of IPOs in certain period, three-factor model will impose a downward bias on the results. We address this by also estimating weighted least squares regressions in the calendar time framework. Furthermore, Fama and French (1996) find three-factor model cannot capture cross-sectional variation in momentum-sorted portfolio returns. Chan et al. (1996) suggest that momentum anomaly is market inefficiency due to slow reaction to information. Therefore, Carhart (1997) add momentum factor based on three-factor model to make it a four-factor model. The momentum factor is calculated as equal weight average of firms with the highest thirty percent eleven-month returns lagged one month minus the equal-weight average of firms with the lowest thirty percent eleven-month returns lagged one month. Data source of three-factor and four-factor model is from Gregory et al. (2010)[20]. Michou et al. (2007) observe that there's no timely basis data for Fama-French and momentum factors in UK. Gregory et al. (2010) fill this gap by constructing monthly data for this information from October 1980 to December 2008. There are several reasons to use their factor results rather than constructing ourselves. First, the monthly return and market capitalization data for their analysis is from LSPD which is same with our database. The use of same return has been confirmed by finding that risk free rate and market return is exactly same between our analysis and their data. Second, they have relatively comprehensive database, including Hemscott, Datastream and Gregory et al. (2009) data, for calculating book value of the firm which is not available for me. Our only access to Datastream will cause survivorship bias. Third, they choose beginning of each October as the portfolio formation time which is different from beginning of July as convention because Agarwal and Taffler (2008) find the year-ends of public firms in UK is more diffuse than that in US, with only 37 percent of firms having December year ends and similar number of firms ending year between January and April and 22 percent of UK firms having March year ends. Fourth, they follow the standard methodology described on Ken French's website to

[20] The website address is http://xfi.exeter.ac.uk/researchandpublications/portfoliosandfactors/files.php

construct SMB, HML and UMD factor. The calculation of abnormal return based on each of five benchmarks is as follows:

Model 1: FTSE All Share Index (FASI)

$$\varepsilon_{it} = R_{it} - R_{FASI} \qquad \text{(Equation 4-1)}$$

where R_{it} is the return on company i in event month t, R_{FASI} is the return on the market index (FTSE all share index) in event month t.

Model 2: Size control portfolio (SD)

$$\varepsilon_{it} = R_{it} - R_{st} \qquad \text{(Equation 4-2)}$$

where R_{st} is the return on the size control portfolio in event month t. The reference portfolios are ten size-based portfolios that are constructed in January of each year. In December of each year, all firms in LSE are ranked on the basis of market value of equity. Size deciles are created based on these rankings. In each decile, the number of firms is the same. We calculate the monthly return for each of the ten size control portfolios by equal averaging the monthly returns across all securities in a particular size decile. IPO sample is allocated to appropriate size decile once each year. The calculation of size-decile returns is equivalent to a strategy of investing in an equally weighted size decile portfolio with annual rebalancing.

Model 3: Capital Asset Pricing Model (CAPM)

$$\varepsilon_{it} = R_{it} - [R_{ft} + \beta_i(R_{mt} - R_{ft})]$$ (Equation 4-3)

where R_{it} is the return on company i in event month t, R_{mt} is the return on the market in event month t as measured by the return on the FTSE All Share Index, R_{ft} is the treasury bill return in event month t, β_i is the CAPM beta of company i, estimated by an OLS regression up to 60 months after the IPO.

Model 4: Fama-French three-factor model

$$\varepsilon_{it} = R_{it} - [R_{ft} + \beta_i(R_{mt} - R_{ft}) + \gamma_i SMB_{it} + \delta_i HML_{it}]$$ (Equation 4-4)

where R_{it} is return on company i in event month t, R_{mt} is the return on the market in event month t measured by the return on the FTSE All Share Index, β_i, γ_i, δ_i is the coefficient of factors (R_{mt}-R_{ft}), SMB and HML respectively. Those three coefficients are estimated by OLS regression from first full trading month to the 60th month or delisting time which took place first.

Model 5: Carhart four-factor model

$$\varepsilon_{it} = R_{it} - [R_{ft} + \beta_i(R_{mt} - R_{ft}) + \gamma_i SMB_{it} + \delta_i HML_{it} + \emptyset_i UMD_{it}]$$ (Equation 4-5)

all parameters are similar with interpretation in three-factor model except having extra factor UMD.

We will focus on the performance of sample IPOs from the first complete trading month until the post-issue 5 year (60 months) anniversary in the aftermarket period. The first partial trading month is excluded from our event window for adjusting the effect of under-pricing and most return information is missing as well. Each trading month actually is consistent with calendar month return. The last transaction price in each calendar month was extracted and dividends, rights and scrip issues during each month will be taken into account as well. Return file in LSPD provides logarithmic returns for each sample. However, discrete returns are used throughout the paper to avoid any downward bias in returns caused by Jensen's inequality. FTSE All Share Index proxy for market portfolio in that it is a value-weighted index comprising approximate 90 percent of UK stocks by value (Levis, 1993).

From papers by Barber and Lyon (1997), Kothari and Warner (1997), Fama (1998), and Lyon et al. (1999), we learn that all methods calculating long-term abnormal return present some inconveniences. Because investor experience is important, most empirical studies report long-run buy-and-hold returns (BHARs). However, the problem with BHARs is that by compounding monthly returns, long-run BHARs are severely skewed. Lyon et al. (1999) alleviate this problem by developing skewness-adjusted t-statistic. Furthermore, the cross-sectional correlation of abnormal returns should be corrected for as well. That problem exaggerates with the measurement horizon. Cumulative average abnormal returns (CAARs) can solve the cross-sectional correlation. However, CAARs require monthly rebalancing, which may lead to an inflated long-horizon return on the reference portfolio. We intend to use both BHARs and CAARs to evaluate the long-run performance of IPOs.

The average benchmark-adjusted return on a portfolio of n stocks for specified time interval is the equally weighted or value weighted arithmetic average of the benchmark-adjusted returns, w_i is the weight of average returns ($^1/_N$ for the equal weight, $^{s_i}/_{\sum s_i}$ where s_i refers to initial market value of firm i):

$$AR_t = \sum_{i=1}^{n} w_i ar_{it} \qquad \text{(Equation 4-6)}$$

The cumulative average abnormal return from event month 1 to event month s is the summation of the average benchmark-adjusted returns:

$$CAAR_s = \sum_{t=1}^{s} AR_t \qquad \text{(Equation 4-7)}$$

When a firm in portfolio p is delisted before the 5th year anniversary, the portfolio return from the next month is an equally-weighted average of the remaining firms in the portfolio. For the month in which IPO is delisted, the return for that individual firm is vacant. We employ the method by Ritter (1991) to test the statistical significance of the calculated CAAR. The t-statistic for the CAAR in month t, $CAAR_t$ is computed as:

$$t(CAAR) = CAAR_t * \sqrt{n_t}/csd_t \qquad \text{(Equation 4-8)}$$

where n_t is the number of companies trading in each month, and csd_t is computed as:

$$csd_t = [t * var + 2 * (t-1) * cov]^{1/2} \quad \text{(Equation 4-9)}$$

where t is the event month, var is the mean cross-sectional variance over 60 months, and cov is the first-order autocovariance of the AR_t series.

One problem with CAAR is that they do not represent an ex ante applicable investment (trading) strategy. In other words, they do not accurately measure the return to an investor who holds a security for a long post–event period. Buy-and-hold abnormal returns which can capture investor experience by compounding short-term returns are reported by most empirical studies.

A T-month BHAR for new issuing firm i looks like:

$$BHAR_{it} = \prod_{t=1}^{T}(1 + R_{it}) - \prod_{t=1}^{T}(1 + R_{Bt}) \quad \text{(Equation 4-10)}$$

Where R_{Bt} is the expected return and R_{it} indicates the return on company i at month t. For the sample of event firms, the mean BHAR is calculated as the average of the individual firm BHARs.

We test whether the mean abnormal returns are significantly different from zero by estimating the skewness-adjusted t. The statistic is computed as:

$$t_{sa} = \sqrt{n}(S + \frac{1}{3}\hat{\gamma}S^2 + \frac{1}{6n}\hat{\gamma}) \quad \text{(Equation 4-11)}$$

Where

$$S = \frac{\overline{BHAR}}{\sigma(BHAR_t)}, \text{ and } \hat{\gamma} = \frac{\sum_{i=1}^{n}(BHAR_{it} - \overline{BHAR_t})^3}{n\sigma(BHAR_t)^3}$$

where $\hat{\gamma}$ is the estimate of the coefficient of skewness and $\sqrt{n}S$ is the conventional t-statistic. The critical values applied to conventional t-statistics are not appropriate when the bootstrapped skewness-adjusted t-statistics are used. The procedure for obtaining an appropriate critical value when using the bootstrapping approach, as suggested by Lyon et al. (1999) is used here.

Loughran and Ritter (1999) stipulate that choice of weighting scheme is important for power consideration. Brav et al. (2000) illustrate this point by a simple example. Consider a sample consists of 1000 firms, 999 of which have a 1 million market capitalization (the "small" firm) and the rest one with 1001 million market capitalization (the "big" firm). Assume all small firms underperform an equal 50 percent relative to a benchmark while the large firm outperforms by 50 percent. An equal weight measure will imply severe mispricing (-50 percent), while value weighting will lead to a conclusion of no abnormal return. The use of weighting scheme is dependent on our research motivation. If we believe that small stocks likely to underperform than large stocks, power consideration alone indicates the use of equal weight. If we are more concerned about the wealth effect of investors subsequent to IPO, value weighting is more appropriate. Since we need a full picture of UK long-term IPOs performance, we present results using both value and equal weighting to highlight cross-sectional differences in abnormal performance.

We have to address the problem of firms delisting within the fifth anniversary. Liu and Strong (2008) replace de-listed firm returns by either zero or the risk-free rate and obtain similar results. Lyon et al. (1999) and Mitchell and Stafford (2000) use benchmark returns as substitution for missing returns on delisted firms. Gompers and Lerner (2003) categorize the firms into three scenario: being acquired, going bankruptcy or low stock price (less than one dollar), and firms not belonging to any of two situations above. The delisting month return has different treatment[21]. In the subsequent months, they are either set to zero or replaced by the matched size and book-to-market portfolio returns. Gregory et al. (2010) replace the return with benchmark if a de-listed firm preserves its value (such as a merger or acquisition). They assume it to be -100 percent if a de-listing firm lose its value (bankruptcy). We follow Gregory et al. (2010). Specifically, treatment on returns on delisting month replicate Gregory et al. since we use the same database (LSPD) as them. G10 could be identified as a criterion to test whether a de-listed firm preserve or loses its value. If codes are 7, 16, 20, and 21, the missing returns on de-listed firms are replaced by -100 percent. Otherwise, they are replaced

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[21] When a firm is acquired, exit price is used to compute delisting return. When a firm goes bankrupt or disappears with a very low price (less than one dollar), -100 percent delisting return is assumed for the last year. When one firm is priced above one dollar, or cannot be confirmed to be acquired, the return is computed until the last price.

by FTSE All Share Index returns. In periods subsequent to delisting, our sample size will decrease which indicates investment strategy focusing on surviving stocks. We identify delisting as returns terminating before 5th anniversary.

4.4 Empirical Results

4.4.1 Buy-and-hold average abnormal returns

We report the buy-and-hold abnormal returns relative to various benchmarks at one-, three-, and five-year horizon. The benchmarks are FTSE All Share Index (FASI), size decile matching portfolio (SD), Capital Asset Pricing Model (CAPM), Fama-French (1993) three-factor model (F-F), and Carhart (1997) four-factor model (CARHART). There are some companies without full return (60 months) history, which we assume to be delisted. We follow Gregory et al. (2010) to add a delisting (terminating) return. As long as these companies lose their values, we replace the corresponding returns with -1 at their delisting month. Otherwise, they have the same returns as FASI at that month. In subsequent months, the delisted firms vanish from the IPO samples. The number of IPOs for calculating abnormal returns based on first three benchmarks (FASI, SD, and CAPM) is full (1953), while there are less IPOs for last two benchmarks (F-F and CARHART) since the monthly factor information for these benchmarks is only available till December, 2008. The IPOs taking place in 2004 do not enter the analysis. Each IPO monthly return is compounded till the 5th anniversary or delisting month, whichever takes place first. The corresponding benchmark returns is calculated in the same manner. The difference of two buy-and-hold returns at certain time interval is termed as BHAR. The average of individual BHARs at one-, three-, and five-year horizon is what we see in panel A of table 4-2. If value weight average is used, panel B of table 4-2 is produced. Value is measured as market capitalization of ordinary shares at the end of first trading month.

[Insert table 4-2 about here]

Panel A of table 4-2 shows that there is a consistent underperformance if measured at five-year horizon. The magnitude of underperformance (-44.1 percent) at that time from size-control benchmark is largest. Additionally, this is quite close (-47.6 percent) to results in Gregory et al. (2010). Buy-and-hold abnormal returns over post-IPOs five year periods based on CAPM is smallest, with statistically insignificant -2.4 percent. Nevertheless, that's the only insignificant underperformance found among five benchmarks. When turning to three-year interval, at which point we notice the underperformance is not significant. Based on this, we find the evidence that underperformance accelerates beyond three years. From panel B, we get different picture as from panel A. IPOs yield outperformance relative to all five benchmarks, among which two measurments are significant. Actually, the outperformance could be found as early as three year horizon. The improvement from value weight scheme supports the view that the size of IPOs with worst performance is smaller.

4.4.2 Cumulative average abnormal Returns

As supplement, we also produce results from cumulative abnormal returns measure. The average abnormal returns are calculated monthly, and then cumulate depending on holding horizon. The number of observations, replacement of delisting returns, and value weight determination follow table 4-2.

[Insert table 4-3 about here]

Panel A of table 4-3 presents equal weighted results and panel B displays value weighted results. Columns 2, 3, and 4 of each panel demonstrate the abnormal returns at one-, three-, and five-year horizon. Consistent with results from panel A of table 4-2, we still find underperformance at five year horizon. FASI, SD, and CAPM based CAARs produce significant underperformance while F-F and CARHART yield insignificant outperformance. Compared with figures at three-year horizon, we cannot find many deviations. As long as value weight is applied, we again find the performance improvement, causing no underperformance finding. While three benchmarks witness the improvement when weight is changed from equal to value, F-F and CARHART experience abnormal returns deterioration. Given the concern mentioned by Espenlaub et al. (2000), we would also prefer not to place too much emphasis on Fama-French model because Michou et al. (2007) warn that we should be cautions in explaining results from Fama-French factor models since different ways of estimating the factors can result in quite different characteristics for the factor time series. For the same reason, Carhart (1997) model cannot be placed too heavily as well.

[Figure 4-1 about here]

Figure 4-1 displays the time series of equal weighted buy-and-hold abnormal returns and cumulative average abnormal returns versus various benchmarks during the post-IPOs 60 months. Two measurements show different time series. From buy-and-hold measure, the deterioration of performance mainly occurs between three and five years. However, the cumulative average abnormal returns drop sharply during the second year. Additionally, we find in the buy-and-hold abnormal returns measurement, the adjusted return experiences the large variation during month 36 to month 44 if based on F-F and Carhart model. It drops from around -10 percent at month 36 to almost -60 percent by the end of 43 month, and then rockets to the -10 percent in next few months. We find the extreme values cause the variation. Among the sample, Geriden group plc has extreme positive benchmark returns which terminate till month 43. In the F-F model, the buy-and-hold abnormal return is -50711.98 percent while it is -66738.53 percent at month 43 for the company. If the sample is excluded from the sample, the F-F and Carhart based number will present much smoother line.

4.5 Calendar Time Abnormal Returns

Besides the analysis based on event time framework, we also include work based on calendar time framework in order to confirm the robustness of the results. Loughran and Ritter (1995) mention that t-statistics is overvalued because of assumption that contemporary returns are independent which is not valid here. Lyon et al. (1999) and Mitchell and Stafford (2000) support use of average abnormal returns on calendar-time portfolios. The composition of sample portfolio changes each month. Our selected portfolio constitutes rolling windows which pick firms for each portfolio being public during the last certain time period (13, 37, 61 months) in each calendar month. The 13, 37, and 61 months correspond to the one-year, three-year, and five-year horizon. The reason that they are one month longer than designated numbers (12, 36, 60) is because the first partial month (issue month) return is not included in the analysis. To ensure the return history is one-year (three-year, five-year), we have to add one month. The monthly returns on those portfolios are estimated by equal averaging monthly returns of firms forming the portfolios. February, 1982 is the first calendar month for all three portfolio and the termination month of the portfolios depends on the fact whether it belongs to 12-month portfolio, 36-month portfolio or 60-month portfolio. 60-month portfolio ends till December, 2009 while 36-month portfolio finishes at January, 2008.

We choose capital asset pricing model (CAPM), Fama-French three-factor model and Carhart four-factor model as benchmarks. Their detailed use will be illustrated in the following:

CAPM is used as the first benchmark to calculate average monthly abnormal return. It could be expressed as follows:

$$R_{pt} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_{it} \qquad \text{(Equation 4-12)}$$

Where R_{pt} is the monthly return on the rolling portfolio in calendar month t, R_{ft} is the monthly return of the 3-month treasury bill in the corresponding month, β_i is the CAPM beta of portfolio, estimated by an OLS regression up to 60 months after the IPO.

Fama-French three-factor model is often used as another asset pricing base for the long-run performance of IPOs (Barber and Lyon 1997, Brav and Gompers 1997, Espenlaub et al. 2000). The calendar-time equal weighted return of the portfolio is used to estimate the following regression:

$$R_{pt} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it} \qquad \text{(Equation 4-13)}$$

where R_{pt} is the monthly return on the calendar-time portfolio, the other parameters being the same interpreted as in event time framework. The regression yields parameter estimates of α_i, β_i, s_i, and h_i. The error term in the regression is denoted by ϵ_{it}. The estimate of the intercept term (α_i) provides a test of the null hypothesis that the mean monthly excess return on the calendar-time portfolio is zero.

Carhart four factor model is the third benchmark in calendar time framework, with an additional factor added to capture the risk related to momentum factor

$$R_{pt} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + l_i UMD_t + \varepsilon_{it} \qquad \text{(Equation 4-14)}$$

[Table 4-4 about here]

Table 4-4 provides evidence of abnormal return in calendar time framework. The t statistics is presented below each coefficient. *, **, and *** represent coefficient significant at 10 percent, 5 percent, 1 percent level. Alphas in the table represent the intercepts of each regression, with 0.0001 indicating 0.01 percent on average each month, or about 0.12 percent per year. In 12 months portfolio, FF yields outperformance of 0.6 percent on average per month, significant at 5 percent level. Carhart model yields similar results except outperformance is not as significant as those from FF. CAPM never produces significant outperformance in all holding period.

Unlike the insignificant underperformance discovered by Espenlaub et al. (2000), none of the benchmark provides the evidence of underperformance in calendar time framework. Market effects, small firm effect, and book to market ratio effect are significant in all models and in all portfolios. However, we find the coefficients capturing momentum effect is insignificant in all portfolios and adjusted R^2 don't increase compared to FF factor. The insignificance of coefficients before momentum factor may indicate the risk related to momentum won't be compensated properly in our sample.

In the calendar time framework, the portfolio variance is time varying and depends on the number of IPOs included in rolling portfolio. The assumption of using ordinary least square

(OLS) is not valid. We switch to general least square (GLS) to estimate the coefficients, which is used in Gregory et al. (2010). Variance is designed to be a linear function of the number of firms entering the portfolio. The variance is assumed to be form of $\hat{\delta}_0 + \hat{\delta}_1 n_t$. To ensure the variance is positive, we set $Var(u_t) = \exp(\hat{\delta}_0 + \hat{\delta}_1 n_t)$. We first obtain the unrestricted residuals $\hat{u}_t$ from:

$$R_{pt} = \alpha + \beta R_{bt} + u_t \qquad \text{(Equation 4-15)}$$

Where R_{bt} is the benchmark return in event month t.

Then we estimate the regression in the form of:

$$\log(\hat{u}_t^2) = \delta_0 + \delta_1 \log(n_t) + error_t \qquad \text{(Equation 4-16)}$$

Finally, we set $Var(u_t) = \exp(\hat{\delta}_0 + \hat{\delta}_1 \log(n_t))$.

[Table 4-5 about here]

Table 4-5 presents results from GLS. GLS formulation seems to provide better fit in terms of R-squared statistics. The results from both GLS and OLS are same in the intercept sign. The magnitude of outperformance from GLS is smaller than that from OLS. Only FF produces significant outperformance in 12 month portfolio at 10 percent significance level. In summary, our results from GLS are consistent with those from OLS.

4.6 Performance by listing market and method

G13 in LSPD provides us listing market information of sample IPOs. We analyse performance through their listing markets into Official list (OL), Alternative Investment Market (AIM), and Unlisted Securities Market (USM). Due to less strict listing requirement, firms in AIM or USM are generally smaller than their counterparts in OL. Goergen et al. (2007) show that smaller firms have different long run performance characteristics. Greogry et al. (2010) also find the discrepancies in the performance among three markets. They show that long-run performance of IPOs in OL is hard to conclude, while firms in AIM and USM perform poorly which contribute to the overall underperformance. We conduct a similar analysis but based on size control portfolio only.

[Insert table 4-6 about here]

Panel A of table 4-6 provides us the equal weight buy-and-hold abnormal returns for IPOs listed in OL, AIM, and USM. The observations of IPOs in each market are also reported. Our results are consistent with Gregory et al. (2010). With size control portfolio as benchmark, we find significant outperformance (28.5 percent) from OL by the end of 5th anniversary, significant underperformance (-94.8 percent and -394.3 percent) from AIM and USM at the same time. Their outperformance or underperformance is prevalent across time series, since their abnormal returns sign do not change ever. The rows including observation information also indicate there's much higher survivor possibility (72.4 percent) from OL. This figure is only 31.4 percent and 59.6 percent for firms listed in USM and AIM by the end of 5th year. Additionally, those three figures are conservative estimate of survivor proportion since we add one extra month returns as delisting returns for firms without full returns history. For companies delisted on 59th month, it cannot be detected from observations reduction. Panel B of table 4-6 provides us with more detailed information about delisted firms. We measure the delisting percentage (delisting IPO number/total IPO number), losing value percentage (losing value IPO number/total IPO number), losing value among delisting (lose value IPO number/delisting IPO number). All three measurements show that IPOs listed in OL has longer history and lower liquidation possibility. IPOs listed in USM tend to be delisted more frequently, which could be expected since there is no firm listed in USM since 1993. Gregory et al. add that the mainly delisting reasons for firms in USM could be either liquidation or administrative receivership.

Panel C lists the IPOs performance excluding delisted samples. It provides us a clue that whether poor or superior performance in different market is influenced by delisted firms or remains the same after excluding those firms. Row 3 (observations) of each sub-section displaying the number of observations remains the same, which confirms excluding delisted firms. The performance for each market improves to small extent compared to results from panel A. However, the conclusion that better performance from OL, and poorer performance form AIM and USM still holds. We could conclude it is not due to the higher delisting or liquidation percentage that causes poor performance from AIM or USM. It is the listing market that determines the long-run performance. We suspect that IPOs with better quality will choose to be listed in OL, while the other firms are more capable of using market overreaction to timing the IPOs.

Besides the information provided by listing market, we are also interested in the performance of IPOs categorized by listing method. Although there are seven listing methods listed in table 4-1, only two (placing and offer for sale) are main, occupying 93.7 percent. Between these two, number of IPOs choosing placing dominate the other (1642 vs. 187). We notice the market value between two methods has significant difference. Therefore, we adopt size control portfolio as benchmark.

[Insert table 4-7 about here]

Table 4-7 presents the results, with panel A reporting buy-and-hold abnormal returns and panel B documenting cumulative abnormal returns. We can find significant underperformance of IPOs with placing at all three time intervals (one-, three-, and five-year) from both panel A and B. For IPOs choosing offers, their performances differ between panel A and B. Given the high volatility of buy-and-hold abnormal returns, skewness, and small size of sample (187), we interpret the offer IPOs from panel B, which we cannot find significant underperformance or outperformance. It appears to us that long-run underperformance is concentrated among IPOs with placing method.

4.7 Comparison with chapter 3

The found underperformance, although not significant, is in contrast with results found in chapter 3. The abnormal returns in chapter 3 are positive. We are trying to find whether the discrepancy would vanish if the samples in chapter 3 and 4 are in the same period, or financial firms are excluded from chapter 3. Therefore, we divide the sample in chapter 3 into non-financial firms and financial firms. Also, sample in the chapter 4 are divided into two periods, 1981-2000 and 2001-2004, the first of which is same with sample period of chapter 3. We calculate the buy-and-hold abnormal returns at five-year horizon for these four sub-samples. The results among different samples are comparable. Firstly, since both chapters use LSPD as data sources, same returns are used for the same firms. Secondly, the benchmarks for the analysis include FASI, CAPM, and FF, which are both adopted in chapter 3 and 4. The reason for not using CAR as abnormal returns in table 4-8 is that the difference between two samples cannot not be detected using normal t test. The 5-year buy-and-hold abnormal returns for four sub-samples are presented in table 4-8.

[Table 4-8 about here]

As shown from the table, the first two rows display the buy-and-hold abnormal returns for non-financial firms and financial firms respectively. The sample is from chapter 3 and sample period is between 1981 and 2000. The rows 3 and 4 are results from chapter 4, two periods 1981-2000 and 2001-2004. We find the results between row 1 and 2 or between row 3 and 4 are quite similar. In other words, the partition of sample (chapter 3) into non-financial and financial and partition of sample (chapter 4) into two periods cannot cause discrepancy in sub-samples. The t-statistics in the last two rows confirm the finding. The t in the fifth row shows there is significant difference between non-financial firms in chapter 3 and 4 during 1981-2000. After controlling for effect from industry and sample period, we still find significant difference between chapter 3 and 4.

4.8 Conclusion

In this paper, we re-examine the evidence of long-term stock performance of IPOs in UK using a new data set of firms over the period 1982-2004. We adopt a number of alternative benchmarks to assess the validity of our results. These benchmarks allow for size and growth expectation effect. Also, to my best knowledge, Carhart four-factor model is applied on similar analysis for the first time in UK. In line with conclusion from Espenlaub et al. (2000), the results on long-run underperformance over 60-months after IPO depend on the choice of techniques. When measured with cumulative average abnormal returns metrics, only results based on size control portfolio show significant underperformance. All remaining CAARs from other benchmarks either display insignificant underperformance or even significant outperformance. On the contrast, the conclusion from BHAR measure is unanimous, with all five negative abnormal returns and four among five significantly different from zero. For each measure, we add value weight scheme to explore whether there is performance difference among different size IPOs. Nearly all benchmarks show dramatic performance improvement if switched to value weight scheme except Fama-French and Carhart model in CAAR measure. The superior performance confirms the literature (Ritter, 1991; Loughran and Ritter, 1995) that worst performances come from small IPOs. Our finding of underperformance in event time is opposite to the evidence found in last chapter. The main reason is that the sample in the last chapter is not comprehensive, only more than 50 percent of sample size in the same period in this chapter. Therefore, conclusion of outperformance from UK IPOs does not hold here.

We also conduct robustness check via calendar-time work and find that across all calendar-time portfolios, there is no underperformance. Besides the conventional OLS, to allow for the changing portfolio variance, we include GLS in the calendar time framework. Results from two methods yield qualitative same results. The significant outperformance is found in 60-month portfolio. 12-month and 36-month portfolios only produce insignificant outperformance if measured from Jensen-alpha approach. This is consistent with Fama (1998) that apparent anomalies can be due to methodology and most long-term return anomalies tend to disappear with reasonable changes in technique.

Table 4-1 Summary statistics of Initial Public Offerings in UK, 1982-2004

Our identified sample (IPOs) includes 1953 non-financial firms from 1982-2004. Panel A displays the distribution by listing methods and calendar year. Panel B shows the distribution by industry and calendar year. Panel C document the distribution by listing market and calendar year. The last two rows of each panel report the mean and median market value of the sample by listing methods, industry, or listing market. The market value is measured at the end of first trading month, market capitalization of ordinary shares. Listing method is based upon the G8 codes; industry is based upon adjustment of G17; and listing market is based on G13. Their listing methods include placement, offers for sale at fixed price, offers for sale by tenders, subscription, and combination of any two. The confirmation and partition of industry is through Industry Classification Benchmark (ICB). Any companies not belonging to AIM or USM listed will be categorized into OL listed. Due to missing information of industry for 16 stocks, the observation for panel B is 1937.

Panel A: Listing method distribution by calendar year

LSPD Class & G8 Year	Placing (53)	Offers for Sale (54)	Tenders (55)	Subscription (56)	Placing & Open Offer (71)	Placing & Intermediaries Offer (72)	Placing & Offer for Sale (73)	Total
1982	33	3	2	1				39
1983	49	11	14	2				76
1984	65	17	4					86
1985	67	29	8	1				105
1986	72	31	3	1				107
1987	81	14		1				96
1988	84	13		1			1	99
1989	67	14						81
1990	19	13						32
1991	3	6		1				10
1992	25			1				26
1993	57	1		1		1	1	61
1994	85	1	1			4	3	94
1995	48	4						52
1996	129	4			1	4	3	141
1997	95	5			1		8	109
1998	54						2	56
1999	57	2			3		1	63
2000	154	9			3		19	185
2001	67	5			1		7	80
2002	45	2			1		9	57
2003	55	1			1		3	60
2004	231	2			1		4	238
Total	**1642**	**187**	**32**	**10**	**12**	**9**	**61**	**1953**
Mean MV (£m)	57.6	499	190	34.2	124	144	203	107
Median MV (£m)	15	29	20.5	13.5	30.6	128	36.4	16

Panel B: Industry distribution by calendar year

LSPD Industry & G8 year	Oil & Gas	Basic Industries	Industries	Consumer Goods	Health Care	Consumer Services	Telecommunications	Utilities	Technology
1982	3		19	7	2	7			
1983		6	39	5	2	15		1	8
1984	3	4	42	12		19	1		5
1985	2	3	47	15	3	30			3
1986	2	3	50	12	2	32			5
1987	1	2	45	10	6	22			10
1988	2	6	54	9	6	16			4
1989	1	2	29	6		23	1	11	4
1990	2	1	4	2	2	7	1	12	
1991	1			1		4		4	
1992			10	4	3	7			2
1993	2	6	18	5	9	13		1	6
1994		3	34	13	7	20	1		16
1995	1	3	19	8	5	15			1
1996	1	4	44	13	9	37	8	2	23
1997	1	3	32	12	7	31	4		19
1998	1	2	17	1	5	17			13
1999	1	3	17	3	1	16	1		21
2000	3	9	20	5	19	56	5		66
2001	2	7	22	5	10	18	3		13
2002	5	9	16	3	8	10			6
2003	3	12	14	3	9	13	1	1	4
2004	21	32	56	15	22	43	11	2	34
Total	**58**	**120**	**648**	**169**	**137**	**471**	**37**	**34**	**263**
Mean MV (£m)	154	119	50.3	57.5	53.2	68.3	1280	651	132
Median MV (£m)	24.4	15	13	14	26.7	15	36.4	526	30

Panel C: Listing market distribution by calendar year

Year	OL	AIM	USM	Total
1982	13		26	39
1983	37	1	38	76
1984	43	11	32	86
1985	55	4	46	105
1986	64	12	31	107
1987	67	13	16	96
1988	65	16	18	99
1989	61	10	10	81
1990	25	2	5	32
1991	9	1		10
1992	25	1		26
1993	56	4	1	61
1994	86	8		94
1995	44	8		52
1996	76	65		141
1997	54	55		109
1998	23	33		56
1999	20	43		63
2000	42	143		185
2001	11	69		80
2002	13	44		57
2003	12	48		60
2004	27	211		238
Total	928	802	223	1953
Mean MV (£m)	197	30.4	10.4	107
Median MV (£m)	28	14	6	16

Table 4-2 One-, three- and five-year post-IPO buy-and-hold abnormal returns versus various benchmarks
The sample is 1953 identified IPOs from 1982 through 2004. One-, three-, and five-year buy-and-hold returns (both equal weight and value weight) are compared to alternative benchmarks. In the first row of each panel, we employ the FTSE All Share Index (FASI) as the benchmark. Row 2 of each panel presents abnormal performance relative to size-dicile matching portfolios. Rows 3, 4, and 5 are abnormal returns adjusted to Capital Asset Pricing Model (CAPM), Fama-French (1993) Three-factor model (FF), and Carhart (1997) four-factor model (CARHART). Number of observations relative to FF and CARHART is 238 less than that in other benchmarks since benchmark factor information is not available in 2009. Columns 2, 3, and 4 document abnormal returns at one-, three-, and five-year horizon. In panel A, we report equal weight results, and we report value weigh results in panel B. Value is based on the market value of ordinary shares at the end of first trading month for each IPO. The returns in delisting months will be replaced by either -1 or FASI returns at that month, depending whether firms preserve their values. The skewness-adjusted t-statistic follows Lyon et al. (1999) to correct for the negative bias of abnormal returns and in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Equal weight buy-and-hold abnormal returns

Benchmarks	One-Year	Three-Year	Five-Year
FASI	-0.027	-0.008	-0.122
(Skewness-adjusted t-statistic)	(-1.625)	(-0.123)	(-1.535)
SD	-0.045***	-0.151**	-0.441***
(Skewness-adjusted t-statistic)	(-2.695)	(-2.335)	(-4.481)
CAPM	-0.014	0.020	-0.024
(Skewness-adjusted t-statistic)	(-0.867)	(0.445)	(-0.313)
FF	-0.039	-0.070	-0.259**
(Skewness-adjusted t-statistic)	(-1.941)	(-0.949)	(-2.029)
CARHART	-0.041	-0.110	-0.326**
(Skewness-adjusted t-statistic)	(-1.891)	(-1.322)	(-2.170)

Panel B: Value weight buy-and-hold abnormal returns

	One-Year	Three-Year	Five-Year
FASI	-0.075***	0.151***	0.096**
(Skewness-adjusted t-statistic)	(-5.312)	(4.474)	(2.204)
SD	-0.061***	0.149	0.082
(Skewness-adjusted t-statistic)	(-4.523)	(4.370)	(1.796)
CAPM	-0.041***	0.214	0.218***
(Skewness-adjusted t-statistic)	(-3.218)	(7.343)	(5.768)
FF	-0.153***	-0.001	0.070
(Skewness-adjusted t-statistic)	(-13.537)	(0.011)	(0.801)
CARHART	-0.123***	0.043	0.043
(Skewness-adjusted t-statistic)	(-13.420)	(0.810)	(0.357)

Table 4-3 One-, three- and five-year post-IPO cumulative abnormal returns versus various benchmarks

The sample is 1953 identified IPOs from 1982 through 2004. Monthly abnormal returns (both equal weight and value weight) compared to alternative benchmarks are cumulated over one-, three, and five-year horizon. In the first row of each panel, we employ the FTSE All Share Index (FASI) as the benchmark. Row 2 of each panel presents abnormal performance relative to size-dicile matching portfolios. Rows 3, 4, and 5 are abnormal returns adjusted to Capital Asset Pricing Model (CAPM), Fama-French (1993) Three-factor model (FF), and Carhart (1997) four-factor model (CARHART). Number of observations relative to FF and CARHART is 238 less than that in other benchmarks since benchmark factor information is not available in 2009. Columns 2, 3, and 4 document abnormal returns at one-, three-, and five-year horizon respectively. In panel A, we report equal weight results, and we report value weigh results in panel B. Value is based on the market value of ordinary shares at the end of first trading month for each IPO. The returns in delisting months will be replaced by either -1 or FASI returns at that month, depending whether firms preserve their values. The t-statistic follows Ritter (1991) and in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Equal weight cumulative abnormal returns

Benchmarks	One-Year	Three-Year	Five-Year
FASI	-0.058***	-0.149***	-0.180***
(t-statistic)	(-2.542)	(-3.410)	(-2.715)
SD	-0.065***	-0.203***	-0.277***
(t-statistic)	(-2.992)	(-4.932)	(-4.422)
CAPM	-0.043**	-0.090**	-0.104**
(t-statistic)	(-1.920)	(-2.116)	(-1.611)
FF	-0.034*	-0.027	0.043
(t-statistic)	(-1.495)	(-0.640)	(0.667)
CARHART	-0.026	-0.021	0.062
(t-statistic)	(-1.157)	(-0.485)	(0.963)

Panel B: Value weight cumulative abnormal returns

Benchmarks	One-Year	Three-Year	Five-Year
FASI	-0.109***	-0.052**	0.039
(t-statistic)	(-8.375)	(-2.100)	(1.030)
SD	-0.097***	-0.067**	-0.001
(t-statistic)	(-7.891)	(-2.856)	(-0.020)
CAPM	-0.073***	0.056**	0.119***
(t-statistic)	(-5.814)	(2.367)	(3.295)
FF	-0.169***	-0.112***	-0.108**
(t-statistic)	(-12.232)	(-4.282)	(-2.766)
CARHART	-0.154***	-0.091***	-0.069
(t-statistic)	(-11.321)	(-3.507)	(-1.797)

Figure 4-1 Equal weight buy-and-hold abnormal returns and cumulative average abnormal returns versus various benchmarks

FASI, SD, CAPM, F-F, and CARHART represents adjusted returns based on FTSE All Share Index, size control portfolio, capital asset pricing model, Fama-French three-factor model, Carhart four-factor model from month 0 to month 60

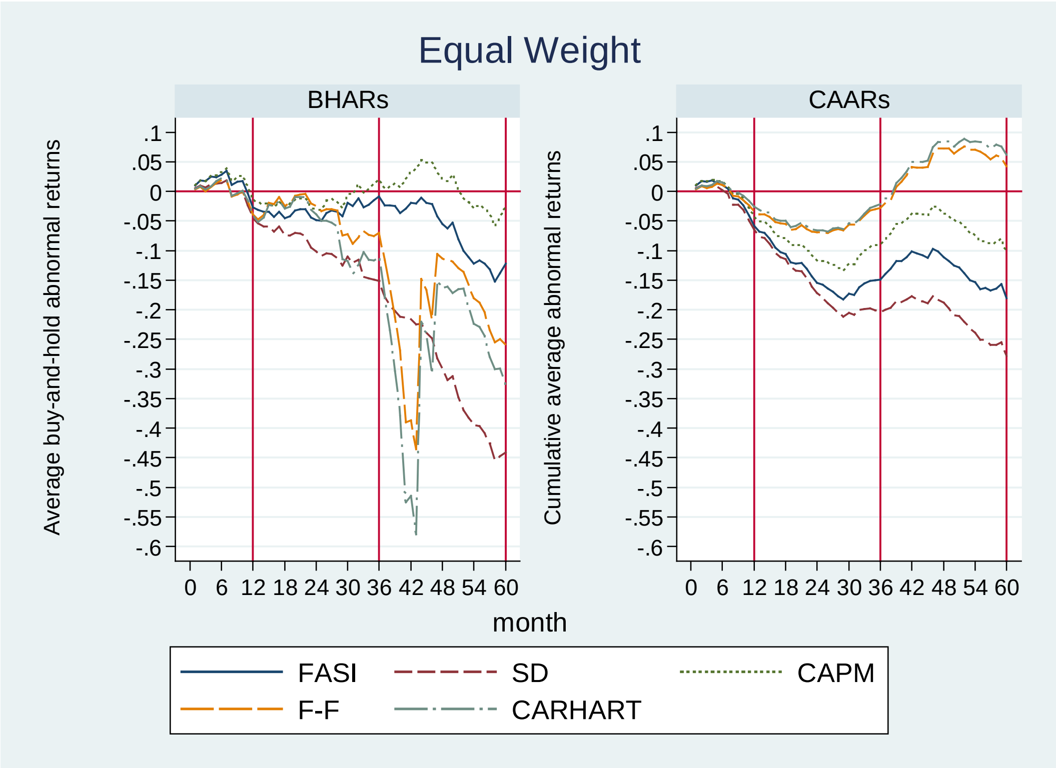

Table 4-4 Calendar time regression results for alternative benchmark models (OLS)

Benchmarks are the Capital Asset Pricing Model (CAPM), the Fama-French (FF) (1993) three-factor model and Carhart (1997) four-factor model. Figures below the coefficients in the parentheses are the t-statistics. The estimated regressions use 288 (312, 323) monthly observations with the dependent variable being the equal weighted return on rolling IPO portfolio which goes public during the last 12 (36, 60) months over the risk free return, and the independent variables being the benchmark factors implied by expressions in the test. RMF is the sensitivity of the excess returns on the company to the excess returns on the market (FASI); SMB is the sensitivity of the excess returns on the company to the "small firms premium", and HML is the sensitivity to the HML factor in the FF and Carhart model, UMD is coefficient for momentum factor in Carhart model. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: 12 Months

	CAPM	FF	Carhart
Alpha	0.002	0.006**	0.004
	(0.77)	(2.13)	(1.44)
RMF	0.786***	0.747***	0.775***
	(10.03)	(14.96)	(15.43)
SMB		0.925***	0.922***
		(9.25)	(9.48)
HML		-0.659***	-0.555***
		(-3.86)	(-3.50)
UMD			0.196**
			(2.21)
R-squared	0.295	0.609	0.618
N	288	288	288

Panel B: 36 Months

	CAPM	FF	Carhart
Alpha	0.001	0.004*	0.004*
	(0.42)	(1.76)	(1.88)
RMF	0.785***	0.764***	0.758***
	(10.94)	(15.83)	(15.52)
SMB		0.975***	0.975***
		(12.00)	(12.04)
HML		-0.414***	-0.440***
		(-5.21)	(-5.15)
UMD			-0.049
			(-0.61)
R-squared	0.351	0.662	0.661
N	312	312	312

Panel C: 60 Months

	CAPM	FF	Carhart
Alpha	0	0.003	0.003
	(0.18)	(1.54)	(1.27)
Beta	0.864***	0.840***	0.843***
	(12.27)	(18.40)	(18.30)
Gamma		1.025***	1.026***
		(13.53)	(13.40)
Delta		-0.360***	-0.344***
		(-4.60)	(-3.96)
UMD			0.03
			(0.41)
R-squared	0.407	0.708	0.707
N	323	323	323

Table 4-5 Calendar time regression results for alternative benchmark models (GLS)

Benchmark models are the Capital Asset Pricing Model (CAPM), the Fama-French (FF) (1993) three-factor model and Carhart (1997) four-factor model. Figures below the coefficients are the t-statistics. The estimated regressions use 288 (312, 323) monthly observations with the dependent variable being the equally weighted return on rolling IPO portfolio which goes public during the last 12 (36, 60) months over the risk free return, and the independent variables being the benchmark factors implied by expressions in the test. RMF is the sensitivity of the excess returns on the company to the excess returns on the market (FTSE All Share Index); SMB is the sensitivity of the excess returns on the company to the "small firms premium", and HML is the sensitivity to the HML factor in the FF and Carhart model, UMD is coefficient for momentum factor in Carhart model. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: 12 Months

	CAPM	FF	Carhart
Alpha	0.002	0.005*	0.004
	(0.64)	(1.87)	(1.37)
RMF	0.790***	0.749***	0.775***
	(10.18)	(16.04)	(15.71)
SMB		0.922***	0.921***
		(9.54)	(9.57)
HML		-0.648***	-0.554***
		(-3.93)	(-3.53)
UMD			0.194**
			(2.20)
R-squared	0.3	0.625	0.622
N	288	288	288

Panel B: 36 Months

	CAPM	FF	Carhart
Alpha	0.001	0.003	0.003
	(0.31)	(1.31)	(1.49)
RMF	0.789***	0.772***	0.766***
	(11.08)	(16.58)	(16.24)
SMB		0.976***	0.976***
		(12.06)	(12.09)
HML		-0.403***	-0.429***
		(-5.01)	(-5.06)
UMD			-0.05
			(-0.63)
R-squared	0.356	0.683	0.683
N	312	312	312

Panel C: 60 Months

	CAPM	FF	Carhart
Alpha	0.000	0.002	0.002
	(0.02)	(1.15)	(0.96)
RMF	0.867***	0.840***	0.843***
	(12.45)	(19.19)	(18.96)
SMB		1.024***	1.025***
		(13.72)	(13.61)
HML		-0.352***	-0.339***
		(-4.45)	(-3.96)
UMD			0.024
			(0.35)
R-squared	0.414	0.728	0.727
N	323	323	323

Table 4-6 One-, three, and five-year post-IPO buy-and-hold abnormal returns by listing market

This table measures the one-, three-, and five-year post issue buy-and-hold abnormal returns compared to size control benchmarks. Panel A and Panel C are similar in the format except the sample in panel C excludes all delisted firms. Sample used in panel A is 1953 identified IPOs from 1982 to 2004. In each market (OL, AIM, and USM), the skewness-adjusted t-statistic (Lyon et al., 1999) and observations at certain time horizon are reported below the returns. Panel B documents the number and percentage of delisting and losing value. Delisting percentage is obtained by using delisted IPO number deflated by total IPO number. Losing value percentage is obtained by using losing value IPO number deflated by total IPO number. Losing value among delisting is calculated as losing value IPO number dividing delisted IPO numbers. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Equal weight buy-and-hold abnormal returns by listing markets

Markets	One-Year	Three-Year	Five-Year
OL	0.068***	0.334***	0.264**
(Skewness-adjusted t-statistic)	(3.431)	(5.333)	(2.608)
Observations	923	814	672
AIM	-0.146***	-0.504***	-0.971***
(Skewness-adjusted t-statistic)	(-4.663)	(-3.800)	(-8.339)
Observations	787	673	478
USM	-0.158***	-1.294***	-3.928***
(Skewness-adjusted t-statistic)	(-3.007)	(-11.889)	(-12.718)
Observations	214	135	70

Panel B: Delisting IPOs analysis

	OL	AIM	USM
Total Number	928	802	223
Delisting Number	290	391	163
Losing Value Number	44	101	32
Delisting percentage	0.313	0.488	0.731
Losing Value Percentage	0.047	0.126	0.143
Losing Value among delisting	0.152	0.258	0.196

Panel C: Equal weight buy-and-hold abnormal returns by listing markets

Markets	One-Year	Three-Year	Five-Year
OL	0.092***	0.448***	0.336***
(Skewness-adjusted t-statistic)	(4.262)	(6.313)	(3.296)
Observations	638	638	638
AIM	-0.095**	-0.292**	-0.897***
(Skewness-adjusted t-statistic)	(-2.206)	(-2.183)	(-7.200)
Observations	410	410	410
USM	-0.225***	-1.329***	-3.247***
(Skewness-adjusted t-statistic)	(-2.769)	(-5.792)	(-11.821)
Observations	60	60	60

Table 4-7 One-, three-, and five-year post-IPO buy-and-hold abnormal returns and cumulative abnormal returns by listing method

This table measures the one-, three-, and five-year post issue buy-and-hold abnormal returns compared to size control benchmarks. G8 is used to identify the listing method. The corresponding G8 for samples with placing is 53 and for samples with offer is 54. Panel A uses buy-and-hold abnormal returns and panel B adopts cumulative abnormal returns. Skewness-adjusted t-statistic follows Lyon et la. (1999) The t-stat in panel B follows Ritter (1991). T-statistics are presented in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Equal weight buy-and-hold abnormal returns

Listing Method	One-Year	Three-Year	Five-Year
Placing	-0.042**	-0.164**	-0.434***
(Skewness-adjusted t-statistic)	(-2.272)	(-2.730)	(-3.939)
Offer	0.004	0.235	-0.243
(Skewness-adjusted t-statistic)	(0.113)	(1.098)	(-1.081)

Panel B: Equal weight cumulative abnormal returns

Listing Method	One-Year	Three-Year	Five-Year
Placing	-0.062**	-0.210***	-0.284***
(t-statistic)	(-2.446)	(-4.336)	(-3.897)
Offer	-0.007	0.012	0.019
(t-statistic)	(-0.194)	(0.179)	(0.197)

Table 4-8 Five-year post-IPO buy-and-hold returns by industry and sample period

This table measures the five-year post issue buy-and-hold abnormal returns compared to FASI, CAPM, and FF. We divide the sample in chapter 3 into financial and non-financial firms to be compared with samples in chapter 4. Similarly, we divide the sample in chapter 4 into between 1981-2000 and 2001-2004. All the figures are five-year equally weighted results. T-statistics are presented in parentheses ( ). *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Chapter	Sample Size	Industry	Time period	Benchmark		
				FASI	CAPM	FF
3	715	non-financial	1981-2000	0.265	0.373	0.511
3	104	financial	1981-2000	0.262	0.363	0.386
4	1518	non-financial	1981-2000	-0.064	0.033	-0.136
4	435	non-financial	2001-2004	-0.062	0.025	-0.360
t-stat for non-financial firms between 1981-2000 in chapter 3 vs. chapter 4				(1.910**)	(1.989**)	(1.791**)
t-stat for non-financial firms between 1981-2000 vs. 2001-2004				(-0.007)	(0.068)	(0.451)
t-stat for firms in chapter 3 between non-financial and financial				(0.006)	(0.020)	(0.264)

Chapter 5 Underpricing and long-term performance of two-stage IPOs in UK

5.1 Introduction

Existing numerous literatures document significant high market-adjusted returns at the first day of trading (IPO underpricing) and low long-term wealth loss compared to comparable benchmarks (IPO long-term underperformance). Therefore, a two-part puzzle exists, including IPO underpricing and long-run underperformance.

One consensus of IPO underpricing is that uncertainty is costly for IPOs and that's why IPOs have to leave money in the table. To solve the pricing uncertainty, some firms wishing to raise capital adopt a two-stage strategy. They first list and develop a public market for existing shares and then sell new shares to public in the second stage. Derrien and Kecskes (2007) (D&K thereafter) confirm the strategy adopted in UK market can reduce the initial returns by 10 percent to 30 percent than comparable IPOs. This is ideal scenario for examining the first puzzle, IPO underpricing. D&K define these companies as two-stage firms. As comparison, they define another two types of public firms (pure introductions and regular IPOs). Pure introductions are firms that list but do not issue equity to the public within 5 years of listing. Two-stage firms differ from pure introductions in that they issue equity within 5 years of listing. Regular IPOs lists and issues equity simultaneously. UK is chosen as the target market since firms have to list and concurrently issue equity in other countries and the two-stage strategy could not be applied.

D&K analyze the short-term benefits of two-stage strategy. First, introduction reduces value uncertainty and displays lower initial returns than comparable IPOs. Extent of underpricing determines the direct cost of an IPO. The two-stage strategy is less costly than an IPO. Second, firms adopting two-stage strategy have stronger market timing ability than comparable IPOs. In cold market, they substitute introductions for IPOs. When market improves, they issue equity faster than IPOs. Using limited data we have access to, we will test whether underpricing for two-stage firms is less than regular IPOs. However, D&K do not mention about long-term wealth effect of these two-stage firms, whether they will display a distinct performance pattern compared to benchmarks or regular IPOs. We try to fill in this gap by tracking the long-term stock performance after these firms' (two-stage firms) offering.

Our results find that two-stage firms experience lower initial returns than regular IPOs and comparable long-term performance relative to regular IPOs. Due to data limitation, we are unable to test the market timing ability hypothesis concerning underpricing.

Chapter 5 is organized as follows. In section 5.2, we provide literature review on underpricing and long-term performance of seasoned equity offerings (SEOs). We also develop our hypotheses here. Section 5.3 describes our samples and methodology used. Section 5.4 presents the empirical results. In section 5.5 we discuss results and provide conclusions.

5.2 Literature review and hypotheses

Our focus of the paper is on the underpricing and long-term stock performance of two-stage IPOs. Since SEO is more similar to two-stage firm relative to IPO, we provide literature on long-term performance of SEO.

Five years is the maximum time period that could be identified as two-stage IPOs if they don’t raise capital originally but do so later. The time interval is given by D&K without further explanation. We need some references to measure the appropriateness of the threshold. The two-stage firm offering is similar to SEO in that they both raise capital a while after being listed. Although D&K emphasize that two-stage firms are distinct from SEO, we could only find some clues from SEO to assure the accuracy of five year being a maximum time interval. Eckbo and Norli (2006) provide a table showing descriptive statistics for follow-on security offerings made by 6,092 firms that went public during the period 1980-2000. The average number of years between the IPO offer date and SEO date is 2.31 years, with standard deviation of 2.5. These two figures show that around 68.2 percent of SEO occur within 4.81 years after their IPO offer date if the distribution is normal. Bear in mind, only after burning through the IPO proceeds, would SEO take place. Eckbo and Norli (2006) find that it appears that it takes 2.35 years on average running out IPO proceeds. After adding another one standard deviation (2.5) and minus of 2.35, we estimate that around 95.4 percent two-stage IPOs occur within 4.96 years since introduction date. However, we could not find any literatures concerning UK firms. The estimate is based on normal distribution assumption, and we do not find any evidence against this assumption.

The underpricing of initial public offerings (IPOs) is well documented. Current research use initial returns to proxy for unobservable underpricing. Ibbotson et al. (1988) find average first-day return is 16.3 percent in the years 1960-1987 in USA. According to Ljungqvist (2007), there are four group theories explaining the phenomenon, asymmetric information, institutional, control, and behavioral. The empirical evidence broadly supports the view that information frictions contribute to IPO underpricing. There are three parties involving IPO transaction, issuing firm, the bank underwriting and marketing the deal, and the investors buying the stock. Asymmetric information models assume some parties know better than other parties. The best known asymmetric information model is Rock's (1986) winner's curse, which is an application of Akerlof's (1970) lemons problem. Rock constructs a model where investors are either informed or uninformed. Informed investors end up with purchasing more successful IPOs while uninformed investors often buy less successful IPOs. This imposes a winner's curse on uninformed investors. In order to retain uninformed investors in the market, the new issuers have to provide additional premium – underpricing. An underpricing is a voluntary cost to the issuer to attract uninformed investors still in the IPO market. The implication is that underpricing could be reduced via reducing information asymmetry problem. The traditional way to reduce information asymmetry is to hire prestigious underwriter (Booth and Smith, 1986; Carter and Manaster, 1990; Michaely and Shaw, 1994) or a reputable auditor (Titman and Trueman, 1986). The choice of underwriter and auditor is viewed as certificate of quality of the firm because banks avoid underwriting low-quality issuers if more reputable capital available. D&K propose another method to reduce information asymmetry, two-stage strategy. Another implication from asymmetric information model is that the greater is ex ante uncertainty, the higher is expected underpricing. This implication is also confirmed in D&K. They find lower valuation uncertainty at offering announcement is associated with lower underpricing. Based on the previous literature and empirical support from D&K, we can develop our first hypothesis

H1: Two-stage IPOs have lower underpricing than regular IPOs

Poor stock performance of firms after raising capital through seasoned equity offerings in one anomaly in financial markets. Recent studies by Loughran and Ritter (1995), Spiess and Affleck-Graves (1995), Brav, Geczy, and Gompers (2000), Eckbo et al. (2000), Mitchell and Stafford (2000), Jegadeesh (2000), and Clarke, Dunbar, and Kahle (2001) etc document significant negative abnormal returns for issuing firms up to five year after the offering date. For example, Loughran and Ritter (1995) demonstrate that average annual stock returns of issuing firms is about 8 percent less than size-matched non-issuing firms over the five-year period after the offering.

The interpretation of low SEO post-offering returns is mixed. Three alternative explanations for this pattern appear in the literature. The behavioral view is that managers choose to issue equity when firms are overvalued and investors excessively extrapolate from positive pre-announcement experience and underreact to bad news of an SEO announcement. The slow recognition and correction result in low long-run returns. Additionally, Jain and Kini (1994), Loughran and Ritter (1995), and Baker and Wurgler (2002) propose managers time the market and take advantage of windows of opportunity. Investors' overreaction to SEO announcement allows managers to sell overvalued equity, again leading to long-run underperformance. Alternative explanation comes from Fama (1998) and others who argue low returns come from the characteristics of SEOs, such as low market-to-book ratio and high past returns, and not related to issuing seasoned equity per se. Brav and Gompers (1997) and Brav et al. (2000) document that SEO firms are concentrated among small-growth firms, and suggest that their underperformance reflects Fama-French (1993) size and book-to-market factors. The third investment-based explanation states that public firm is expected to earn lower returns after issuance since required return is lower or risk of the firm decrease. Furthermore, Carlson et al. (2006) propose a comprehensive explanation for[22] pre-issuance run-up, announcement effect and long-term underperformance. According to them, they can all be attributed to a growth option exercise. Zhang (2005) argues that firms raising capital are likely to invest more and earn lower expected returns. The NPVs of new projects are inversely related to their cost of capital or expected returns, controlling for their expected cash flows. If cost of capital is low, then NPVs are high, leading to high investment. Lyandres et al. (2007) support real investment is an important driving force behind

[22] Ritter (2003) reports average stock returns of 72 percent prior to a SEO, an announcement effect of -2 percent, and five-year post-issuance abnormal returns of -30 percent relative to seemingly reasonable benchmarks.

long-term SEO underperformance and therefore use investment-to-assets as a key matching characteristic. Adding investment factor into standard factor regressions explains 75 percent of SEO underperformance.

We propose the two-stage IPO would experience poorer performance compared to different benchmarks. We develop our second hypothesis about the long-term performance of two-stage firms:

H2: Two-stage IPOs underperform the benchmark in the long-run after the offering

Behavioral view proposes that mangers have market timing ability to issue equity. D&K also confirm their timing ability in two-stage strategy. Two-stage IPOs go public in the form of introduction substituting IPO at cold periods, and raise capital in the form of offerings taking place at the beginning of IPO waves. An offering is fast for a listed firm, faster than an IPO is for a private firm. Manager timing will lead investors to develop optimistic expectations regarding future stock performance of issuing firm during the post-offering period. The stage of listing until offering gives managers an extended period to time their issues and build up investor expectations, and thus the poorer long-term performance compared to regular IPOs is expected. However, this is only based on D&K. We are not sure about the performance of two-stage IPOs relative to regular IPOs.

5.3 Sample and Methodology

5.3.1 Sample selection and descriptive statistics

In this section, we outline the data resources and sample selection procedure. Our sample spans from June 1996 to July 2004, inclusive, which is the same with D&K. Also, introductions are divided into pure introductions (firms that are listed but do not issue any new shares within five years of listing) and two-stage IPOs (firms that are listed and issue new shares within five years of listing). D&K use the same criterion to define pure introductions and two-stage IPOs.

[Insert table 5-1 about here]

We obtain the list of new issue and IPO summary file from the website of London Stock Exchange[23]. Table 5-1 describes the filters used to construct our sample of pure introductions and two-stage IPOs. We first pick up the firms with issue type "introduction" and "introduction from 4.2" and birth date between June 1996 and July 2004. Then we identify firms that are cross-listed (listed in capital market other than London Stock Exchange), firms that have been listed before (traded in Unlisted Securities Market), investment funds and trusts, and misclassified as introductions. Those companies are excluded. Also, the companies that cannot be matched with LSPD are excluded as well since the return data is from LSPD. The results presented in column 2 have some discrepancy with sample size of D&K presented in column 5. Therefore, we have two further filters and present the results in columns 3 and 4. Since D&K do not explicitly mention whether their sample includes the firms to be introduced from 4.2, we exclude this kind of companies besides the filters above. Also, there are few two-stage IPOs introduced from main market, we exclude those and

[23] http://www.londonstockexchange.com/statistics/new-issues-further-issues/new-issues-further-issues.htm

only keep firms introduced in AIM. The other filters keep valid. After eliminating firms that do not satisfy one of the filters, we browse the press releases from Factiva for each company for five years since the introduction date. We deem the first release date of primary shares sale news as announcement date and first trading date of new shares as offering date. Therefore, introduction firms are either pure introductions or two-stage IPOs. However, only some news provides the full information on offering date, offer price, gross proceeds, and purposes. We find that less than 40 two-stage IPOs are left if we apply the extra two filters. Given data availability which implies even less companies can process to following analysis, we choose 84 two-stage IPOs resulted from the 2nd column as our final sample. Compared to sample from D&K, we have more original sample size (257 vs. 203). This difference (153 vs. 101) remains nearly the same after we apply all filters. Correspondingly, this results in a size of two-stage IPOs and pure introductions, both around 20 more than that in D&K's sample. We will also compare more information of our sample with counterparts in D&K's.

There is some missing information in D&K's paper which is quite important for further research. First, D&K do not explicitly state which market their sample is listed. We could only infer from the fact that they use the regular IPOs in AIM to assume the most companies in their sample is from AIM as well. In our sample sized with 84 companies, only 4 firms choose official market as their listing market. Therefore, we also choose regular IPOs on AIM as comparison group. However, with change of sample period, it isn't necessarily the case always. Second, the filters do not mention about companies with issue type listed as "introduction from 4.2". We include these companies in our introduction list (including pure introduction and two-stage IPOs). We do this for two reasons; one the one hand, there is no issue price for these companies before their introduction dates. On the other hand, the email reply from statistics of London Stock Exchange confirms that those companies could not be categorized as officially listed.

[Insert table 5-2 about here]

We then collect the further information about these two-stage IPOs. The further information including the purposes for the first primary share sale after the introduction date, issue price, announcement date, first trading date of the new shares, and proceeds are again hand collected from Factiva. The table 5-2 presents the results. In this table, we also compare both available information between our sample and D&K's. Panel A of table 5-2 shows that two-stage IPOs introduction is predominately distributed in 1995, with 44 among 84. However, in D&K's sample, only 6 two-stage IPOs choose to be listed in this year. Additionally, 28 two-stage IPOs choose to issue new shares in 1995 and 1996, while this number is only 6 in D&K's sample. There is significant discrepancy in terms of sample distribution, even if we use almost the same criterion as D&K. We further find that among 44 two-stage IPOs taking place in 1995, only 1 is labeled as introduction, while the remaining 43 is labeled as introduction from 4.2. We propose the different distribution, especially in 1995 and

1996, is due to the fact that we include some companies with introduction from 4.2 as two-stage IPOs while this sub-group is not included in D&K's sample. Panel B of table 5-2 shows the purposes of new issues. If the new offering is for exercise of options (warrants), the offer price cannot be found in the news in most case. Furthermore, the size of offering is usually limited to less than ten thousand. We therefore exclude new offering for exercise of options (warrants). The two-stage IPOs conduct new offerings either for acquisition or increasing working capital. 40 companies issue for acquisition and 37 firms conduct offerings for increasing working capital. Press does not disclose the offerings purpose for 7 companies. Panel C of table 5-2 compares the gross proceeds of two-stage IPOs and regular IPOs. Although our sample size and distribution is different from that of D&K, the gross proceeds from new offerings are comparable. We both find that money raised from first new offerings is slightly smaller than that from regular IPOs listing. Panel D of table 5-2 compares the extent of underpricing and initial returns for our sample and D&K's. We follow D&K in calculating underpricing and initial returns. Underpricing is defined as market price on the day before the offering announcement day divided by the offering price, minus one. Initial return is the market price on the offering ay divided by the offering price, minus. The price here refers to the unadjusted price, meaning history closing price that has not been adjusted for bonus and right issues. The figure represents actual or raw prices as recorded on the day. Our price choice for calculating underpricing and initial return is also consistent with D&K's. In our sample, the mean underpricing is 20.4 percent and initial returns only 11.2 percent, which indicates that offerings have a significant effect on the price fluctuation. While in D&K, the underpricing and initial return is 13.9 percent and 11.9 percent on average respectively, with no significant difference. We also find that initial return distribution for comparable IPOs (regular IPOs in AIM) is quite similar with D&K's. We achieve this by deleting 22 observations with absolute value of initial return larger than 3. Besides, 26 regular IPOs cannot be matched with DataStream. Therefore, we are left a size of 682 observations in calculating initial returns. Another interesting finding is that the days between announcement and trading is around one month for D&K's sample, while the figure is only around two weeks in our sample. Our interpretation for this is that most of the offerings in D&K's need's shareholders' approval in EGM (Extraordinary general meeting) or AGM (Annual general meeting). However, in our sample, we have some new offerings with very brief introduction from press, with only 2 or 3 days from announcement to trading. This finding is consistent with Barnes and Walker (2006), which discuss the issuance method choice of seasoned equity issues. Some security issuance mechanisms obtain the approval of existing shareholders before issuing new shares. Therefore, the time between announcement date and trading date is only couple of days.

D&K state that IPOs on AIM are the most suitable comparison group for the two-stage IPOs. The comparison group includes 786 IPOs virtually all IPOs on AIM during the sample period. We concur and therefore choose the same comparison group.

However, we could only find 730 IPOs between June 1995 and July 2004. From London Stock Exchange, we obtain the statistics on offering date, offering price, market capitalization, gross proceeds, broker, and industry. Additionally, we hand collected the closing price of first trading day from DataStream. With this procedure, only 704 companies are left with available market price on the offering day. The remaining 26 regular IPOs could not be found in DataStream. The DataStream only recorded updated name of the companies, we find 167 companies change name for one time, 56 companies for two times, 8 companies for three times, and 4 companies for four times. Another interesting phenomenon found is that base date in DataStream is usually one day earlier than that from LSE. Therefore, we have another closing price on the previous day before the birth day of LSE. Usually, the price is same with offer price, with exception sometimes.

5.3.2 Methodology

D&K states that two-stage strategy is less costly than an IPO because it can reduce the uncertainty, which is a part of cost of going public. Since both two-stage strategy and initial return are endogenous variable, a treatment effects model is appropriate if we are interested in the effect of two-stage strategy on the initial returns after controlling the endogenity. The treatment effects model estimates the effect of an endogenous binary treatment (two-stage strategy), z_j, on a continuous, fully observed variable initial return y_i, conditional on the independent variable x_j and w_j. The primary interest is in the regression function

$$y_j = X_j\beta + \delta z_j + \epsilon_j \quad \text{(Equation 5-1)}$$

where z_j is an endogenous dummy variable indicating whether the company use the two-stage strategy. The binary decision to obtain the treatment z_j is modeled as the outcome of an observed latent variable, z_j^*. It is assumed that z_j^* is a linear function of the exogenous covariates W_j and a random component u_j. It is in the form of

$$z_j^* = W_j\gamma + u_j \qquad \text{(Equation 5-2)}$$

and the observed decision is

$$z_j = \begin{cases} 1, if\ z_j^* > 0 \\ 0, otherwise \end{cases}$$

where ϵ and u are bivariate normal with mean zero and covariance matrix

$$\begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}$$

The treatment effects model estimates the two models. The first stage model estimates the probability of choosing a two-stage strategy over a regular IPO, conditional on a set of exogenous variables. The second-stage model finds the effect of two-stage strategy on initial returns. We use maximum likelihood (ML) to estimate two models. In the second stage model, we also present the results of ordinary least squares (OLS) for comparison. The choice of exogenous variables is quite similar to D&K.

For the first-stage model, we use the following variables:

- Ln(Market capitalization at introduction/IPO)
- Market level at introduction/IPO: The closing price of HGSC excluding investment trust index is used to proxy for the market condition on the day of introduction/IPO.
- Descending market dummy: This is a dummy variable. It equals to one if the

month of introduction/IPO falls between July 1998 and December 1998 or between January 2001 and March 2003 inclusive. These two periods are reported to have substantial and sustained market decline. The dummy variable is designed to control for unfavorable market conditions.

- Prestigious broker at introduction/IPO dummy: The variable proxies for the quality of the firm, assuming that high quality firms employ high quality broker. It equals to one if the firm's nominated broker at introduction/IPO is prestigious, and zero otherwise. D&K construct a list of broker name, which is from 1997 to 2003 editions of Thomson's Extel Survey.[24]

We do not include the health dummy and spin-off dummy in our model. Firstly, we have no access to Worldscope, which provides the annual sales, operating income, and net income in D&K's paper. Secondly, the number of observations of spin-off is very limited, only 4 in our two-stage IPOs.

For the second-stage model, we use the following variables:

- Ln(Gross proceeds of offering/IPO)
- Market return at offering/IPO: Loughran and Ritter (2003) use this variable to proxy for market conditions. It is the return on the HGSC excluding investment trusts index over the 3 months ending the day before the offering/IPO day. If the

[24] We only consider the following brokers are prestigious. They are ABN AMRO (including Hoare Govett), Cazenove & Co., Credit Lyonnais Securities, Dresdner Kleinwort Wasserstein, HSBC Securities (including James Capel), ING Financial Markets (including Charterhouse Securities), Investec Henderson Crosthwaite Securities, KBC Securities (including Peel Hunt), Lazard, Lehman Brothers, Nomura International, Schroder Salomon Smith Barney, SG Securities, UBS, and WestLB (including Pannmure Gordon).

day of 3 months ago is not trading day, we make it the next available trading day.

- Prestigious broker at offering/IPO dummy: This is variable with value 1 if the nominated broker at offering/IPO is prestigious, otherwise zero. The standard for defining prestige is same as that in the first-stage model.

We also include the industry dummies in the second-stage model. The classification of industry is based on industry classification benchmark, which is standard industry benchmark developed by Dow Jones and FTSE. We add two-stage IPO probability, the probability of choosing the two-stage strategy estimated from the first-stage model. The independent variables of OLS models in the second stage is just two-stage IPO dummy, plus the other exogenous variables.

In terms of long-term, it is five years after the offering or issuing month. The event month is excluded from the analysis. The benchmark for calculating abnormal returns is HGSC (Hoare Govett Smaller Companies) index, which is chosen by D&K. HGSC index is Britain's longest established small-company index, constructed on a consistent basis since 1955. Because of its long history, it is widely used as a benchmark for evaluating performance of UK equity portfolio. We adopt both mean buy-and-hold abnormal returns and mean cumulative abnormal returns to evaluate the performance. However, the procedure to obtain average is different. Mean buy-and-hold abnormal returns are firstly compounded individually for each sample firm and then calculated average based on weight scheme. Mean cumulative abnormal returns are obtained by cumulating average abnormal returns monthly. Also, value weight in addition to equal weight is also used to provide more information concerning the size effect on performance. The value is based on initial market capitalization, which is from London stock exchange. The monthly abnormal return is the difference between actual individual IPO returns and expected returns from certain benchmarks, which could be expressed as follows:

$$AR_{it} = R_{it} - ER_{Bt} \qquad \text{(Equation 5-3)}$$

A T-month BHAR for new issuing firm i is in the form of:

$$BHAR_{iT} = \prod_{t=1}^{T}(1 + R_{it}) - \prod_{t=1}^{T}(1 + R_{Bt}) \qquad \text{(Equation 5-4)}$$

where R_{BT} is the expected return and R_{it} indicates the return of company i. For the sample of event firms, the mean BHAR is calculated as the average of the individual firm BHARs. The returns are compounded monthly first and then average is obtained.

The calculation of mean CAAR is different. First, the average abnormal returns on a portfolio of n stocks for specified time interval is the equally weighted or value weighted arithmetic average of the benchmark-adjusted returns:

$$AR_t = \sum_{i=1}^{n} w_i ar_{it} \qquad \text{(Equation 5-5)}$$

The mean CAAR from event month 1 to event month s is the summation of the average abnormal returns:

$$CAAR_s = \sum_{t=1}^{s} AR_t \qquad \text{(Equation 5-6)}$$

When a firm in portfolio p is delisted before the 5th year anniversary, the portfolio return from the next month is an equally-weighted average of the remaining firms in the portfolio. For the month in which IPO is delisted, the return for that individual firm is vacant.

We also evaluate the sensitivity of performance to the choice of benchmarks. Since Fama (1998) and others state that low returns for these firms are not related to issuing seasoned equity per se, but to cross-sectional relationships between characteristics of SEOs, such as low book-to-market ratios, past returns, future returns, we choose different benchmarks to correct for the possible biases. The benchmarks include market index (HGSC index) and factor-model (CAPM and FF).

5.4 Empirical Results

[Insert table 5-3 about here]

Table 5-3 presents the results (excluding results for our industry dummies) of underpricing of two-stage IPOs compared to regular IPOs after controlling for firm characteristic and endogeneity. In the first-stage regression, the market level is statistically significant determinants of the choice of the two-stage strategy. That possibly can explain that firms choosing two-stage strategy possess marketing time ability. Since the coefficient of market level is negative, it could be interpreted that when market level is low, there is higher possibility of using two-stage strategy. Besides market level, we find prestige of the broker also has negative effect on probability of two-stage strategy. Firms adopting two-stage strategy tend to employ less prestigious broker. The pseudo R square for the probit model is 0.148, higher than 0.0686 found in D&K. The results from second stage ML model are that if the size of offering is larger and the market return of the prior 3 months is lower, the initial returns will be lower. This is consistent with literature prediction that initial returns are negatively related to gross proceeds of offing and positively related to the market return at the offering. Also, the prestige of nominated broker is found not to be significantly related to observed initial returns. The sign and significance of coefficients in comparable OLS also confirm our findings. The size of offering and market condition are found to play an important role in extent of underpricing. The coefficient of two-stage IPOs dummy is around 0.1, indicating that two-stage IPOs have around 10 percent initial return lower than comparable regular IPOs. After accounting for endogeneity, the initial return advantage of two-stage firms grows to about 34.3 percent. The result is quite similar to D&K, who find that benefit of a two-stage strategy on underpricing is around 30 percent. In most specifications, the coefficient on the two-stage IPO probability/two-stage IPO dummy is statistically significant. The initial returns for two-stage IPOs are lower than comparable regular IPOs, as we expect. Our first hypothesis holds.

Next, we explore the long-term stock performance of two-stage IPOs and regular IPOs. Our purpose is to evaluate the long-term performance of two-stage IPOs relative to benchmarks and regular IPOs. Therefore, in tables containing buy-and-hold measure results, we include the difference of returns between two-stage IPOs and regular IPOs. The number of regular IPOs in the analysis of long-run performance is 661, 24 smaller than size in analysis of underpricing since those regular IPOs cannot be found from LSPD. The sample of two-stage IPOs in underpricing and long-term performance is exactly the same, with 38 companies.

[Insert table 5-4 about here]

Table 5-4 displays the buy-and-hold raw and abnormal returns for two-stage IPOs and regular IPOs. The benchmark in this table is HGSC index. Additionally, we evaluate the performance of two-stage IPOs relative to regular IPOs. Panels A and B show the results at five-year and three-year horizon respectively. Both equal weight and value weight results are presented in the table. Weight is determined by the initial market value of IPOs, which is from London Stock Exchange. We choose the regular IPOs from the AIM since all 38 two-stage IPOs are initially listed on the AIM as well. In columns 2 and 3, we calculate the buy-and-hold returns for two-stage IPOs and regular IPOs respectively. The difference is displayed in column 4, which is an indication of performance from two-stage IPOs relative to regular IPOs. We mainly focus on equal weight results since value weight results are additionally dependent on size of the company. At five-year horizon, there is no performance difference, while the difference is also limited to 8.3 percent at three-year horizon. The columns 5 and 6 display the adjusted performance of two-stage IPOs and regular IPOs based on HGSC index. Two-stage IPOs underperform HGSC index by 5.1 percent and 1.7 percent by the end of 5^{th} and 3^{rd} year. The corresponding figures for regular IPOs are 2 percent and -8 percent. In short, those two groups do not produce abnormal returns in long-run measured from BHAR. The similar methodology has been used in Brav and Gompers (1997), which compares the performance difference between venture backed IPO and non-venture backed IPO. The difference is that they adopt wealth relative as performance measure while we use buy-and-hold abnormal returns. The difference in value weight scheme is larger. However, none of the difference is significantly different from zero. Therefore, both equal and value weight scheme indicates that two-stage IPOs perform similarly to HGSC index and regular IPOs.

We also evaluate the performance in terms of cumulative average abnormal returns. Previous literatures state that BHARs tend to magnify the underperformance due to the compounding properties from BHAR. It indicates the cumulative abnormal returns will have better results than from BHARs. Our evidence is consistent with this statement.

[Insert table 5-5 about here]

Table 5-5 shows results based on cumulative average abnormal returns. Generally, we find superior performance from two-stage IPOs and regular IPOs expect at three-year horizon for regular IPOs. Specifically, by the end of 5^{th} year, the CARs for the two-stage IPOs based on HGSC index are 10.4 percent and 3.5 percent for equal weight and value weight respectively. The counterparts for regular IPOs are 8.6 percent and -5.5 percent. None of these abnormal returns is statistically significant. Again, there is small performance difference between two-stage IPOs and regular

IPOs. By the end of 3rd year, two-stage IPOs remain the positive performance pattern, with 24.9 percent and 9.2 percent for equal and value weight. The situation is different for regular IPOs at three year horizon. Equal weight and value weight cumulative average abnormal returns of regular IPOs are -12.6 percent and -29.8 percent, with the latter figure significant at 1 percent level.

To check the robustness of our conclusion that two-stage IPOs have similar performance with benchmarks and regular IPOs, we adopt three additional benchmarks besides HGSC index. These benchmarks are Capital Asset Pricing Model (CAPM), Fama-French (1993) three-factor model, and Carhart (1997) four-factor model.

[Insert table 5-6 about here]

Table 5-6 presents the additional evidence. In this table, we only present the equal weight scheme. The focus in this table is to evaluate performance of two-stage IPOs and regular IPOs relative to alternative benchmarks. We already find that two-stage IPOs have similar performance to regular IPOs in table 5-4. By the end of 5th year, two-stage IPOs underperform different benchmarks by various magnitudes. Specifically, the underperformance relative to CAPM is -18.6 percent; the adjusted return relative to three-factor model is -3.3 percent; the abnormal return compared to four-factor model is -16.2 percent. None of these abnormal returns is significantly different from zero. At the same event time interval, regular IPOs present similar results. While BHAR based on CAPM is 0.5 percent, the corresponding figure based on FF and CARHART model is -7.4 percent and -18.9 percent. When we check the difference of adjusted returns between two groups, it is very limited, with largest magnitude less than 20 percent. Additionally, none of the difference is significantly difference from zero. Similar pattern is also found at the three-year horizon. The evidence confirms there is no significant abnormal return for two-stage IPOs and regular IPOs in terms of long-term performance.

Also, we are interested in the performance of two-stage IPOs before the offering date. Due to the limit of sample, we only have 24 two-stage IPOs which have at least one year price history. We analyze the performance of two-stage IPOs 12 months before and after the offering. The month in which offering takes place is treated as event month and excluded from analysis.

[Insert table 5-7 about here]

Panel A of table 5-7 displays the buy-and-hold abnormal returns 12 months before and after the offering month. The HGSC index is used as benchmark since all 24 two-stage IPOs are from AIM. The mean and median buy-and-hold abnormal returns are -2.1 and -9.6 percent in one year before offering. The counterparts during the post-offering one year are -8 and -7.8 percent respectively. Basically, these companies both underperform the benchmark before and after the new offering in terms of one year. However, it is not statistically significant. Panel B of table 5-7 shows z value of Wilcoxon signed rank test. It measures the adjusted performance difference in median values. We could find the performance improvement both in raw and adjusted returns.

Nevertheless, the change is statistically insignificant. Unlike the price behavior in SEO, which shows a superior performance before and inferior afterwards, our two-stage IPOs both shows an insignificant underperformance.

5.5 Conclusion

This chapter studies the underpricing and the long-term performance of 38 two-stage IPOs in UK between 1996 and 2004. Consistent with results from previous studies, we find that there is less underpricing of two-stage firms. Without controlling for endogeneity, there is 10 percent less underpricing for two-stage IPOs. After controlling for endogeneity of two-stage strategy, the benefits increase to around 34 percent compared to regular IPOs. This underpricing confirms the results found in D&K. We also document the long-term performance of two-stage IPOs and regular IPOs. They do not underperform various benchmarks. Additionally, the IPOs with worst performance come from small companies could not apply to two-stage IPOs because the value weighted scheme decrease rather than increase the adjusted performance of sample. Furthermore, the regular IPOs listed in AIM from June 1996 to July 2004 do not underperform the benchmark on the long-run.

Table 5-1 Sample selection from June 1995 to July 2004, inclusive

This table describes the filters we use to construct our sample of pure introductions and two-stage firms. An introduction is a public firm that lists without issuing new equity within five years of listing. A two-stage IPO is a public firm that lists and issue new equity within five years of listing. Our sample firms span from June 1996 to July 2004, inclusive. We have three different versions to define original introduction firms. The first one is firms from LSE with issue type as "Introduction" and "Introduction from 4.2". The second one is firms from LSE with issue type as "Introduction" only. The third one is firms from LSE with issue type as "Introduction" and listed in AIM only. The fourth column is the relevant information from D&K (2007). We use the same criterion and period as theirs. We eliminate cross-listings, firms that have already been listed before, investment funds and trusts, firms that cannot be matched to LSPD, combination of two classes of shares, and IPOs misclassification. We also eliminate irregular introductions, which are spin-offs from large companies and re-introduced.

Original Sample	Firms from LSE data for which issue type is "introduction" and "introduction from 4.2" (AIM+OL)	Firms from LSE data for which issue type is "introduction" (AIM+OL)	Firms form LSE data for which issue type is introduction and listed on AIM only (AIM)	D&K Sample
	257	**179**	**129**	**203**
Less: cross-listings from other exchanges	18	16	6	35
Less: Firms already traded before introduction somewhere in the world	18	18	17	17
Less: Investment funds and trusts	21	18	9	16
Less: Firms that cannot be matched to LSPD	14	9	9	3
Less: Combinations of two classes of shares into one				1
Less: IPOs misclassified as introductions	8	7	4	12
Less: IPOs classified as introduction but actually introduction from 4.2		8	8	
Equals: Introductions	**178**	**103**	**76**	**119**
Less: Irregular introductions	25	25	5	18
Equals: Sample introductions (pure introductions and two-stage IPOs)	**153**	**78**	**71**	**101**
Less: Sample pure introductions	69	40	36	35
Equals: Sample two-stage IPOs	**84**	**38**	**35**	**66**

Table 5-2 Descriptive Statistics

This table presents descriptive statistics for two-stage IPOs and regular IPOs. The sample comprises 84 two-stage IPOs and 730 regular IPOs on the Alternative Investment Market in the United Kingdom between June 1995 and July 2004. A two-stage IPO is a public firm that lists and issue new equity within five years of listing. Panel A presents statistics on year distribution. Panel B presents purposes of new issues for those two-stage IPOs. Panel C presents statistics on gross proceeds. Panel D displays statistics on underpricing and initial return, years between introduction and offering announcement, days between offering announcement and trading. We define underpricing as the market price on the day before the offering announcement day divided by the offering price, minus one. Initial return is the market price on the offering day divided by the offering price, minus one. In each panel, we provide the corresponding figure from D&K, if possible.

Panel A: Two-stage IPOs at introduction and offering

	Pure Introductions		Two-stage IPOs at introduction		Two-stage IPOs at Offering		IPOs	
Year	Our Sample	D&K	Our Sample	D&K	Our Sample	D&K	Our Sample	D&K
1995	30	5	44	6	9	1	15	17
1996	11	7	7	11	19	5	85	95
1997	1	2	5	7	11	10	60	70
1998	3	0	4	7	9	7	34	35
1999	2	2	5	3	6	4	54	58
2000	9	9	6	10	8	7	169	176
2001	3	1	4	10	4	10	88	90
2002	4	3	3	6	6	9	53	60
2003	1	4	5	5	3	8	61	63
2004	5	2	1	1	5	5	111	122
2005					2			
2006					2			
	69	35	84	66	84	66	730	786

Panel B: Two-stage IPOs at offering

Number and % stating that reason for issues is		
Acquisition	40	47.62%
Increasing working capital	37	44.05%
No available information	7	8.33%

Panel C: Two-stage IPOs and IPOs

	Two-stage Firms at offering		IPOs from AIM	
Gross proceeds (million pounds)	Our sample	D&K	our sample	D&K
Mean	4.832	5.882	7.592	6.579
Standard deviation	9.961	12.655	20.780	11.751
First quartile	0.472	0.477	1.477	1.45
Median	1.172	1.747	3.100	3
Third quartile	3.96	3.64	7.000	6.83
Obs	66		730	

Panel D: Two-stage IPOs and IPOs

	Our Sample	D&K	Our Sample	D&K
Underpricing				
Mean	0.204	0.139		
Standard deviation	0.568	0.167		
First quartile	0.012	0.013		
Median	0.071	0.1		
Third quartile	0.22	0.2		
Obs	54			
	Two-stage IPOs at Offering		IPOs	
Initial return				
Mean	0.112	0.119	0.221	0.247
Standard deviation	0.296	0.208	0.417	0.463
First quartile	0	0.03	0.038	0.042
Median	0.063	0.113	0.12	0.124
Third quartile	0.21	0.216	0.25	0.25
Obs	40		685	
Years between introduction and offering announcement				
Mean	1.44	1.1		
Median	0.87	0.9		
Obs	82			
Days between offering announcement and offering				
Mean	16.2	32.4		
Median	11	29.4		
Obs	58			

Table 5-3 Initial return for the two-stage IPOs versus regular IPOs

This table presents the difference in initial returns between two-stage IPOs and regular IPOs after controlling for the firm characteristics and accounting for endogeneity. The sample comprises 38 two-stage IPOs and 685 regular IPOs on the Alternative Investment Market in the United Kingdom between June 1995 and July 2004. We exclude all spin-off firms. A two-stage IPO is a public firm that lists without issuing equity and then issues primary equity within 5 years of listing. We estimate two models. In the first stage, we use probit model to estimate the probability of a firm adopting two-stage strategy. In the second stage, with probability obtained from first stage and some exogenous independent variables, we also use ML to estimate the coefficients. Initial return is the market price on the offering day divided by the offering price, minus one. Ln(Market capitalization at introduction/IPO) is measure in million pounds. Market level at introduction/IPO is the level of the HGSC excluding investment trusts index on the introduction/IPO day. Descending market dummy equals one if the introduction/IPO day falls between July 1998 and December 1998 or between January 2001 and March 2003, inclusive. Prestigious broker at introduction/IPO dummy equals one if the firm's nominated broker at introduction/IPO is prestigious, and zero otherwise. Ln(Gross proceeds of offering/IPO) is measured in million pounds. Market return at offering/IPO is the return on the market index over the 3 months ending the day before the offering/IPO day. Prestigious broker at offering/IPO dummy equals one if the firm's nominated broker at offering/IPO is prestigious, and zero otherwise. All models include our industry dummies. Standard errors are heteroskedasticity-consistent. Below each coefficient is its corresponding p-value. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Model ML
Stage 1: Dependent variable is two-stage IPO dummy	
Independent variables	
ln(Market capitalization at introduction/IPO)	0.088
	0.260
Market level at introduction/IPO	-0.002***
	0.000
Descending market dummy	-0.114
	0.610
Prestigious broker at introduction/IPO dummy	-0.893*
	0.069
Constant	1.830***
	0.008
N	723
Pseudo-R^2	0.148

	Models			
	OLS	OLS	OLS	ML
Stage 2: Dependent variable is initial return				
Independent variables				
Two-stage IPO dummy	-0.117*	-0.119*	-0.102	
	0.082	0.078	0.139	
Two-stage firm probability				-0.343***
				0.000
ln(Gross proceeds of offering/IPO)	-0.0454***	-0.0438***	-0.0421***	-0.047***
	0.000	0.000	0.001	0.000
Market return at offering/IPO	1.012***	1.014***		0.9997***
	0.000	0.000		0.000
Prestigious broker at offering/IPO dummy	0.048		0.0508	0.039
	0.424		0.408	0.511
Constant	0.100	0.109	0.141	0.129***
	0.483	0.441	0.332	0.000
N	723	723	723	723
Adjusted-R^2	0.095	0.094	0.054	
p-value of Wald chi-square				0.000
p-value of test of rho=0				0.003

Table 5-4 Three- and five-year post-offering buy-and-hold returns versus HGSC index

The sample includes 38 two-stage IPOs and 661 regular IPOs from June 1996 through July 2004, inclusive. Three- and five-year buy-and-hold abnormal returns (both equal-weighted and value-weighted) are presented based on HGSC index. Initial market value from LSE determines the weight. Columns 2 and 3 present raw buy-and-hold returns of two-stage IPOs and regular IPOs. Column 4 displays the difference. Columns 5 and 6 present buy-and-hold abnormal returns of two-stage IPOs and regular IPOs, with difference showing in column 6. The t-statistic is presented below corresponding return figure in parentheses ( ) respectively. All return information is from LSPD. If the sample firm delists before the fifth anniversary, we compound the return up until the delisting. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Five-year post-offer raw and buy-and-hold abnormal returns

	Raw Return			BHAR		
Weight scheme	Two-stage IPOs	Regular IPOs	Difference	Two-stage IPOs	Regular IPOs	Difference
Equal Weight	0.213	0.213	0.000	-0.051	0.002	-0.053
(t-statistic)			(0.000)	(-0.036)	(-0.042)	(-0.040)
Value Weight	-0.047	0.189	-0.236	-0.252	-0.023	-0.229
(t-statistic)			(-1.254)	(-0.480)	(-0.243)	(-0.464)

Panel B: Three-year post-offer raw and buy-and-hold abnormal returns

	Raw Return			BHAR		
Weight scheme	Two-stage IPOs	Regular IPOs	Difference	Two-stage IPOs	Regular IPOs	Difference
Equal Weight	0.193	0.110	0.083	-0.017	-0.080	0.063
(t-statistic)			(0.091)	(-0.076)	(-0.804)	(0.473)
Value Weight	0.027	0.041	-0.014	-0.212	-0.161	-0.051
(t-statistic)			(-0.025)	(-1.095)	(-1.608)	(-0.383)

Table 5-5 Three- and five-year post-offering cumulative abnormal returns

The sample includes 38 two-stage IPOs and 661 regular IPOs from June 1996 through July 2004, inclusive. Three- and five-year cumulative abnormal returns (both equal-weighted and value-weighted) are presented based on HGSC index. The t-statistics are computed according to the Crude Dependence Adjustment method of Brown and Warner (1980). The t-statistic is presented below corresponding CARs in parentheses ( ) respectively. All return information is from LSPD. If IPO delists before the fifth anniversary, we cumulate (sum) the portfolio abnormal returns of remaining IPOs. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Five-year		Three-year	
Weight scheme	Two-stage IPOs CAR	Regular IPOs CAR	Two-stage IPOs CAR	Regular IPOs CAR
Equal weight	0.104	0.086	0.249	-0.126
(t-statistic)	(1.101)	(0.500)	(1.182)	(-1.230)
Value weight	0.035	-0.055	0.092	-0.298***
(t-statistic)	(0.012)	(-0.384)	(0.541)	(-3.500)

Table 5-6 Three- and five-year post-offering buy-and-hold returns versus alternative benchmarks

The sample includes 38 two-stage IPOs and 661 regular IPOs from June 1996 through July 2004, inclusive. Three- and five-year buy-and-hold abnormal returns (both equal-weighted and value-weighted) are compared to different benchmarks. The benchmarks from top to bottom are Capital Asset Pricing Model (CAPM), Fama-French (1993) three-factor model and Carhart (1997) four-factor model, respectively. Columns 2 and 3 present buy-and-hold abnormal returns of two-stage IPOs and regular IPOs at five-year horizon. Column 4 displays the difference. Results from column 5 to 7 are counterparts at three-year horizon. The t-statistic is presented below corresponding BHARs in parentheses ( ) respectively. All return information is from LSPD. If the sample firm delists before the fifth anniversary, we compound the return up until the delisting. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Benchmarks	Five-year			Three-year		
	Two-stage IPOs	Regular IPOs	Difference	Two-stage IPOs	Regular IPOs	Difference
CAPM	-0.186	0.005	-0.191	-0.115	-0.125	0.010
(t-statistic)	(-0.332)	(0.077)	(-1.322)	(-0.615)	(-1.233)	(0.076)
FF	-0.033	-0.074	0.041	-0.164	-0.153	-0.011
(t-statistic)	(-0.021)	(-0.811)	(0.225)	(-0.882)	(-1.395)	(-0.079)
CARHART	-0.162	-0.189	0.027	-0.116	-0.165	0.049
(t-statistic)	(-0.296)	(-1.184)	(0.135)	(-0.674)	(-1.433)	(0.355)

Table 5-7 One year before and after offering performance analysis

The sample includes 24 two-stage IPOs from June 1996 through July 2004, inclusive. Panel A shows the performance one year before and after offering. Panel B shows the performance difference changes in median between one-year before and one-year after offering. A Wilcoxon singed rank test is employed to test for differences in median The benchmark used in this table is HGSC index. The skewness adjusted t-statistic is presented on the 6th column. The calculation of t follows Lyon et al. (1999). All return information is from LSPD. If the sample firm delists before the fifth anniversary, we compound the return up until the delisting. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: One year prior and post offering buy-and-hold performance

Event	Buy-and-hold returns		BHAR		Skewness-adjusted t
month	IPOs	HGSC	Mean	Median	
-12	0.022	0.013	0.009	-0.017	0.375
-9	-0.082	0.046	-0.128	-0.066	-2.585**
-6	0.010	0.069	-0.060	-0.107	-0.661
-3	0.034	0.093	-0.059	-0.124	-0.630
-1	0.089	0.110	-0.021	-0.096	-0.169
1	0.049	0.005	0.045	-0.006	0.963
3	0.064	-0.001	0.065	0.039	0.926
6	-0.018	0.026	-0.044	-0.063	-0.451
9	-0.005	0.021	-0.026	-0.164	-0.163
12	-0.022	0.057	-0.080	-0.078	-0.596

Panel B: median change in BHAR

Measurement	N	Change
Raw buy-and-hold returns	24	0.743
Buy-and-hold abnormal return	24	0.314

Chapter **6** Conclusions

The purpose of the thesis is to empirically examine the long-term post-IPO stock performance. Specially, we provide empirical answers to the following questions in UK. First, does the choice of dataset result in different conclusion on long-term post-IPO performance? Second, whether UK IPOs underperform the market in the post-IPO three- to five-year period? Third, do two-stage IPOs have less underpricing and worse long-term performance than regular IPOs?

We empirically test those hypotheses in three empirical studies. The first relates to the impact of choice of dataset on long-term post-IPO performance. We use both LSPD and DS to test the performance based on the same sample, and try to shed some light on the possible results discrepancy. The second empirical study re-examine the conclusion made by last empirical work using more comprehensive dataset. The study considers several important characteristics that influence the performance and test them in cross-section scenario. The third empirical study focuses on underpricing and long-term post-offering performance of IPOs which adopt two-stage strategy. We test whether this strategy will make a difference on the well-documented puzzle.

In chapter 3, we examine the performance of UK IPOs using both DS and LSPD as datasets. We investigate both the size and market timing effect on the found abnormal returns. Our results reveal that the used sample does not show long-run post-IPO underperformance. On the contrary, outperformance is found at five-year horizon. DS and LSPD produce same qualitative results in equal weight case. However, due to significant difference in terms of size, their value weighted results are significantly different as well. Additionally, we test hot market hypothesis by analyzing the sub-period abnormal returns. We find the evidence on the issue is mixed. On the one hand, the periods with higher IPO activity display better performance. On the other hand, the performance in the period with most frequent IPO activity (1998-2000) is worst.

In chapter 4, we investigate the five-year post-IPO stock performance for all non-financial firms in UK from 1992 to 2004. The findings reveal underperformance when event-time buy-and-hold abnormal returns are used, and this result is nearly statistically significant. The underperformance is not so consistent when we use cumulative abnormal returns. At least, Fama-French three factor and Carhart four-factor model displays insignificant outperformance in CAR scenario. A calendar time portfolio approach shows that IPOs return at least as much as benchmarks. In summary, the relative performance of an IPO sample is contingent on the methods of examining performance.

Our analysis of UK IPOs serves to underscore the additional questions about IPO performance in different markets and/or different listing methods. We find IPOs listed in AIM and USM perform consistently poorer than counterparts in main market. Additionally, firms choosing placement methods perform not as good as firms choosing offer.

In chapter 5, we investigate underpricing and long-term performance of two-stage firms. Two-stage IPOs refer to special IPOs which list first and then issue new equity within subsequent five years. Previous literature shows the two-stage strategy can reduce the underpricing relative to regular IPOs by 10 percent to 30 percent. Our sample confirms the lower underpricing of two-stage firms relative to regular IPOs. Additionally, we analyze the long-term performance for these IPOs after their offering. The results from standard methodology shows there is no significant underperformance relative to various benchmarks. Furthermore, the performance of two-stage IPOs is similar to that found in regular IPOs. Therefore, two-stage IPOs do not show underperformance relative to benchmarks or regular IPOs.

The main limitations of the study are three-fold. First, it does not consider all potential determinants of long-term post-IPO performance. Due to data availability, there is limited information about book value[25] and some other firm characteristics at the IPO time. Secondly, we stress the importance of misspecification of statistics by using solution provided from Lyon et al. (1999). However, a more comprehensive valuation of different statistics is needed to assess the statistical significance. Thirdly, due to data availability, we do not report the accounting performance after the IPOs. It is interesting to assess the relationship of stock performance and accounting performance change. Fourthly, we are interested in the potential difference of

[25] For example, Espenlaub et al. (2000) report that over 50 percent of firms on LSPD for which market value is available for January 1980, do not have book-to-market ratio available. Gregory et al. (2010) also mention the lack of book value information.

long-term post-IPO performance between venture-backed and nonventure-backed IPOs since Brav and Gompers (1997) document nonveture-backed IPOs significantly underperform venture-backed IPOs. We are not sure whether this difference could be applied to UK IPOs.

Accordingly, we provide some potential ways to extend our work from the aspects of dataset, empirical methods, and research topic. Firstly, we can collect more firm characteristics to shed more light on the determinants of long-term post-IPO stock performance. Secondly, some new statistics need to be developed to address the problem that Lyon et al. (1999) cannot. For example, in non-random sample, the methodology proposed by Lyon et al. (1999) still produces misspecified statistics. Thirdly, as long as annual accounting information is available, we can conduct the long-term post-IPO accounting performance analysis.

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Appendices

Appendix A1: Summary of international empirical evidence of long-term IPO performance

Author(s)	Year	Country	Number of observations	Time period covered	Average abnormal returns after		Measurement	Benchmark
					36 months (percent)	60 months (percent)		
Ritter	1991	US	1,991	1975-1984	-27.4		BHAR	Matched firm (industry, size)
					-29.1		CAR	Matched firm (industry, size)
					-26.9	-50.7	BHAR	Matched firm (size only)
Levis	1993	UK	712	1980-1988	-11.38		CAR	FTA
					-8.31		CAR	HGSC
					-22.96		CAR	Equally weighted all shares index
Loughran and Ritter	1995	US	4,753	1970-1990		-41.6	CAR	Value weighted market portfolio
						-33.1	CAR	Equally weighed market portolio
					-5.04		BHAR	Equally weighed market portolio
Stehle, Ehrhardt, and Przyborosky	2000	Germany	187	1960-1992	1.54		BHAR	Value weighted market portfolio
					-6.64		BHAR	Equally weighed size portolio
					-6.61		BHAR	Value weighted size portfolio
					-11.59 percent		BHAR	Control firm with similar size

Espenlaub, Gregory, and Tonks	2000	UK	588	1985-1992	-15.9	-28.67	CAR	Capital Asset Pricing Model
					-16.24	-21.32	CAR	Size decile porfolio
					-8.12	-4.3	CAR	Value weighted multi-index model
					-28.15	-42.77	CAR	Fama-French three factor model
Drobetz, Kammermann, and Walchli	2005	Switzerland	109	1983-2000		-26.17	BHAR	Swiss Performance Index (SPI)
						11.56	BHAR	Vontobel Small companies Index (VSCI)
Ahmad-Zaluki, Campbell, and Goodacre	2007	Malaysia	454	1990-2000	32.63		CAR	KL Composite Index
					31.15		CAR	EMAS/SB Index
					17.86		BHAR	KL Composite Index
					14.86		BHAR	EMAS/SB Index

Appendix A2: Summary of main empirical studies and our work in UK market

Study	Sample	Data	Benchmarks	Measurements	Results
Levis (1993)	712 IPOs 1980-1988	LSPD		Cumulative average abnormal returns	UK IPOs underperform many benchmarks in the full 36 months since the first day of trading.
Espenlaub et al. (2000)	588 non-financial IPOs 1985-1992	LSPD	Capital Asset Prcing Model (CAPM), size control portfolio, multi-index model using Hoare-Govett index, Fama-French three factor model, RATS	Cumulative average abnormal returns and calendar time regression	Long-run IPOs performance depend on the choice of technique. Four among five except Hoare-Govett model produce significant negative abnormal returns
Goergen et al. (2007)	240 IPOs excluding investment trusts January 1991- June 1995	LSPD	Financal Times Actuaries All Share Index (FTA) and Hoare Govett Smaller Companies Index (HGSC)	Buy-and-hold average abnormal returns, cumulative average abnormal returns, and Fama-French three-factor model	UK IPOs underperform similar non-issuing firms. Quality of firm has significantly positive influence on its performance after the IPO
Gregory et al. (2010)	2499 non-financial IPOs 1975-2004	LSPD	Size-control (Decile) portfolio, size matching firm	Buy-and-hold average abnormal returns and calendar time regression	In both event time and calendar time, IPOs underperform significantly. Underperformance is more prounced in AIM and USM markets.

Chapter3	824 IPOs 1981-2000	DS and LSPD	FTSE All Share Index (FASI), Capital Asset Pricing Model (CAPM), and Fama-French three-factor Model	Buy-and-hold average abnormal returns and cumulative average abnormal returns	There is outperformance found at post-IPO three- and five-year horizon. Value weihgts have opposite impact on results.
Chapter4	1953 Non-financial IPOs 1981-2004	LSPD	FTSE All Share Index (FASI), Size control portfolio, Capital Asset Pricing Model (CAPM), Fama-French three-factor Model, and Carhart four-factor Model	Buy-and-hold average abnormal returns, cumulative average abnormal returns, and calendar time regression	Four among five benchmarks except CAPM produce significant underperformance by the end of 5th anniversary.