The Role of Private Equities in Equity Capital Markets

A short- and long-term quantitative study of European IPOs

Master's Thesis

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Abstract

The purpose of this master's thesis is to identify in quantitative terms the role of private equity firms in capital markets. In particular, the impact of private equity firms in the context of initial public offerings. Private equity firms are some of the most prestigious entities in financial markets, and their reputational significance for capital markets is something that cannot be easily put a number to.

This study provides short-term and long-term analyses of the impact of private equity backing of firms deciding to float their shares in some of Europe's main stock exchanges as a part of their exit strategies. Specifically, this academic research presents a comparison of PE-backed IPOs and non-PE-backed IPOs in Western and Northern Europe over the period 2005-2012.

In addition, an in-depth analysis of prior literature concerning underpricing and long-term performance of IPOs is provided. The overall notions in them are that underpricing exists, reliable analysis of long-term performance of IPOs is highly dependent on methodological procedure, and that PE-backed IPOs should result in lower levels of underpricing and higher levels of long-term performance when compared to IPOs without PE involvement.

The process in this study consisted on confirming the existence of underpricing as a whole in the given sample, followed by a comparison across both sets of samples. The results pointed out that first-day underpricing is an observable phenomenon in the given scope. Nevertheless, there was no evidence to point out a difference between PE-backed companies and non-PE-backed companies. The short-term performance appeared to be equal regardless of the ownership structure pre-IPO.

Furthermore, the long-term performance analysis focused on returns over a three-year period. This approach resulted in a significantly better performance of PE-backed IPOs over non-PE-backed IPOs. In fact, non-PE-backed IPOs proved to present patterns of underperformance while PE-backed IPOs delivered positive returns.

The results of this academic study do not follow the empirical evidence from past literature in terms of short-term studies. While underpricing is confirmed, the evidence with regards to PEs did not confirm differences in performance when compared to non-PE firms. Additionally, the long-term performance investigation provided proof in line with past academic research, as long-term performance of PE-backed IPOs was better than "normal" IPOs.

1 Glossary

BHR	Buy-and-hold return
BM	Benchmark
CAPM	Capital asset pricing model
CAR	Cumulative abnormal return
EW	Equally-weighted
GP	General partner
ICB	Industry classification benchmark
IPO	Initial public offering
LBO	Leveraged buyout
LP	Limited partner
LPA	Limited partnership agreements
M&A	Mergers and acquisitions
NYSE	New York stock exchange
PE	Private equity
RLBO	Reverse leveraged buyout
VC	Venture capital
VW	Value-weighted
WR	Wealth-relative

2 Introduction

2.1 Motivation

This master's thesis will perform an analysis on the role of private equities ("PEs") in capital markets through a study focused on initial public offerings ("IPOs").

In general, IPOs are events that mark a major milestone in the life of a company. Because of the impact such happenings have for the company, but also all stakeholders, IPOs tend to be the focus of attention in financial markets when the decision of going public is made. For instance, when a company decides to list shares on a stock exchange the public attention increases substantially.

Private equity companies are prestigious entities that are known for their ability to overturn companies completely by improving its operations and finances in an efficient manner. Such entities rely on reputational and experience factors to be able to overhaul the state of a company throughout.

One of the main motivations behind this thesis is understanding the role of PE companies in capital markets. In particular, the quantification of such a role. PE firms appear to play a significant role in the development and evolution of the economy. In particular, a very noteworthy characteristic of such firms is the role of their reputation. It appears that mere interactions with PE companies raises the value of a company, which can be attributed to the reputational impact of PE firms.

Because of the above, the authors of this thesis set out to find a way to identify in quantifiable measures the role of PE companies in the economy as a whole. IPOs came to mind as a possible focus point as they are part of the alternatives PE companies have when exiting a company. Thus, we can use the aftermarket performance of IPOs with PE involvement to by measuring the difference with regards to companies without PE sponsorship. The role of capital markets in this context serves as a tool to reliably measure which role PE companies have, as the mechanisms applied when a company is exchange traded gives the ability to measure through shares and prices what the impact of PE firms is.

The reach of this thesis is bound by time and space. On these grounds, the most relatable scope to perform this study is a Danish one. Nevertheless, the Danish stock market is relatively small. In order to enhance the explanatory power and validity of this research, countries

resembling Denmark in economic terms will be the main focus of this paper. Western and Northern European countries seem to fit the context of this thesis.

In addition, an element that became apparent when studying past literature around the given topic was the lack of recent papers in a European context. Therefore, one of the main efforts of this study will be to update the empirical and theoretical information available on this subject. The hope is to shed light on more recent events and to expand the available data on the matter.

2.2 Problem Statement

Initial Public Offerings have traditionally been one of the most researched topics in modern times, giving way to multiple types and degrees of scrutiny, in an array of areas such as business, finance, management, among others. The nature of such events is, like its name points out, very public. Essentially, most dimensions of information of companies going public is made available to investors all over the world. What this means is that a widespread dissemination of the company's equity and, more importantly, the company's previously "secret" information is made available to the general public. For most companies, such an event marks a milestone. Since the company is no longer subject to a small set of shareholders' interests, and instead becomes subject to the scrutiny of capital markets as whole, i.e. a large set of shareholders, the external (and internal) forces impacting the company arrive to a new state. At large, the dynamics of the company change to a large degree.

In simple terms, private equity is capital held by investors or funds that is not available on stock exchanges. This private capital is invested in private companies or specific deals, such as acquisitions or buyouts of public or private companies. Private equity can be invested in three main ways: through direct investments into private companies (either by the investors themselves or in cooperation with PE firms and/or funds), through investment in PE funds and/or firms that are dedicated to acquiring companies, or through a fund-of-funds, a fund that holds a portfolio with investments in several PE funds and/or firms.

A typical PE firm is involved in multiple partnership agreements, i.e. multiple funds. The ultimate goal of a PE firm is a successful exit strategy of its investment, which entails enhancing the operations and finances of the company invested in up to a point where either an acquisition by a third party or an IPO will yield in an acceptably high level of return. Nevertheless, exit

strategies can come in multiple forms, such as partnerships or even bankruptcy, as there are a wide range of outcomes for PE investments.

PE-backed IPOs take place mainly under the premise of an exit strategy, i.e. when PEs decide to get involved in an IPO they do so with the prospect of exiting one of their investments. The most common method of PE-backed IPOs are the cases where a PE fund acquires a privately held company, and then improves the company's operation up to the point where placing the firm's shares in the open market will yield in an appropriate return for the fund. Nevertheless, the costs and focus needed to go through the IPO process are substantial, as are the reputational factors put in line when this alternative of exit is chosen. PE firms have multiple exit options and when flotations are chosen it entails that the gains expected to be achieved overturn all factors that point towards other options. If an unsuccessful IPO with PE backing were to take place, the publicity resulting from it could potentially jeopardize the future of the given PE firm.

The task at hand in this master's thesis will be to make an analysis of IPOs where PE funds are involved. In particular, a comparison of the similarities and differences between IPOs where PEs are involved, and when they are not, will be made. Parting from this comparison, the background, reasons and implications will be described and deepened into in order to gain a better understanding of IPOs in general and, more importantly, the effect of PEs in such situations.

Consequently, the context presented above leads to the central problem this master's thesis will try to resolve:

"How does the performance of IPOs with involvement of private equity firms differ from IPOs where there is no such involvement?"

This problem will be supported and expanded upon through the following research questions:

- What is the performance of a typical IPO in the post-issue period?
- Are there patterns in post-IPO performance of issuing firms?
- If patterns can be identified, are they supported theoretically and/or empirically?
- Is there a difference in performance between PE-backed IPOs and non-PE-backed IPOs in the short-term?
- Is there a difference in the long-term?

The questions will guide the development of this thesis throughout. They will set the foundation for the areas to be looked into, as well as the formulation of hypotheses. Ideally the goal is to ultimately be able to provide reliable answers through empirical and theoretical research methods.

2.3 Methodology

This master's thesis objective is to expand the theoretical and practical knowledge in relation to IPOs and PEs, in particular the relationship between both. In order to achieve this, a primarily empirical study on stock markets will be performed. The analysis will part from a historical point of view, with past developments in capital markets at the center of the study.

From a philosophical point of view, this thesis will take a realistic approach, which entails looking at the phenomenon at hand from an objective viewpoint. Ultimately, the goal is to be able to analyze the subject matter from a perspective where the authors do not take a stance or position with regards to the information, but merely takes the role of an unbiased observer.

Furthermore, this study will take an iterative deductive approach. While theory testing will lie at the core of the study's approach, the theories and their corresponding hypotheses will be subject to constant modifications. This same approach will be applied to the rest of the thesis; data collection, empirical testing, analysis and interpretation, as well as concluding arguments, will be subject to alterations throughout the process.

The intuition behind this approach is that the question at hand is subject to multiple dimensions of possible analysis, which entails that different approaches are available to tackle the problem statement. Regardless, this empirical analysis will be highly dependent on the quality and availability of data. Therefore, the possible implications of an initially formulated theory and its hypotheses will be a constant appraisal of their relevance. Empirical data and analysis will dictate the overall evolution of this master's thesis. Moreover, this thesis will focus on a descriptive and explanatory level of knowledge.

Parting from the approach lined out above, this study will be initiated by formulating a general problem statement which, in turn, will be lead into the formulation of single hypotheses. These will be tested through interpretation & analysis of empirical data. The purpose is to identify the relationship between IPOs and PEs. The last stage of this study will be to present

concluding arguments based on the results of all analyses and interpretations and, parting from them.

2.4 Delimitations

In terms of chronological focus, an eight-year period of relevant data spanning from January 2005 to December 2012 was chosen. This period was selected based on the analyses that are planned to be performed on the data, as well as the economic conditions surrounding the stock exchanges. On one hand, in order to be able to perform a coherent and valid analysis, a big enough sample of IPOs (particularly PE-backed IPOs) has to be available. Therefore, an eight-year period was deemed appropriate. On the other hand, the information of IPOs from the biggest European stock exchanges will be subject to short-term (one day) and long-term investigations (one year to three years). Since the long-term analysis includes on a three-year analysis of the data, and having consistency and ease of interpretation considerations in mind, any IPO occurring after 2012 was disregarded.

Moreover, one of the defining factors to set the time frame's starting point was structural changes in two of the main exchanges in Europe. The main French and German exchanges underwent a redefinition of main and secondary markets in the period 2003-2005. Consequently, the starting limit of the analysis needs to be set in a period where comparable exchanges were established.

This research paper will focus on the Western and Northern European markets. More specifically, a set of ten of Europe's major stock exchanges in this area will be included. The reasoning behind this is the importance of analyzing a subject that readers can relate to and get involved with. The contextual setting of this master's thesis – a Danish perspective within a larger European context, deemed the given regional focus especially appropriate in light of the similarities between stock exchanges in the selected regions. The basis for this conclusion is the similarities in IPO mechanisms and regulation across the chosen stock exchanges; all stock exchanges in scope are subject to EU regulation and have been subject to similar economic conditions in the period studied.

The set of stock exchanges to be included in the study is the following:

- Copenhagen Stock Exchange – Nasdaq OMX Copenhagen
- Stockholm Stock Exchange – Nasdaq OMX Stockholm

- Helsinki Stock Exchange – Nasdaq OMX Helsinki
- Iceland Stock Exchange – Nasdaq Iceland
- Oslo Stock Exchange – Oslo Børs
- London Stock Exchange – LSE
- Frankfurt Stock Exchange – Deutsche Börse Frankfurt (Amtlicher & Geregelter)
- Paris Stock Exchange – Euronext Paris (Eurolist/NYSE Euronext)
- Amsterdam Stock Exchange – Euronext Amsterdam (Eurolist/NYSE Euronext)
- Brussels Stock Exchange – Euronext Brussels (Eurolist/NYSE Euronext)

The criteria to select the stock exchanges above relates (besides the points made above) to the groups in which the single countries' main stock exchanges can be separated into, i.e. stock exchange ownership groups. In Scandinavia, the Nasdaq OMX Nordic Group is present, consistent of the main Danish, Swedish, Icelandic and Finnish stock exchanges. In France, Belgium and the Netherlands the Euronext Group, ran by the NYSE, is the owner and provider of stock exchange capabilities. The rest of the stock exchanges are run by independent parties not part of larger groups, but were included based on their size and/or geographical location. The notion is that the conditions surrounding the stock exchanges are comparable and ideal for the analysis at hand.

One of the most important factors of analysis that were left out of this research was the role of venture capital ("VC") firms in IPOs. While VC firms and funds do play a role in PE firms' and funds' investments, the focus of PE firms in terms of investments is fundamentally different. While both companies essentially pool capital to enhance to potential success probability of a set of companies, PE firms play a larger role in terms of involvement in the companies, including management and incentive alignment, while VC firms focus on giving "smaller" companies the ability to expand and grow to a more profitable venture.

Traditionally, the performance and involvement of PE companies in terms of IPO and exit strategies has been more successful than the more volatile characteristics of VC investments (Levis, 2011). Therefore, the focus of this study lies on PE firms/funds only. The proved performance and reputation of PE firms is what drives the main idea behind this thesis, as opposed to VC firms. It can also be mentioned that the investment horizon and early involvement of VC firms compared to the one of PEs is probably the main difference between both sets of funds.

2.5 Data Collection & Choice of Data

Data collection will be performed with two perspectives in mind. On one hand the focus will lie on gathering all relevant quantitative data. More specifically, this entails gathering stock prices for a three-year period for all companies in the sample. On the other hand, quantitative data needs to be supplemented by qualitative data in the form of literature. Qualitative data is vital for hypothesis formulation and testing, as well as in order to apply a coherent and accurate analysis on the qualitative data. Both primary and secondary sources will be used. The nature of the data to be collected, in particular the quantitative part, can only be approached through the use of databases compiling information straight from the source.

Quantitative data will mainly be gathered through financial databases. The authors of this study have access to five main sources which will be used throughout to gather all relevant information. These are Bloomberg (2016), Datastream (2016), Thomson One Banker (2016), Zephyr (2016) and Orbis (2016). Based on the problem statement it can be derived that three main sets of information are to be collected and subsequently analyzed in order to be able to assess the hypotheses: information regarding the ownership characteristics of the company performing the IPO, information regarding the IPO itself, and information on the company's stock post-IPO. Specific factors to be analyzed will be deepened into in succeeding sections.

In terms of qualitative data, literature in the form of academic articles, research and books will be used. These will be approached through academic article databases, as well as the resources available through CBS' library.

It is vital to evaluate the quality of data in order to accomplish a reliable academic study. Failing to maintain a set of reliable data entails including unnecessary biases in the study, as well as being subject to faulty analyses and interpretations. Therefore, all sources of information to be used throughout this thesis will be subject to analysis of the "value" of the source, i.e. an examination of the originator of the sources, the motives behind the creation/recreation of the sources, tendency and the situation of origin of the source. The goal of this examination is to utilize sources of undoubted quality, and thereby assuring that all information used paint a trustworthy picture of real empirical developments.

Applying this examination to the qualitative sources presented above, it can be seen that data quality seems to be at an acceptable value. Financial databases are created in a context of free market competition; these databases are created with the goal of providing information of

capital markets to institutional and public users. They are secondary sources that gather the information of developments in capital markets and present them to paying customers. They have no interest or reason for altering the data, as their reputation is built around delivering a trustworthy replication of actual market movements. Nevertheless, the output of such databases is mostly standardized and, therefore, not tailored to every individual's needs. Because of this the information taken from these databases needs to be molded by the single users.

In short, financial databases are trustworthy sources of information, but the output of these sources has to be looked at from a critical stance as it might not reflect the actual information needed, but instead show a standardized version thereof.

In terms of analyzing the quality of qualitative data, the information used has to be evaluated on a case to case basis. However, it can be mentioned that books and academic articles are subject to editorial and peers' evaluation before and after they are published, and as such their quality tends to be in the higher end of the spectrum. Nevertheless, their objectivity can be sometimes compromised and/or outdated.

3 Overview of players and industry

The decision of going public is a milestone for the companies deciding to leave the private segment and joining public capital markets. Such a process gives firms the ability to raise equity capital, whereby the company's funding costs are lowered. Furthermore, when such an event takes place the firm at hand gets increased attention from all stakeholders. The IPO process affects virtually all sectors in a company. For instance, the accounting procedures and disclosure requirements cause the practices and operations of companies to be changed for as long as the company stays public. Furthermore, the dissolution of ownership concentration entails a shift in the role and amount of external shareholders. With dissolution of ownership, substantial changes in corporate governance and management methods are involved.

On the other hand, IPOs also include a set of positive factors affecting the company. The IPO itself gives the company the ability to have a wider range of external shareholders, which also leads to an increased amount of pressure to perform at a high level. Stock price becomes a reliable indicator of the market's views on the company's current and future outlook. Additionally, the spotlight brought by the IPO may lead to indirect benefits as well. The involvement in stock markets for any company is often coupled with increased public attention. Ultimately, this can lead to more favorable positions than otherwise could not have been achieved. For instance, higher exposure can lead to the attraction of management from a higher caliber, the reputation of the company can be held to a higher level, among others.

The research of the role of PEs in IPOs has already been put into question in other academic papers and theses. As such, it is the authors' point of view that a contextualization of the central players and events analyzed in this study would be necessary to understand the premise behind the research as a whole. In this sense, a presentation of PE firms, IPOs and IPO-related factors will be performed.

This section will introduce the foundation of the thesis' research; the main actors (e.g. PE firms) and events (e.g. IPOs, pricing developments). They will be described in order to provide the reader the most relevant contextual information needed to understand the theories that will be expanded upon in succeeding sections of the paper.

3.1 Initial Public Offerings

The process of selling stocks to the public for the first time is called an initial public offering. This happens when companies that were formerly held privately decide to sell shares of the company in the open market, either by listing them in large stock exchanges, or in secondary exchanges. Thereby the ownership of the company gets dispersed into capital markets at large.

The process results in the possibility for private and institutional investors to invest in the company. It mainly has two advantages. First, it gives companies the ability to gain capital through the process (and also through the possibility of other offerings in the future), and second, from the buyers' perspective, it gives the investors the possibility to diversify by investing in one more stock (Berk & DeMarzo, 2014).

When a company decides to go public, managers of the company get involved with underwriters. Underwriters are investment banking firms that assist the company in selling shares in the open market by managing and designing the structure of the public offering, as well as collaborating with management to be able to achieve the highest price possible for the shares to be sold. The assistance entails everything from which type of shares to sell to, which kind of process to follow, legal and financial regulation requirement fulfillment, among others Berk & DeMarzo (2014).

Traditional IPOs follow a standardized process. Typically, a number of multiple underwriters collaborate in the IPO process. There is a lead underwriter, who is responsible for most of the advice and it lines up other underwriters to help market and sell the shares issued. The main role of the underwriters is to help with all necessary fillings, as well as marketing the offering, in addition to being highly active participants in the price setting process.

Financial institutions across countries, such as the SEC in the U.S., oblige the companies to prepare a legal document, in the form of a registration statement, where the company at hand provides financial statements and other information to prospective investors in advance of the IPO. This usually includes a preliminary prospectus, where the general terms of the offering are lined out for investors. Subsequently, once the regulatory entity has approved the disclosure of information and all legal requirements have been fulfilled, including whether enough information has been disclosed, management and underwriters work closely in order to finalize the registration statement. This stage will include the final prospectus, a document that lines out the

complete IPO process and structure, including the amount of shares and price thereof that will be available once the market opens on a specified date.

The most important section of the prospectus is the price setting and amount of shares offered, which are typically the conclusion of a long valuation and market seeking process where both the company's management and the underwriters try to identify what the actual value of the company in the open market could be. Thus, the process includes a thorough valuation of the company, as well as road shows where underwriters and senior management visit investors to promote the company's shares and explaining the intuition behind their offer price range, and ultimately to register all kinds of interest and demand for the shares (i.e. book building) (Berk & DeMarzo, 2014).

IPOs can be divided into types of processes followed. In general, there a three types of processes companies can follow when deciding how the offering should take place and who should be involved. The path chosen depends on the size of the IPO, the type of company and/or the underwriters involved. The typical "normal-sized" IPO follows a firm-commitment IPO, where the underwriter commits to selling a specific amount of shares at the offer price. This is done through a process where the underwriter buys the full package of shares to be issued at a price slightly lower than the offer price, and then sells it on the open market. Through this process, the underwriter undertakes potential losses, and the company is guaranteed a fixed sum, regardless of the outcome of the IPO.

Smaller IPOs, on the other hand, typically follow best-efforts IPOs where underwriters do not commit for the shares to be sold, but only commit to selling them at the best possible price. These IPOs usually go hand in hand with clauses that state that the IPO can only take place if all of the shares are sold.

The third type of IPOs are auction IPOs, where the company essentially disregards the main underwriting functions (i.e. price setting/finding), and lets the market itself "find" the price through its mechanisms by auctioning off the company's shares. Investors place bids over a period, and then the highest price that equals the amount of shares offered in relation to the bids is used as the price for all winning bids.

The main reason behind IPOs is the ability to gain access to greater liquidity and better access to capital. Getting involved in the stock market also give the sellers the ability to have access to much larger amounts of equity capital than under other circumstances. Furthermore, the

open market is assumed to be the best measure of a company's "true" value. By getting involved in equity markets, the forces that shape the open market, which are largely driven by the dispersion of the company's internal information and structure, are able to show the fundamental price of a company's current assets and opportunities, and possible future growth. On the downside, IPOs lead to a lower level of ownership concentration, which undermines the ability of the companies' management to be monitored. In addition, the process itself is riddled with all types of regulation, which levy a cost on the companies willing to go through with such an offering (Berk & DeMarzo, 2014).

The amount of IPOs and the total volume of the IPO transactions move in line with cycles in the economy. This premise is logical, as we can expect there to be a greater need for capital in times with more growth, whereas in times with fewer growth opportunities the demand is lower. However, the data shows that, even though cyclicality does play a role in demand for capital in the form of IPOs, it appears that the number of IPOs is not solely driven by that factor. For instance, the number of IPOs and dollar proceed of IPOs in the U.S. has moved together with macroeconomic cycles. However, the magnitude of the offerings has been extrapolated in "good times" and "bad times". The rise and decline in activity is tied to capital demand, but also sentiment in the market, where recessions and crises have pushed investors to walk away from risky assets (Berk & DeMarzo, 2014).

IPO activity in Europe came to a near halt due to the world's recession of 2008 and the Eurozone crisis in 2011. Market conditions have been widely documented to play a substantial role in a firm's decision to go public, but other factors come into play as well. The activity level of IPOs is evidenced to be correlated to cycles. According to Ritter, et al. (2013), the decline in IPOs in the period 1995-2011 can be attributed to two main reasons, the overall decline in market valuations because of market conditions (in particular extraordinary market events), but also because of economies of scope which point out that companies growing larger in size in a quick manner has become more important. This has resulted in smaller firms getting acquired i.e acquisitions of small firms by larger organizations has been on the uprise, impacting the overall amount of companies going public (Ritter, et al., 2013).

In most of the literature related to IPOs the focus lies on trying to research so-called IPO puzzles. IPO puzzles are patterns identified in IPO data (including pricing, amount of deals, costs and performance), which cannot completely be explained based on general analyses.

Specifically, they tend to contradict the efficient market hypothesis (Berk & DeMarzo, 2014). Instead, specific analyses are performed to try to explain in which cases and/or under which circumstances these puzzles can be explained. The most investigated IPO puzzles are underpricing, cyclicality, long-run under performance and IPO costs.

Looking at IPOs as a whole, the average thereof appears to be underpriced. In particular, first-day underpricing is a clear phenomenon (Ljungqvist, 2007). The price of a share in an IPO is substantially higher at the end of the first trading day than when the set offer price. There are multiple theories and vast literature with regards to the explanation of underpricing as such. In general, the main reasons to interpret the phenomenon relate to information asymmetry theories, which point out that because of the unequal amount of information held by one or multiple players in relation to the rest of the players in the IPO market, information asymmetries are created. As a result, the share price of a company's IPO jump in price on the first day of trading. Main players in the IPO market consist of the issuing firm, underwriters and investors (private and institutional).

3.2 Private Equities

Private equity can be thought of in two ways, the type of equity that is actually invested in companies, and the actual private equity firms that carry out those investments. Private equity in the larger sense of the phrase refers to long-term illiquid investments on privately held companies or assets. These investments can come in multiple shapes and forms, the most popular ones being leveraged buyouts, venture capital investments or growth equity. Other types of private equity include real estate, mezzanine or infrastructure investments. The more common sense of the phrase refers to the firms that typically carry out such investments. Usually, when somebody mentions private equities they refer to firms or funds, while the investments per se are not completely what is in focus.

Regardless, private equity investments are classically performed in three ways. Direct investment is the first one, where investors can directly put their capital into companies, either by themselves or in cooperation with a private equity fund. Second, private equity firms pool investors' money in funds which are then used to acquire companies. There are multiple private equity firms all around the world, in multiple sizes, and just like other funds, they also take focus

in specific sectors and industries. The third way is a fund-of-funds, which is a fund that holds a portfolio of investments in PE funds.

The structure of PE investments relies on three main parties: the PE firm (General Partners), the providers of capital (Limited Partners) and the PE fund (where the capital will be invested and then managed).

General Partners ("GPs") are PE professionals that manage the day-to-day operations of the firm, as well as of the companies in the portfolios, i.e. the companies in the funds. GPs are usually organized in a management company. GPs are employed by the PE firms (and might be part of the owners), who in turn are essentially management companies. They have all the decision rights in the funds, and are subject to fixed fees and a pre-specified share of the profits in the funds. This lies characteristically around the 20% mark.

Limited Partners ("LPs") are the providers of capital. They are normally long-term institutional investors, such as pension funds, insurance companies or banks, but also private individuals with large amounts of wealth or asset managers. LPs have no involvement in the management or the operation of the funds, and only have limited liability. However, they provide almost all the capital in the funds and are typically rewarded with 80% of the profits in the PE funds (plus their initial invested capital). They are also liable to pay management fees.

PE funds are the foundation of the PE business model. The process of performing investments in PE relies on PE firms setting up the funds. PE firms establish PE funds either based on demand for the PE firm's funds, which is a normal occurrence for successful PE firms, or on the PE firms own interest. They are established in the hopes that the necessary capital from investors (LPs) to establish the funds can be gathered. PE funds are typically organized as limited liability partnerships, mainly to protect partners from a legal stance (if necessary) and because of the tax nature of such companies.

Once the necessary capital has been raised, GPs (the PE firm) and LPs (the providers of capital) sign the limited partnership agreements ("LPA"). The main purpose of the LPAs is defining the liabilities and responsibilities of the LPs, as well as lining up the interest of the PE firm with the ones of the GPs. The LPA specifies the terms of the LPs investment into the funds. Mainly, the compensation of GPs and the allocation of profits is specified, including management fees, return hurdles, timing of payouts, as well as provision to keep interests aligned. LPAs also specify the lifetime of the fund, i.e. the time frame of investment period and

when the fund should be liquidated. Logically, the LPA also includes negative covenants, such as limits to the exposure of the fund and restrictions on capital use or the ability of LPs to sell their interests in the partnerships.

The life of a fund can be divided into four main stages, spanning from a short period before the fund starts being functional until its liquidation. Usually, around a year before the PE fund is planned to come into force, GPs raise capital from LPs to set up the funds by marketing its establishment. Once the GPs have raised enough capital, and the LPA is signed, the investment period starts. Here, the fund buys companies based on the decision of GPs, but also this is the period where the capital from LPs is actually put in use. This stage lasts usually between four and six years.

Subsequently, the companies invested in in the previous stage are sold -the exit stage-, and the proceeds are allocated back to the LPs according to the allocation of profits. The last stage of PE funds is the "end of life" where the fund is liquidated and all remaining assets sold and distributed to the LPs. The period between the establishment of the fund until the liquidation characteristically lasts around ten years, but each PE fund differs in scope and prospects. It has to be mentioned that the investment stage and the exit stage are usually overlapping, as some companies bought might deliver the desired amount of return sooner than expected, and companies might still be bought by the fund while other ones are being sold.

The defining characteristic of PE firms is their ability to enhance a company's market value by restructuring it and enhancing its overall operational capabilities. This is mainly done through three main channels: operational engineering, financial engineering and governance engineering.

Operational engineering takes place through industry expertise provided by GPs in the form of internal operation groups that focus on how to improve a company's operations.

Governance engineering is carried out through incentive monitoring and exercising control through ownership. PE investors take part in the management of the company's board, and since they are better incentivized to deliver result, the overall impact on the company is prospectively one of improvement. PE owners are very concentrated and active, which gives them the ability to exercise a high level of control. In addition, their incentives to improve the company are tied to the company's performance, which aligns both owners' and company's incentives. When comparing this type of governance to the one used in public companies, where

exercising control and aligning shareholders' and management incentives is challenging, it can be easy to understand why PE governance is able to deliver a better performance.

Financial engineering is performed by involving higher levels of leverage, more equity stakes for management and higher degree of financial flexibility than in "normal" companies. High levels of leverage is one of the most, if not the most, characteristic factors attributed to transactions where PE firms have an involvement. Leverage is important because it serves as a disciplining device for management, but also it enhances the value of equity. If this is added to the increased amounts of equity held by management, the incentive to deliver better performance is clear.

When a PE fund evaluates the attractiveness of an investment in a specific company, one of the most important aspects to be considered are exit strategies. If a given company seems to have potential, but the available possibilities for transfer of ownership are limited, the investment might not fulfill its potential. The GPs main concerns when it comes to companies in the funds' portfolios is yielding the highest level of return when "exiting" those companies. If the possible buyers or platforms to which ownership will finally be transferred to are scarce, the PE funds' bargaining power is low. Therefore, one of the main considerations of PE firms when choosing which companies to include in the funds' portfolios is an analysis of each company's industry players. The purpose is to identify possible buyers of the company at hand once the restructuring and enhancement of operations has taken place. This entails that the analysis will be focused on the likelihood that competition or the size of industry's player might lead to an acquisition or a merger.

Nevertheless, mergers and acquisitions are only one of the possible exit strategies. IPOs are another way to go. In this case, the analysis performed entails analyzing the current state of the economy, including the industry, but also the trends in capital markets. Furthermore, IPO possibilities entail a larger degree of cost considerations in terms of transactional costs, legal costs, as well as an analysis of the possible downside of such a process. Since IPOs involves putting the company through a number of open market considerations, which the GPs cannot directly control, IPOs entail a higher degree of analysis and interpretation of external forces.

In extension to the alternatives above, where a prospective exit is assumed to part from a positive development in the turnaround process, other exit strategies include the sale of the company in parts, liquidating a company's assets, or even forcing a firm's bankruptcy.

3.3 PE-backed IPOs

As mentioned above, PE firms' involvement in IPOs takes shape by being one of the possible exit strategies. To be able to understand the relevance of IPOs, it is important to further contextualize the significance of listing companies in a stock exchange from a PE point of view. IPOs offer an attractive exit opportunity because of the capital available in stock exchanges, in addition to the amount of investors participating in those.

For a PE firm to decide that an IPO is the best alternative to exit the investment in a specific company, a thorough analysis of the situational context has to be performed. In particular, the state of the economy and the industry are relevant, since positive trends in both of these entail a higher positive return than under other circumstances. If the context is not favorable, such as in cases where the industry is in an unfavorable cycle, or the economy as a whole is in a recession, an IPO might not be the ideal exit strategy. Therefore, the decision of whether to exit or not is reliant on a set of factors that cannot be directly influenced by the PE firm, i.e. IPO activity is very dependent on the state of the economy as a whole and to industry developments.

Oppositely, the PE firm can more easily control exit strategies where a merger or an acquisition is involved, even when external drivers can still affect them. If the company at hand developed positively, if the market or industry circumstances are not ideal, M&A deals may be more realistic and/or profitable.

In the case where PE firms decide that IPOs are the most profitable exit strategy, one of the most important aspects that might come into play in favor of the PE-backed firms is their relationship with underwriters. Classically, one of the core competences of PE firms is management. In particular, the managers' experience, network and connections are vital for the success of any given PE firm. Such qualities can be scouted for in the labor market, but more often than not the development over time of PE funds leads to a situation where management expands its network and connections to multiple sectors of the financial sector, including investment banks are made.

The more deals a PE firm makes, the higher the degree of confidence between parties involved, as well as the higher the reliance of all players to one another, e.g. the more IPOs performed by a specific PE firm, the better the relationship to underwriters. In this context, the

role of PE firms when an IPO actually takes place is important to analyze. This will be expanded upon in the following section, parting from prior studies on this relationship.

4 Data Collection

4.1 Overview

Data collection was this study's central focus in the stages prior to the analysis and interpretation. In particular, what permeated the approach were the conditions described in section 2. Comparability, coherence and reliability lied at the core of the process of collection and evaluation of data.

While the conditions predisposed for this part of the study seem straight forward, the sizeable amounts of data at hand posed considerable challenges. In order to preserve these conditions an extensive effort was made.

This subsection first presents the data collected to contextualize the analysis and interpretation that will be performed in later stages of this thesis. After this, a description of the collection process, including an evaluation of the conditions set out, will be offered to confirm the validity and quality of the data basis of this academic study.

As was previously mentioned, the data set needed to conduct this report can be divided into three areas: IPO data including whether or not the company is PE-backed, stock prices & company information, and underlying variables to test our hypotheses.

The final data set consisted of the following data sets:

General company data was gathered and consisted of:

- Name of company (including name after last takeover/merger or name changes),
- ISIN number,
- Place of incorporation,
- Industry (ICB classification), and
- PE ownership prior to the IPO.

The factors above were deemed necessary to be able to properly identify the companies involved in the IPOs, as well as to be able to categorize the companies in subsequent phases of the study. Moreover, they are important in order to be able to identify the separation between the focus of this study – PE-backed companies –, and the subject of comparison – non-PE-backed companies –.

In terms of IPO data, the data collection consisted of:

- IPO date,
- Offer price,
- Main stock exchange of IPO,
- Offer size, and
- first day of trading.

These essential elements of information were deemed vital to be able to place the single IPOs in a timeline that can be descriptive of the dynamics of the stocks.

With regards to stock prices, the factors collected were:

- Closing price of first day of trading (unadjusted)
- Adjusted stock prices for 36 periods where one period is defined as 21 trading days,
- Holidays in each main exchange, and
- 36 periods of adjusted closing prices for the represented exchanges.

Furthermore, since this study will take place in a broad capital markets context, it is important to identify what its state is. Therefore, in addition to the information presented above, indices will be researched. This entails gathering index prices at the same time intervals as the stock prices mentioned above. See 4.3 for an explanation of the use of benchmarks in this master's thesis.

4.2 Final process

The factors above comprise the data that will be used in all subsequent sections. This dataset will be subject to factual calculations and statistical tests that will ultimately set the basis for the interpretation and analysis stages. At large, the data above is the undeniable foundation in the process of testing if our hypotheses hold, which will ultimately lead to inferences about this thesis' problem statements. It is for this reason that the authors have focused extensively on this subsection, with the aim of keeping a very high level of reliability and coherence.

In order to concise the data collected into a valid sample, we turned to the EurIPO publications by Paleari, et al. (2006-2013)[1]. This source consists of a series of physical books that present each year's IPOs in all of Western Europe's main exchanges. Based on the

[1] Citation is referring to all Academic EurIPO Fact Book publications in the time frame 2006-2013 (See section 11).

information gathered from Paleari, et al., (2006-2013), the sample presented in these sources was established as the basis of IPOs to be analyzed. However, the data provided by the yearly publication was insufficient as not all information elements were presented. In order to be able to find all relevant data items, a cross-check of all available databases presented in section 2.3 had to be applied.

An alternative approach that could have been taken is to have used one specific database to retrieve all information possible and then to complement it with few data elements from others if needed. However, the central issue faced by the authors of this test was the unreliability of IPO samples provided.

All databases available were consulted in order to find the set of IPOs in the scope of this thesis, but in the process it became apparent that the set of IPOs differed widely from one database to another. This can be attributed to the different methods used by databases to retrieve data, as well as to the deviation across categorization criteras applied. Regardless, in order to mitigate this problem the method used involved using the literature of Paleari, et al. (2006), as it was deemed a more reliable source of information than databases.

To illustrate, when analyzing the reliability of data available from Bloomberg in terms of how much it ressembled data gathered through other financial databases, it became clear that there were systematic inconsistencies. In fact, a large set of the information gathered that was cross-compared contained discrepancies with regards to the companies that performed IPOs, exchanges where the IPO took place, IPO dates, offer prices, among others. Hence, the validity and trustworthiness of the information gathered proved to be weak. Because of this, it became common practice in the data collection process to cross-check all information gathered. The goal was to acquire a final set of companies that satisfied the methodological criteria (see 2.3).

The initial sample from the choice of EurIPO's publications left us with a limited set of data on each IPO. Only company name, exchange, country, industry and year of IPO were provied. While the informaiton presented in the publications was not sufficient, it did prove to be vital in order to be able to identify the most basic pieces of information needed to begin our search. After establishing the sample, the focus lied on retrieving fundamental data, such as company ticker and/or ISIN, in order to be able to trace back all other relevant pieces of information. Tickers and ISIN numbers are generalized codes used across the world to identify

shares of traded companies in stock exchanges. By finding these, the rest of the relevant data would prove to be more easily accessible.

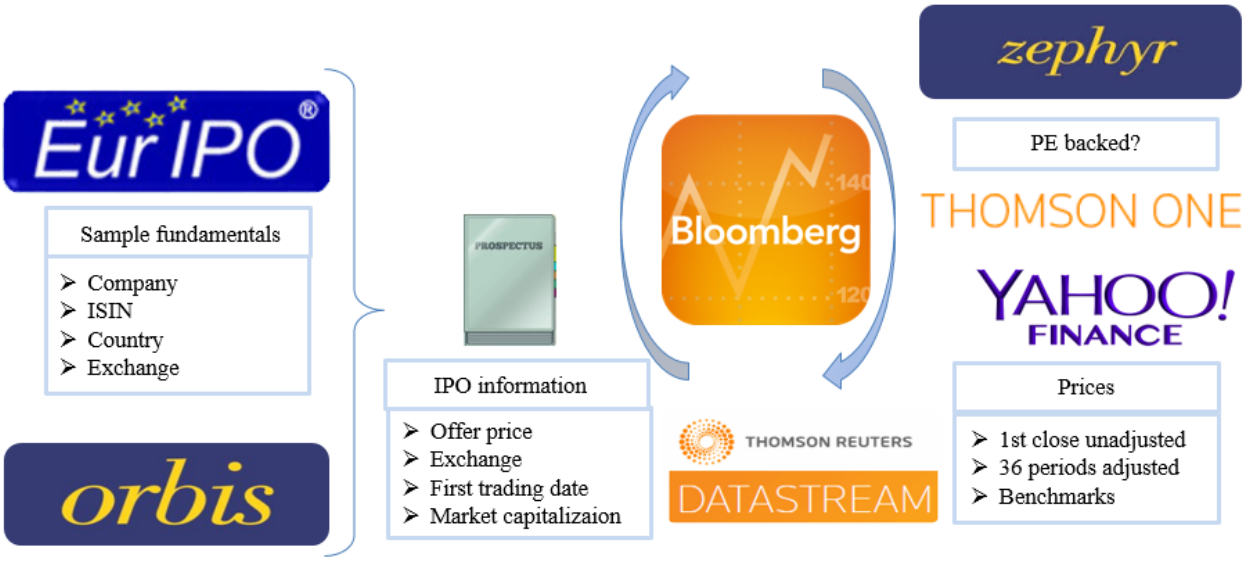
Based on the above, we turned to extract such data elements from the available databases. Orbis (2016) and Zephyr (2016), provided the most vital informaiton in the sample. They provided both codes described above for the largest share of the companies, as well as providing official name and name changes for almost every single company in the sample.

What followed was to use the given codes to find all relevant stock prices and stock-exchange related information. This stage of the process took place in Bloomberg, the most widely used source of stock prices in financial markets, as well as in Datastream (when Bloomberg was unable to provide the relevant information). Yet, not all stock prices were available in these databases. Where information was lacking, online sources such as stock exchange websites were used.

Nevertheless, the approach above did not provide elements of information that were vital for this master's thesis. In particular, offer prices and date of IPO proved to be extremely challenging to gather. Since the time between establishment of the offer price and the actual flotation varies from IPO to IPO, databases had conflicting information in these regards. At times, offer prices tend to be set within hours of IPOs. The date of the IPO, too, tends to be shifted during the month the IPO is planned to take place. The research of IPO prospectuses was performed by examining company websites, stock exchange official releases, news databases, among others, to confirm the data.

Lastly, the definition of PE-backed or non-PE-backed companies was performed. The method was focused on consulting the Zephyr database, as this database is exclusively focused on M&A deals in financial markets. Still, this process included an additional cross-examination of financial databases, as well as consultation of local PE- and VC associations in the single countries. Furthermore, news databases were consulted to confirm the presence of PE-backing. The process has been visualized in figure 1 to help the reader gain a better overview of the process:

Figure 1 - Overview of data collection process



After the procedure lined out above was performed, and while following a constantly iterative progression, the data collection culminated in a sample of 418 companies. Out of the initial 418, 50 companies had to be discarded based on a lack of available information, unintelligible information or because the IPO was cancelled after the process was initiated.

4.3 Benchmarks

This study will rely on benchmarks to adjust and compare IPO returns against the overall status of the market. Benchmarks serve as support to be able to normalize or have a reference point between the performance of the IPOs and general market conditions. At large, benchmarks serve as proxies of what the macroeconomic or industry developments are like at different points in time.

In the context of this master's thesis, benchmarks will be used in the analysis of long-term performance of stocks. Benchmarks serve as reflections of what a neutral investor could expect to gain if he were to follow market or industry developments as a whole, as opposed to single stocks or a portfolio. In order to identify what the return of an investor would be if he/she were to invest in a neutral world, in this case a specific index of stocks, appropriate benchmarks have to be selected. The notion is to find a set of stocks that can reflect the overall context of the stocks/portfolio to be analyzed, and can thereby be compared to. As such, it is important to

define factors that might affect the stocks or portfolios that will be subject to analysis, which includes identifying defining characteristics.

This academic paper has defined three areas of research that were deemed vital for finding a benchmark. The scope of this study focuses on IPOs across a wide range of European countries, across all industries. On these grounds, three main factors were selected as benchmarking basis: European applicability, country specific applicability and industry applicability. The process of selecting benchmarks involved categorizing the final data sample of IPOs at our disposal (see section 5) in terms of main exchange and industry to be able to identify the latter two points presented above.

In literature, benchmark and indices are terms usually used interchangeably. In specific terms, an index is a tool used to benchmark the returns of a given set of companies, e.g. countries, sectors, industries or region. It also is an investment vehicle which can be bought to act as a portfolio of stocks acting as a "single stock". To be able to identify relevant benchmarks, criteria factors need to be defined. In this study the requirements pertained similarities to the sample's characteristics. The criteria elements included, therefore, indices including stocks from main exchanges only, indices that are generally liquid in the exchanges where they are traded (to ensure reliable price developments from which statistical tests could be inferred) and, in particular, indices that resemble the qualities of the companies in our sample.

Using the foundation laid out above, three types of benchmarks were chosen: A European benchmark reflecting the development of stocks in Europe as a whole, a set of country benchmarks relating to the main exchanges in the scope of this thesis, and a set of industry specific benchmarks reflecting the qualities of all companies in the sample.

From a European perspective, the STOXX Europe 600 index was deemed the most appropriate. The benchmarks include a wide set of companies across all industries in Europe, in particular Western Europe, that reflects developments in the European markets.

Disregarding the European benchmark, the approach in the other two areas entail matching each company in the sample on a country and industry basis so that a specific benchmark can be applied to all given companies. The intuition is to find benchmarks that more closely resemble the companies in the sample themselves, as opposed to applying generalist benchmarks that could lose explanatory power. The goal is to find benchmarks that truly compare to the stocks in specific terms, as opposed to applying a broad benchmarking approach.

From a country-specific point of view, the most representative country indices in terms of types and size of companies included were chosen. It has to be mentioned that, while the most renowned benchmarks of each country are usually used, this study focused on finding benchmarks whose composition resembled more the market as a whole and not only the most representative companies in the given country.

From an industry-specific point of view, the process involved applying ICB industry classification identification standards on all companies in our sample to find the specific industries to be benchmarked. There are 10 ICB Industry Classifications, and once these were found the authors of this text researched benchmarks that could reflect the developments in each one of them. As a result, STOXX Europe 600 industry indices were selected as relevant benchmarks as they replicate indices based on ICB industry classifications.

Table 1 presents the specific indices used as benchmarks that will be used in all succeeding section of this master's thesis:

Table 1 - Overview of selected benchmarks

Industry	Country	Country Index name	Europe
Basic Materials	Amsterdam	AEX	STOXX 600 Europe
Consumer Goods	Brussels	BEL 20	
Consumer Services	Copenhagen	KBXHB	
Financials	Frankfurt	DAX	
Health Care	Helsinki	OMXHB	
Industrials	Iceland	OMX Iceland all	
Oil & Gas	London	FTSE All share	
Utilities	Oslo	OBX Benchmark	
Technology	Paris	CAC 40	
Telecommunications	Stockholm	OMX Stockholm benchmark	

The table provides the chosen exchanges from all three criteria set out previously. From a country benchmarking perspective, it is important to mention that the indices chosen tend to reflect wide arrange of companies (they include amounts in the range of 100-300 companies) when available, with the exception of the Belgian, German and French indices which were the only main exchange representative benchmarks available.

Alternatives to the benchmarks above included, as previously mentioned, the most renowned index in each country, or from an industry perspective, FTSE-based indices. These were not chosen as they did not fulfill the criteria of relatability to this study's sample.

5 Data description

The data collection process culminated with a final sample of 368 companies, down from an initial 418 companies[2] (12% of companies initially included were discarded). The criteria for deletion involved identifying insufficient data with regards offer prices or IPO date, unfulfilled IPO process (cancelled or postponed IPO), or data that was deemed unreliable (irregular aftermarket trading/dubious price ranges):

Table 2 - Final sample summary

Original sample	Disregarded	Final sample	Non-PE-backed	PE-Backed	Exchanges	ICB Industries
418	50	368	286	82	10	10
	% of total sample		**% of final sample**			
	12%		78%	22%		

The sample consists of 22% of PE-backed companies and 78% of non-PE backed companies. To further identify how the final sample can be broken down, in particular in terms of PE-backed and non-PE-backed IPOs, a geographical and industry breakdown will be presented. Thereby it can be made clear how and where IPOs take place.

Table 3 presents an overview of the geographical location of the IPOs. Please note that this does not entail that the companies that floated their shares come from these countries, but merely points out where the IPOs took place.

Table 3 - Breakdown of final sample by main exchange

Exchange	Non-PE-Backed	PE-Backed	Total	Non-PE-Backed	PE-Backed	Total
Amsterdam	5	2	7	1.7%	2.4%	**1.9%**
Brussels	13	3	16	4.5%	3.7%	**4.3%**
Copenhagen	22	2	24	7.7%	2.4%	**6.5%**
Frankfurt	66	25	91	23.1%	30.5%	**24.7%**
Helsinki	6	1	7	2.1%	1.2%	**1.9%**
Iceland	4	0	4	1.4%	0.0%	**1.1%**
London	76	16	92	26.6%	19.5%	**25.0%**

[2] An overview of the whole sample can be found in Appendix 1 – Overview of sample

Oslo	31	3	34	10.8%	3.7%	**9.2%**
Paris	44	23	67	15.4%	28.0%	**18.2%**
Stockholm	19	7	26	6.6%	8.5%	**7.1%**
Total	**286**	**82**	**368**	**100%**	**100%**	**100%**

The table shows that in the given period the highest level of IPO activity took place in the Frankfurt and London stock exchanges. At the same time, these exchanges also show the largest amount of PE-backed IPO activity as well.

Table 4 below presents a breakdown of the sample by the industry in which the companies in the sample operate:

Table 4 - Breakdown of final sample by industry

Industry	Non-PE-Backed	PE-Backed	Total	Non-PE-Backed	PE-Backed	Total
Basic Materials	26	3	29	9.1%	3.7%	**7.9%**
Consumer Goods	28	5	33	9.8%	6.1%	**9.0%**
Consumer Services	32	10	42	11.2%	12.2%	**11.4%**
Financials	68	4	72	23.8%	4.9%	**19.6%**
Health Care	33	19	52	11.5%	23.2%	**14.1%**
Industrials	43	19	62	15.0%	23.2%	**16.8%**
Oil & Gas	21	9	30	7.3%	11.0%	**8.2%**
Technology	25	10	35	8.7%	12.2%	**9.5%**
Telecommunications	4	3	7	1.4%	3.7%	**1.9%**
Utilities	6	0	6	2.1%	0%	**1.6%**
Total	**286**	**82**	**368**	**100%**	**100%**	**100%**

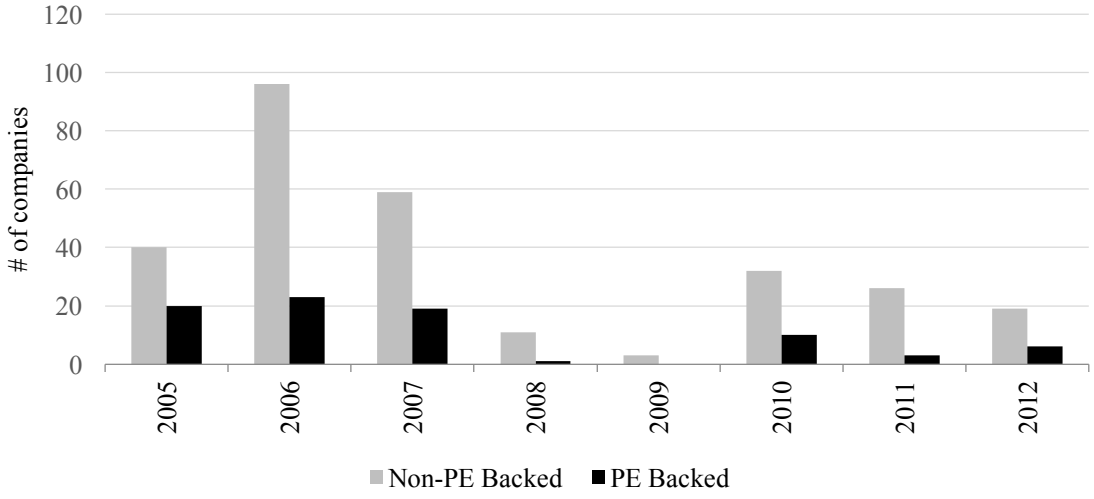
The table shows that the largest concentration of IPOs as a whole lie in financial, industrial and health care industries. On the other hand, the set of companies going public in the telecommunications and utilities sector is relatively small. This can be attributed to the fact that these last two industries tend to be made up of few players and the growth possibilities have a limit. Non-PE-backed IPOs are distributed across most industries approximately uniformly, except for IPOs in the financial industry. In terms of PE firm backing, the largest share of IPOs is concentrated in the health care and industrials ICB industries, in a similar fashion to the overall sample.

To put into perspective the composition of PE-backed IPOs, a graphical interpretation of the view of PE-backed companies and industries performed by Bain & Company, Inc. (2016) can be found in Figure 2 - Attractiveness of PE targets:

Figure 2 - Attractiveness of PE targets[3]

From a time specific point of view, it is important to analyze how the level of IPO activity has developed over time. Table 5 presents an overview of such developments and figure 3 presents a graphical representation of IPOs by year:

Figure 3 – Graphical time distribution of IPOs, 2005-2012



[3] (Bain & Company, Inc., 2016)

Table 5 - Time distribution of IPOs, 2005-2012

Year	Non-PE-backed	PE-backed	Total	Non-PE-backed	PE-backed	Total
2005	40	20	60	14.0%	24.4%	**16.3%**
2006	96	23	119	33.6%	28.0%	**32.3%**
2007	59	19	78	20.6%	23.2%	**21.2%**
2008	11	1	12	3.8%	1.2%	**3.3%**
2009	3	0	3	1.0%	0%	**0.8%**
2010	32	10	42	11.2%	12.2%	**11.4%**
2011	26	3	29	9.1%	3.7%	**7.9%**
2012	19	6	25	6.6%	7.3%	**6.8%**
Total	**286**	**82**	**368**	**100%**	**100%**	**100%**

The data and representation show the changes over time in amounts of IPOs completed between 2005 and 2012 (specifically 01/01/2005 to 31/12/2012). The most noteworthy development of the sample is the substantial fall in IPO activity between 2008 and 2009. This can be attributed to the financial crisis. Only a single PE-backed company went public in the period, and the level of PE-backed IPOs did not go back to pre-crisis level afterwards. Approximately 7% of the IPOs in the crisis period are PE-backed IPOs, compared to 30% in the rest of years, and 29% in the whole sample.

On the other hand, the period of 2006-2007 seems to show substantial IPO activity, in particular 2006, which also follows the development of the market as a whole. The closeness of IPO activity with macroeconomic circumstances is logical, but the theoretical intuition from an IPO perspective can be specifically traced. The next section will expand on these trends.

6 Hot and Cold Periods

Section 5 hinted towards the idea that there is a correlation between the overall state of financial markets/macroeconomic factors and the level of IPO activity. This specific notion can be thought of as a logical causal relationship since stock market and stock prices must have a relationship to the macroeconomic conditions. However, this specific phenomenon has been identified and researched in IPO literature previously, most commonly known as "hot and cold periods" theories. In the context of this paper this becomes particularly relevant since the financial crisis spanning between 2008 and 2009 (and its repercussion in following years) is part of the scope. This section will set out to clarify the influence of external financial factors on IPOs, as well as expanding the theoretical contextualization of the study as a whole.

Ibbotson & Jaffe (1975) was the first academic paper to look into the existence of hot and cold periods. Around the publishing time of the article, underpricing was experiencing increasing amounts of attention. Ibbotson & Jaffe (1975) tried to find an empirical foundation of such a phenomenon by trying to determine whether investors could benefit by investing in specific periods of high/low underpricing over others. In the article, hot issue markets were initially defined as periods where the average aftermarket performance of new issues presented an abnormally high return. This was done by focusing on average return in the first and/or second month(s) of trading.

The subject was then further analyzed by Ritter (1984) some years later. In this article the focus lied on risk and underpricing. The analysis focused on the hypothesis that high-risk IPOs are more underpriced than low-risk IPOs. Thus, the argument was that an "overweight" of companies with high-risk in some years over others could be the reason for hot and cold periods. The difference identified was of 32% on the initial returns of companies going public during hot and cold periods in 1977-1982. However, the analysis did not present statistically significant results.

Ritter & Loughran (2004) presented another academic attempt to explain hot and cold periods. This paper, too, was not able to provide sufficient evidence to come up with a hypothesis of the reasoning behind such events. The article focused on "the realignment of incentives hypothesis" which stated that hot periods, and in particular money left on the table, were positively affected by the tendency of CEOs to have low ownership levels, leading to little motivation for them to negotiate higher IPO offer prices.

Through the evolution of hot and cold markets literature, the definition of such a phenomenon has evolved into a more general notion. Namely, hot- and cold-issue markets began to be put forward in terms related to activity instead of returns. Nowadays the overall idea of hot (cold) markets is defined as periods where new issue activity is higher (lower) relative to the average activity level. This definition is vague and does little to point towards a specific identification of such periods. This is also the reason why this phenomenon has not been subject to substantial empirical scrutiny, and is mostly interpreted as means to describe flotation activity levels at large instead. The literature often leads to inconclusive hypotheses. Hot and cold periods is a phenomenon generally described through qualitative reasoning and descriptive statistics of underpricing.

At large, the IPO market is usually described as a cyclical market. This can be traced back in literature to two reasons. On one hand, there are periods where companies are in need of funding for investment projects. This can be because of overall market conditions or industry conditions, but the logic is that, at times, multiple companies need funding simultaneously (Günther & Rummer, 2006). On the other hand, the investment appetite of investors can define the activity levels in IPO markets. There are periods where investors have high investment appetite due to high optimism. These periods are gauged by issuers, and when positive sentiment can be noticed in the market, issuers decide to take advantage. IPOs are said to be scheduled around periods of high investor optimism, thereby taking advantage of "windows of opportunity".

The reasoning presented above relates to hot markets in overall terms, but the logic can be reversed to argue for the existence of cold periods. For instance, using opposite intuition, pessimistic investors lead to issuers gauging interest in the market to be low. In this case they would rather wait until the investors' mood changes in order to issue the given shares, which in the end leads to cold periods.

7 Underpricing

7.1 Underpricing theory

The phenomenon of underpricing can be described as the occurrence that takes place in the first day of trading for companies performing IPOs when stock prices rise by substantial levels from their initial offer price. When companies decide to place shares in the open market, also known as going public, the equity sold in the IPO tends to be underpriced, leading to a large jump in the first day of trading. Underpricing is estimated as the difference between the price at which the issuing firm's IPO shares were sold to initial investors – the offer price –, and the price at which the shares were traded in the stock market subsequently. Usually the offer price is set a few days, or even a few hours, before the trading of shares in the stock market begins, but in some markets the delay is substantial (Ljungqvist, 2007).

Notable early analyzers of these events include Logue (1973) and Ibbotson (1975), and the phenomenon has been observed and tested thoroughly ever since. Underpricing is noticeably costly to the firm issuing new shares in stock markets; shares are sold at a price that is too low, which is coupled with dilution of the share value kept after the IPO. It appears that during the IPO process, firms leave a large amount of money "on the table" (Ljungqvist, 2007). To illustrate, the average underpricing in the U.S. since the 1980s until 2015 was around 18%, equaling to around $150bn left on the table (Ritter, 2016). Underpricing has traditionally been described as a market anomaly, as the intuition behind this anomaly poses a question in terms of the market efficiency hypothesis (Berk & DeMarzo, 2014).

The constant empirical proof is noticeable, and has inspired a set of theoretical models that try to explain the reasoning behind underpricing. In general, theoretical approaches trying to come up with argumentation behind such occurrences can be categorized into four main (broad) categories: asymmetric information (information frictions), institutional reasons, control considerations and behavioral theories (Ljungqvist, 2007).

Asymmetric information theories seem to be the most accepted string of explanatory literature within underpricing. Asymmetric information theories focus on the idea that at least one of the principal players involved in the IPO process (issuing firm, underwriter and investors) knows more than the others. The theories present multiple information friction situations where either the issuer is better informed about its true value than others Welch (1989), or the

investment bank (underwriter) has a better understanding than the issuer about the situation of the market (Baron, 1982), while other theories assume that some investors are better informed than others (Rock, 1986) (Ljungqvist, 2007).

Institutional theories, on the other hand, focus on marketplace factors: taxes, litigation and the role of investment banks as stabilizing agents once trading begins. Meanwhile, control theories are based on the idea that underpricing is a practice undertaken in order to help the firm shape the shareholder base in order to reduce intervention by external investors once the company is made public. Behavioral theories either part from the assumption that irrational investors bid IPO share prices up beyond their true value, or they part from the assumption that behavioral biases impact issuers negatively which causes them to put and insufficient amount of pressure on underwriters to reduce underpricing (Ljungqvist, 2007).

The models and/or theories lined out have been tested through time, either from a structural econometric viewpoint or from a viewpoint correlating specific variables with underpricing. At large, empirical evidence supports the idea that asymmetric information contributes to IPO underpricing. There is a large amount of evidence supporting the view that information frictions have a first-order effect on underpricing.

On the other hand, the results are mixed for institutional theories mainly because of their applicability. Underpricing is still present in markets where the notion of the theories cannot be applied. For the time being, control theories and behavioral theories are still relatively recent, but initial evidence is consistent with the idea of the presence of behavioral biases among people in charge at IPO firms and overoptimistic investors. In addition, from an empirical stance it is clear that there is a degree of fluctuation over time of the level of underpricing, as well as the amount of companies performing IPOs (Ljungqvist, 2007).

This master's thesis will focus on asymmetric information models. Based on the availability of empirical evidence and the relative certainty of the correlation between underpricing and information frictions among the main players in IPOs, the authors of this study are of the opinion that the outcome of the interpretation and analysis section of this thesis will be largely explained by the theories presented below.

7.1.1 Asymmetric information models

The most regard asymmetric information models part from two main strings of literature: Ibbotson (1975) and Rock (1986). On the one hand, Ibbotson (1975) presents the information

frictions between issuing firms and investors, where the companies' ability to signal their true quality lies at the center of the underpricing anomaly. On the other hand, Rock (1986) explains underpricing based on information frictions parting from the side of investors.

Multiple models are based around this intuition, such as the winner's curse model, where information frictions relate to the fact that some investors are better informed about the true value of shares on IPOs than others (Rock, 1986). Information relevant theories point out that underwriters' main challenge is to try to incentivize well-informed investors to reveal positive information about the IPO (e.g. book building as a mechanism).

7.1.1.1 Underpricing as a signal of firm quality

One of the earliest models explaining IPO underpricing through the notion of information frictions was presented by Ibbotson (1975), who is credited with the original explanation around "signaling". In his article, Ibbotson presents a two period signaling model where companies issue equity. In it companies raise equity in two stages, the IPO date and at a later stage. Ibbotson's model is expanded in Welch (1989) (among others).

The model is based on the information asymmetry between the issuing company, which holds better information in terms of cash flows and risks relating to the company, and thereby the company's present value, and the other players. The model divides between high quality and low quality companies. Firms use underpricing as means to signal (true) high quality. The model describes a tradeoff between costs of imitation and getting discovered, or appearing high quality in the first place and having a low price offering. High quality firms have an incentive to credibly show the nature of their company as doing so can lead them to raise capital in more positive terms, while low quality firms have an incentive to imitate high quality firms in order to free-ride as a way to raise higher amounts of capital.

What is presented in the underpricing as a signaling mechanism literature is that the true nature of a company can be identified with some positive degree of probability before the post-IPO financing stage, i.e. the stage where low quality firms could reap the profits of free-riding. Because of this, the risks undertaken, and thereby costs incurred, by low-quality firms when imitating high quality ones can be a deterrent of imitation. This entails that high-quality firms deliberately performing underpricing can be used as a signal to influence investors' certainty about the firm's true quality (Ljungqvist, 2007).

In short, the additional costs of underpricing can induce low quality firms to voluntarily reveal quality when real imitation costs versus possible profits of free-riding are not sufficiently favorable. Furthermore, high quality firms use underpricing to signal their nature, thereby leaving money on the table during the IPO, because they are confident that their losses can be overturned once the next round of equity financing takes place.

7.1.1.2 Winner's curse.

One of the best-known asymmetric information models about underpricing is the work of Rock (1986), which is an extension of the so-called "Lemon's problem" posed by Akerlof (1970). In essence, the model presents the hypothesis that there is asymmetric information across the investors involved in the purchase of shares, in which some investors are better informed than either other investors, the issuing firm or the underwriter itself in relation to the true value of the shares to be offered.

Informed investors withdraw from buying shares when the offering is above its value, therefore uninformed investors will get a full allocation when the offering is overpriced and a rationed one when it is not. In other words, informed investors only invest in attractively priced IPOs, whereas uninformed investors invest indiscriminately. This market disadvantage for uninformed investors – "winner's curse" – entails that in attractive IPOs informed and uninformed investors compete/bid for the same shares, whereas uninformed investors get a full allocation of shares in unattractive ones. Consequently, the conditional expected returns of uninformed investors will be negative and they will be unwilling to take part in any IPO. Rock's assumption is that the primary market is dependent on the participation of *both* types of investors, as the demand from informed investors only is insufficient. Therefore, in order to compensate uninformed investors for this adverse selection, all IPOs have to be underpriced in expectation (Ljungqvist, 2007) (Rock, 1986).

In relation to this model, one more assumption points out that issuing firms benefit from underpricing because it ensures continued participation of uninformed investors. However, this also incentivizes free-riding of individual firms through too little underpricing (Rock, 1986) (Ljungqvist, 2007). Beatty & Ritter (1986) point out that investment banks (underwriters) have an incentive to ensure that IPO are not underpriced by too little or too much. Underwriters' reputation is at stake as intermediaries that price firm's offerings. If they price the offerings too high (too little underpricing), the average initial return will be too low and informed investors

will stop doing business with the underwriter. Too much underpricing will cause the initial return to be too high, meaning that the issuers will not want to get involved with the underwriter. These underwriters would lose business if they did so consistently.

From an empirical viewpoint, an important implication is formalized in Beatty & Ritter (1986). There is a positive relation between the ex-ante uncertainty about the value in the IPO and the expected initial return. The intuition presented is that when an investor decides to produce information it is, in a way, investing in a call option on the offering. The option will be exercised if the true price of the shares exceeds the offer price (in this case the strike price). As is the case for most options, the higher the uncertainty the higher value an option has. The value of the option grows with the valuation uncertainty of the issuing firm, thereby increasing the underpricing (the spread between true price and strike price) (Ljungqvist, 2007). Therefore, it can be said that ex-ante uncertainty intensifies the winner's curse problem since a larger amount of informed investors worsens the winner's curse problematic. Ex-ante uncertainty has been wildly supported in an empirical context.

7.1.2 Information relevant theories

Further extending Rock (1986)'s notion of allocation between informed and uninformed investors, also known as winner's curse, has led to multiple book building methods across the globe that try to mitigate it through allocation discretion methods. Book building entails for underwriters to gather information around the interest of investors concerning an issuing firm's IPO in order to be able to identify the price at which a company should price its offering.

If the assumption is that there is information asymmetry between a set of investors (informed investors) and other investors, or the issuing company, the underwriters' ability to extract such information from investors is a vital task. This, however, would lead to a mismatch in incentives between both parties. For informed investors to reveal the fact that they are informed is not in their best interest as doing so would prospectively lead to higher offer prices, i.e. lower profit. In fact, there is a strong incentive to misrepresent any positive information (to point out a negative outlook of the issuing firm) in order to achieve a lower priced IPO offer.

Because of the above, the underwriter's challenge (and role) is to come up with a mechanism that persuades investors to reveal information in an honest manner by incentivizing them in a way that is more beneficial for them (Benveniste & Spindt, 1989); (Ljungqvist, 2007). Benveniste & Spindt (1989), amongst others, show that under certain circumstances book

building can be a mechanism that collects interest from investors and incentivizes them to express their positive information. Once the underwriter has collected the information regarding interest in shares, it can decide how many shares are to be allocated to each investor. The more aggressively investors bid the more likely they are to be allocated shares. This system reduces the incentive to misrepresent information, as the more interest is shown, and the more aggressively this is shown, the more likely it is that investors will receive a (set of) share(s) at the end of the book building process. Nevertheless, this is only beneficial for investors when underpriced stock is being allocated. Truth-telling can only be expected if money is to be left on the table. If the investors are not able to have a positive return, it will not be in their interest to take part in any kind of share allocation (Ljungqvist, 2007).

Furthermore, underwriters hold more information than other parties do, whereby underpricing can be justified as a means to attract full subscriptions to the IPOs. By underpricing, and thereby offering positive returns to a pool of constant investors, the underwriter can build a relationship with investors that will then subsequently subscribe to future IPOs. This is only beneficial up to a point where the costs of underpricing (related to firm commission costs) do not outweigh the benefits from positive returns to clients (Bergström, et al., 2006).

As an extension of the above, investment banks with higher degrees of activity in the IPO underwriting market gain an advantage over less active banks because the repeated collaboration with investors gives them the ability to gain information more cheaply. In addition, it gives them the ability to make investors agree to less favorable deals with the promise of these being outweighed by being involved in profitable IPOs. Summing up the factors above, it can be expected for underwriters to interact with regular investors in more favorable terms than occasional investors, since the constant future cooperation is beneficial for both parties. Investors accept to bidding in poorly priced IPOs as long as they can expect positive present value returns of the relationship with the underwriter, and underwriters value constant cooperation with investors more than pricing IPOs more ‘fully’ (Ljungqvist, 2007).

Underpricing is not a practice that generally benefits issuing firms, but in the context of book building the mechanism is used in favor of the company by means of upwards adjustments to the IPO price prior to the IPO. Through this market mechanism, underwriters collect valuable information on investors’ price and size demands, thereby giving them the ability to adjust the

offer prices upwards. This benefits the issuing firms by reducing the money left on the table and/or increasing the total amount of money collected in the IPO. Even though the price will further increase in the aftermarket trading, the original price will have risen to a higher state than would have taken place had book building not been undertaken by the underwriter.

7.1.3 Literature on PE-backed underpricing

The academic articles surrounding PE-backed IPOs focuses on the role of PEs in terms of the theoretical approaches presented above by figuring out what the effect of PE ownership is on the markets sentiment, as well as analyzing the reputation and organizational effect of PEs on firms in their funds. At large, the general understanding is that PE-backed IPOs entail lower levels of underpricing than other IPOs. There are multiple explanations, and they will be presented in this subsection.

Private equities are, broadly speaking, financial sponsors with substantial reputational capital. The importance of PEs' reputation results in certification of the value of the given backed firm. PEs have a particular interest in not underperforming, i.e. delivering subpar returns, as investors and stakeholders in general rely on them. While this might apply for all companies, PEs also rely on public markets for their continuing exit of investments. Based on this, investors take PE firms as a signal of quality. The notion is that such signal assures investors as a whole to be more certain about a company's valuation. This leads to more stable levels of stock prices once the specific stocks hit the market. The market recognizes PE firms based on their management monitoring and alignment abilities, as well as their operational efficiency levels levied on the target firms as a sign of validation (Ljungqvist, 2007).

One way for PE companies to realize a return on their initial investment in a portfolio company is to use an IPO as an exit strategy. In this context, it is fair to assume that they are aiming to realize the highest possible return on their investment. It is also reasonable to assume that when an IPO is used as an exit strategy there are limited opportunities to further improve or increase the operational efficiency and/or effectiveness of the portfolio company. On the basis of PE firms' value drivers, such as intense monitoring of management, enhancement of management expertise, as well as access to large levels of (cheap) debt. These key drivers, as extensively presented and discussed in Jensen (1989), are pointed out as elements ultimately able to impact underpricing. Portfolio companies may have reached a stable growth with limited operational effectiveness at the time they reach flotations. If this were not the case, there would

be no clear reason to expect PE firms to exit their investment through an IPO. PE firms have multiple exit strategies at their disposal, and so the intuition is that all other possibilities are not as attractive as the sale of shares in capital markets.

When PE firms use IPOs as an exit strategy three factors become clear. First, underwriters engage with PE firms with the idea of establishing a long-term relationship. They see PE firms as means to establishing a connection to a source of constant business by means of IPOs. Based on this, the level of underpricing might be used as a tool to make PE firms to keep a relationship with a given underwriter. This implies leaving less money on the table to improve the PE firms' return on investment. Second, when private equities decide to take up an investment, the markets take this event as a positive signal for the acquired company. From an investor's point of view, the involvement of PEs gives certain companies more credibility, as the expertise and management skills made available and applied to them are almost given. Increased efficiency, changes in strategy or a more efficient and profitable structure of operations are examples of what investors have in mind when they think of PEs.

By investors' reasoning, such characteristics decrease uncertainty and enhance the probability of a future stable performance. In relation to this, Bergström, et al. (2006) argue that PE companies are likely to only take high quality firms public through IPOs, since there is lot of attention and publicity involved. PE firms, therefore, think of IPOs not only as an exit strategy, but also as a signal to the market. Maintenance or even enhancement of reputation can be the result of using IPOs as an exit strategy, and therefore PE firms do not use this strategy unless there is certainty of success.

Lastly, for non-PE companies to decide to float their shares in the market is a milestone. As opposed to PE-backed firms, such firms do not have the experience to handle these processes, nor do they understand what the ultimate consequences of doing so are. Additionally, the motivation to go public is very different than the one of PE-backed firms. The purpose of doing so, too, are different. For instance, non-PE-backed firms have the aim of raising capital in order to achieve further growth, to have easier access to capital through capital markets or to merely be subject to a larger set of external pressure. In this context underwriters have the ability to use underpricing as a tool to achieve full subscription of an IPO, and thereby assuring non-PE-backed issuers to achieve their goal of a "successful" IPO. In such circumstances both parties' interest can be assumed to be cared for, as underwriters may be chosen as future advisor for

additional capital issues, while companies may find value added in the fact that underwriters have a better ability to understand capital markets and the pricing of new shares. These considerations lead us to the fourth hypothesis:

Private equity companies can also be used to explain the mitigation of adverse selection in the context of information asymmetry theories. Because the involvement of a PE company leads to a smaller difference in information gathered by investors, as well as leading to more homogenous expectations, due to higher publicity or more transparency. Lowering the information asymmetries across investors lowers the ex-ante uncertainty, resulting in lower levels of first day returns (Bergström, et al., 2006).

Furthermore, another argument points out the PE-backed IPOs experience lower underpricing because they have an ongoing relationship with underwriters, in particular underwriters with good reputations. As such, underwriters give an edge to PE-backed firms by means of further certification. Prestigious investment banks have the incentive to reliably price companies going public as not doing so could ultimately lead to loss of business. Stakeholders rely on their constant interaction with underwriters to mitigate the incentives of overpricing IPOs. This is in line with (Beatty & Ritter, 1986) theory on the certification role of underwriters.

7.1.4 Empirical Literature

The largest share of empirical literature on underpricing focuses on USA based studies. Most notably, the studies of Ritter (see Ritter (1984) or Loughran & Ritter (1995)) have permeated the field and shaped the approach taken to analyze the phenomenon of underpricing. Underpricing literature is less prevalent, but the overall notion points towards the same conclusion as American studies (Ljungqvist, 2007), (Bergström, et al., 2006). Namely, underperformance exists.

The empirical literature on underpricing presents substantial evidence to prove the existence of such a phenomenon. The mean and median initial returns ranges typically 10%-20% (see Table 6), and available empirical data on the phenomenon dates back to, at least, 1975 (Ibbotson & Jaffe, 1975). At large, the consensus is that underpricing is a singularity to be taken into account by investors and all players in capital markets.

Table 6 - Summary of selected academic literature on underpricing methodology

Authors (Year)	Market (Period)	Focus: Size	Initial return	Matching	Price (adjusted)
Ritter **(1984)**	USA (1977-1982)	No PE focus 1,028	26.5% (mean)	-	First day closing bid price
Hogan et al. **(2001)**	- (1986-1998)	RLBO: 232 Other: 232	7.64% (mean) 13% (mean)	Matching 1:1 (industry, offer size & date)	-
Ljungqvist & Wilhelm **(2003)**	USA (1996-2000)	No PE focus	35.7% (mean) 13.9% (median)	-	First day closing price (raw)
Loughran & Ritter **(2004)**	USA (1980-2003)	6,391 No PE focus	18.7% (mean)	-	First day closing price (raw)
Bergström et al. **(2006)**	Paris & London (1994-2004)	PE: 152 Other: 1,370	9.33%/ 12.87%	Group matching (stock exchange, industry, year)	First day closing price (adj.)
Schöber **(2008)**	USA (1973-2007)	Buy out: 461 Other: 461	11.56%(mean), 6.33%(median) 16.34%(mean) 11.56%(median)	Group matching (industry, date, offer size & assets)	-
Cao & Lerner **(2009)**	USA (1981-2003)	RLBO:437 Other:5,706	12.88% (mean) 22.18% (mean)	-	-
Levis **(2011)**	UK (1992-2005)	PE: 204 Other:1,141	9.1%(mean)/6.3%(median) 21.1%(mean)/7.4%(median)	-	First day closing price

Nevertheless, the range of literature has developed over time. In particular, the array of methodological procedures can lead to faulty conclusions about the results presented by the multiple strings of literature. A set of authors establish the underpricing period to be analyzed in a period longer than the first day of trading, e.g. (Ibbotson & Jaffe, 1975). Because of this, underpricing is analyzed from a point of view that cannot be directly comparable to present figures, since recent literature typically focuses on the first day of trading only.

Furthermore, the use of adjusted returns as opposed to "raw" returns also has an impact on the results used for comparison. In other words, market returns are used to adjust initial returns to reflect the impact of the market as a whole. While Beatty & Ritter (1986) made the case against this kind of practices as the effect of the market is very small compared to initial returns. Regardless, academic literature still tends to apply such a practice and should therefore be kept in mind when using previous data for perspective.

A set of studies present data related to the underpricing phenomenon in the context of PE-backed IPOs. Most recently, Cao & Lerner (2009) present evidence for considerably large levels of underpricing, where the difference in mean underperformance is measured at 9.30%. This is similar to other PE-related literature, such as Bergström et al. (2006) and Schöber (2008) who also present evidence of the existence of differences between PE-backed IPOs and non-PE-backed IPOs. These two studies proved differences in the magnitude of approximately 3.5% and 4.8% respectively.

In terms of methodology, the approach taken by a set of academic studies includes the use of matching pairs. This approach entails matching each PE-backed IPO found to either a set of companies, or a single company, of non-PE-backed companies. This approach will be expanded upon in section 7.3. The articles mostly focus on matching procedures based on date, industry and size characteristics, but other criteria include distribution of assets or asset size.

7.2 Hypothesis formulation

As mentioned in preceding sections, the combination of IPOs and underpricing is a widely discussed and tested phenomenon in empirical and theoretical finance literature. The methodology used in prior literature has substantially evolved over time, mostly because specific areas of theory have been tested in depth. As can be logically expected from any thorough IPO study, and mostly based on the theories mentioned in preceding sections, the interest of the authors of this paper will be to investigate whether the sample at hand has been subject to underpricing. In addition, the degree of underpricing will be looked into. Consequently, the following hypotheses will be researched:

H1: Underpricing was present in Northern & Western Europe in the period 2005-2012.

This central area of analysis can come as no surprise, as the study of IPOs as a field has largely focused on this basic notion. In addition, literature has shown that the presence of underpricing is a general phenomenon that does not seem to depend on the type of ownership structure prior to the IPO. Therefore, we would like to test whether this applies in the context of this academic study:

H2: Underpricing is present in PE backed and non-PE backed IPOs

In order to be able to further deepen the theoretical plane of knowledge, and in light of the theoretical and empirical evidence presented above, it is clear that a central theme is the timing of IPOs. In the case of this academic study, the sample period includes a very particular event: the 2008 financial crisis. This event contrasts a large set of other literature related to the subject, since financial crises are rare events in the history of the modern world. On these grounds, another area of study will be related to the extent and degree of underpricing with regards to the financial crisis, a period of time that can be classified as a cold period.

As the theoretical background pointed out, companies going public during a cold period should, all things equal, experience lower market valuations due to pessimistic future growth prospects and uncertainty. Based on prior evidence, we would find it reasonable to believe that cold periods would have a negative effect on underpricing. From the issuing firm's point of view, in these periods there is an increased focus to leave as little money on the table as possible. In cold periods company valuations tend to be low, which enhances the incentive to leave as little money on the table. Furthermore, the economic context makes the company more nervous about major decisions. Therefore, cold period IPOs lead to an expectation of issuing firms to perform worse. Along these lines, the general expectation would be that in cold periods there would be tendency for increased volatility, more uncertainty and lower market valuations.

When stock markets are hit as a common entity, it is logical that single companies are susceptible to the market's consequences as well. Therefore, the third hypothesis that this study will look into will be the following:

H3: There is a noticeable difference in underpricing because of cold periods in the period 2005-2015

Furthermore, literature has shown that private equity firms have been impacted by the underpricing phenomenon in a different manner than "normal" IPOs. It has been empirically shown that the degree of underpricing is lower than the one of normal IPOs. While theories point

out to multiple possible reasons behind this (see section 7.1.3), it can be said that a difference can be expected.

H4: The degree of underpricing differs between PE-backed and non-PE-backed companies

The three hypotheses above will be subject to economical and statistical tests to be able to identify their implication in the larger context of IPOs, and with the hopes of shedding more light on underpricing as a phenomenon, as well as the role of PE firms in capital markets.

7.3 Data Presentation and Analysis

7.3.1 Underpricing methodology

7.3.1.1 Calculations

Historical literature on IPO underpricing has stated different approaches on how to calculate initial returns. Nevertheless, in most recent articles the consensus has been to use the closing price of the first trading date as the basis of calculation. Furthermore, the methods also differ in terms of the role of the market. While some literature takes the approach of subtracting the return of a benchmark from the raw return to find the initial "adjusted" return (see table 6), others argue that the effect of a benchmark is minimal. The arguments against this are that the market return for one day should not have a substantial impact on underpricing, as well as pointing out that IPO dates are generally chosen in an approximately random manner.

Beatty & Ritter (1986) presented the argument against adjusting for the market empirically by showing that the mean return for underpricing in the analysis period was 14.1% while the market return was 0.1%.

The approach to the choice of aftermarket price used has also changed over time. In older research papers, academics have used bid prices, closing prices and/or the mean of ask-bid prices (mostly in connection to research on stock liquidity). There is no reason to assume low liquidity in the sample in this study, as the scope pertains IPOs from main exchanges only. Moreover, when it comes to time considerations the approach has shifted from a focus on longer periods (a set of days or weeks), to the norm that is currently used, i.e. underpricing on the first day of trading only.

Following the intuition laid out above, the authors of this study have chosen to calculate the initial return by means of closing price at the end of the first trading day, without adjusting for market conditions (benchmarks). There is little reason to believe market adjustment or other

methodological approaches would improve the calculations. Therefore, the following equation will be used in order to evaluate underpricing:

$$\text{First day initial return}_{0,1} = \frac{\text{First trading day close price}_1}{\text{Offer price}_0} - 1$$

7.3.1.2 Test statistics

Statistical means will be central to identify the actual existence of underpricing, but also will be highly relevant to identify its degree. At large, the purpose of the statistical tests is to determine whether the hypotheses presented previously are, in fact, true. In this case, the use of statistical test will take the form of test on samples distribution, sample characteristics, as well as comparison of two sets of samples (i.e. comparison of PE-backed IPOs and non-PE-backed IPOs).

In terms of statistical distribution of samples, underpricing has been shown to present fat right tails and, to some extent, a right-skewed distribution. At large, one of the main requirements to be able to perform reliable statistical procedures is normality in a sample. For instance, a requirement of parametric t-tests (Student's t-test) is for the sample to fulfill normality requirements. Based on the above, we expect normality to not be fulfilled when testing for it in our sample(s), therefore additional approaches are needed to be able to test for the factors mentioned above.

Having in mind that normality might not be fulfilled, a solution is to make use of non-parametric tests. When normality is not fulfilled, non-parametric tests perform statistical significance tests on distribution and location of samples, as opposed to actual contents of the sample. By assuring that non-normality tests are performed, the idea is to cover all possible methodologies that can provide answers to our hypotheses.

To be able to identify if our sample has the same qualities than "normal" underpricing samples, normality should be tested for. This can be performed statistically. However, the central limit theorem states that means of samples from a population with finite variance approach a normal distribution as samples grow large, regardless of the distribution of the population. Thus, in probability theory the normal distribution can be assumed when the sample is large enough. While there are different opinions regarding how large the sample has to be in order to fulfill such requirement Keller (2009) states that samples with more than 20 observations are large enough to infer normality.

On the grounds of the items presented above, this study will make use of parametric and non-parametric tests in order to identify the existence of underpricing, the degree of underpricing, as well as the difference in underpricing between samples (PE vs. Non-PEs).

7.3.1.2.1 Matching pairs

As was briefly mentioned previously, this study will perform tests on two samples of IPOs, private-equity-backed IPOs and non-private-equity backed IPOs. However, as the characteristics are far from equal in all IPOs, and the initial return can be affected by a lot of firm and/or market characteristics (Schöber, 2008), this study will attempt to increase its validity and improve the causal relationship between samples by means of a so-called "matching pairs" approach. This approach has been used widely in literature, mainly in the context of long-term analysis of stocks, but also often in connection to underpricing.

The matching-pairs procedure is based on the idea of finding a company in each sample that is completely identical to another one in the other samples, and then comparing both. In an ideal world, a PE-backed company would be matched with a non-PE-backed company in order to find similarities and differences. However, this is not realistic and adaptations have to be used to approach this methodological procedure. The most logical adaptation is to find common characteristics between companies in both samples in order to compare them to one another. The most relevant measure for matching is time frame. Ideally IPOs with similar qualities take place in identical circumstances. This requires, however, that all companies in both samples have a match in the other one. Such characteristics can be geographical location, main exchange, industry, market capitalization, or a combination of these.

Another issue arises when looking at sample sizes. If both samples are not exactly the same in size, adaptations need to be made to tailor the comparison. The best approach to tackle this is to pool companies in one of the samples and then comparing it to a single counterpart in the other one. This approach also enhances statistical significance and validity, as comparing a pool of observations deliver more accurate picture of one of the "matching pairs".

In terms of PE-backed studies, the matching-pairs procedure is performed by finding a connection/identical pair of PE-backed company with a non-PE backed company (i.e. 1:1 matching pairs) in order to be able to compare underpricing directly. However, in order to do this, the samples need to be resemble each other identically. In our samples this is not the case,

as the sample sizes differ, as well as relevant common characteristics are difficult to find. Nevertheless, the size of our samples give us the possibility to extend the pair-to-pair procedure.

Instead of using a single PE-backed company as control to find a non-PE-backed counterparty, portfolios of non-PE backed IPOs will be built to match each PE-backed IPO. This procedure was adopted and used by Schöber (2008). In this study, the characteristics upon which IPOs will be matched are industry-specific characteristic, as well as time of IPO. Specifically, each control portfolio will be matched to the characteristics of PE-backed IPOs by means of ICB industry classification, as well a window of 6 months (in both directions).

To illustrate, a PE-backed IPO was identified by date of IPO and industry. Then, a pool of non-PE-backed companies that performed an IPO in the same industry, in a window of six months before and six months after were found. All companies fulfilling the criteria were pooled into a portfolio.

Four PE-backed companies had no matching pair in the non-PE-backed pool, and where therefore left out of the sample. The matching portfolios of the non-PE backed IPOs range from 1 to 17 companies.

Due to the size of the non-PE-backed matched portfolios, the median of the returns has been chosen to set the basis of comparison. This choice has a large impact in the comparison of portfolios containing little companies. Hence, if portfolio average would have been used as measure of comparison, large values within the portfolio could have had an unproportioned impact on "pool underpricing". Using median as metric minimizes the impact of extreme observations. A complete overview of the matching control-pairs can be found in the full data set provided on the flash drive.

7.3.1.2.2 Parametric tests

Parting from the assumption of normality, the parametric test will be applied to test for underpricing in the samples, as well as to compare across samples. The first tests applied will determine whether the sample means are different from zero. Underpricing was defined in previous subsections as the difference between the closing price on the first trading date and the IPO offer price. If this number turns out to be positive, underpricing exists while negative values are said to show overpricing. The statistical test is therefore one that tests for a mean above zero (positive returns):

$$H_1: \mu > 0$$

$$H_0: \mu = 0$$

And applying the student's t-test statistic:

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

Where μ=0, $\bar{x}$ is the mean of the sample, s is the standard deviation and n is the number of observations

In order to do a parametric test to determine whether the two sample means are statistically different from each other, a t-test can also be applied. The t-test can be applied in two different forms, one where equal variances are assumed, while another form uses unequal variances. Therefore, equal variances need to be tested for:

$$H_0: \frac{\sigma_{PE}^2}{\sigma_{Non-PE}^2} = 1$$

$$H_1: \frac{\sigma_{PE}^2}{\sigma_{Non-PE}^2} \neq 1$$

Rejecting H_0 above results in unequal variances.

If equal variances are found to hold a parametric test can help determine the difference in underpricing of the PE-backed sample and non-PE-backed sample. The tests are performed on the difference between means of both samples. In this case a positive value means that PE-backed IPOs are more underpriced than non-PE-backed IPOs. The hypothesis tested for, in this case, is the following:

$$H_0: (\mu_{PE} - \mu_{Non-PE}) = 0$$

$$H_1: (\mu_{PE} - \mu_{Non-PE}) < 0$$

In the specific case of this study, the relevant question at hand is whether PE-backed IPOs are less underpriced than non-PE-backed IPOs. Therefore, the alternative hypothesis above is established so that a negative value is shown. In this case, this would entail for the sample of PE-backed IPOs' mean to be smaller than their non-PE counterparts.

If unequal variances are found instead, the parametric t-test with unequal variances and an estimator of $\mu_{PE} - \mu_{Non-PE}$ where the test statistic is a Student-t distributed with $n_1 + n_2 - 2$ degrees of freedom is used instead. The following test adjusts for the case where the two samples are not similar in variance:

$$v = \frac{\left(\frac{s_{PE}^2}{n_{PE}}\right)^2 + \left(\frac{s_{Non-PE}^2}{n_{Non-PE}}\right)^2}{\frac{\left(\frac{s_{PE}^2}{n_{PE}}\right)^2}{n_{PE}-1} + \frac{\left(\frac{s_{Non-PE}^2}{n_{Non-PE}}\right)^2}{n_{Non-PE}-1}}$$

$$t = \frac{(\bar{x}_{PE} - \bar{x}_{Non-PE}) - (\mu_{PE} - \mu_{Non-PE})}{\sqrt{\left(\frac{s_{PE}^2}{n_{PE}} + \frac{s_{Non-PE}^2}{n_{Non-PE}}\right)}}$$

In the context of paired-matched samples, a specific variation of the t-test can be applied, which resembles the tests presented above. This also comes in two different forms depending on whether equality of variances can be assumed. The test is applied on the differences in means across samples and the approach taken is the same as the one taken in the equal variances approach presented above, i.e. testing for negative difference to confirm less underpricing in PE sample:

$$H_1: \left(\mu_{Matched\_PE} - \mu_{Matched\_Non-PE}\right) < 0$$

$$H_0: \left(\mu_{Matched\_PE} - \mu_{Matched\_Non-PE}\right) = 0$$

If the variances are not equal, the following t-test has to be performed:

$$t = \frac{\left(\bar{x}_{Matched\_PE} - \bar{x}_{Matched\_Non-PE}\right) - \left(\mu_{Matched\_PE} - \mu_{Matched\_Non-PE}\right)}{\sqrt{s_p^2\left(\frac{1}{n_{Matched\_PE}} + \frac{1}{n_{Matched\_Non-PE}}\right)}}$$

where, $s_p^2 = \left(\left(n_{Matched\_PE} - 1\right)s_{Matched\_PE}^2 + \left(n_{Matched\_Non-PE} - 1\right)s_{Matched\_Non-PE}^2\right.$

The above methodological approaches will be applied to both sets of samples, as well as the single samples to shed light on the hypotheses formulated.

7.3.1.2.3 Nonparametric tests

If, as opposed to the section above, normality cannot be taken for granted, a non-parametric approach has to be taken. When the samples are assumed to not fulfill the normality assumption, Wilcoxon tests can be used instead. This is the statistical method to use when the data is ordinal and thereby we cannot test on the mean. In other words, if the returns do not follow a normal distribution the mean cannot be used as the basis of the tests.

In Wilcoxon tests, the test is not applied on the means (or difference of means) but instead on the difference of the locations of the populations (samples). Thus, the robustness of the tests is weaker than the one provided by parametric tests. In Wilcoxon tests, the median is

commonly used as the proxy which is used to understand the location of the populations, but it is not the measure that is being tested for. The locations of the samples are determined based on ranks, where each return in a set of samples is ranked and given a value. The single values in each sample are then summed and adjustments are applied on the sample sizes and volatility.

The Wilcoxon-rank-sum test is used to test for the difference between two samples. In this case, the hypothesis reflects the fact that we would like to see whether PE-backed IPOs show less underpricing than non-PE-backed IPOs. That entails that the PE-backed underpricing sample distribution should lie to the left of the non-PE-backed sample.

H_0: The two populations are the same

H_1: The location of the PE population is to the left of of the location of the non − PE population

$$T = T_{PE}$$

$$E(T_{PE}) = \frac{n_{PE}\left(n_{PE} + n_{Non\_PE} + 1\right)}{2}$$

$$\sigma_{T_{PE}} = \sqrt{\frac{n_{PE} n_{Non-PE}(n_{PE} + n_{Non-PE} + 1)}{12}}$$

$$z = \frac{T_{PE} - E(T_{PE})}{\sigma_{T_{PE}}}$$

For the matched pairs samples, the Wilcoxon-signed-rank-sum test for locations will be used. This test also uses ranks to test for the location of the samples. Again, the hypothesis is designed so that the location that is tested for is whether the PE-backed sample distribution location lies to the left of its non-PE counterpart. If the test is statistically significant we can conclude that the sample of matched PE-backed IPOs have a lower level of underpricing than the portfolios of matched non-PE-backed companies.

In the Wilcoxon-signed-rank-sum test, the observations are ranked based on the absolute value of non-zero differences in the matched pairs. These are then summed, which is denoted as T^+ in the calculations.

H_0: The two populations are the same

H_1: The location of the PE population is to the left of of the location of the non − PE population

$$T = T^{+}$$

$$E(T) = \frac{n(n+1)}{4}$$

$$\sigma_T = \sqrt{\frac{n(n+1)(2n+1)}{24}}$$

$$z = \frac{T - E(T)}{\sigma_T}$$

The non-parametric test coupled with the parametric test should give a clear and wide picture of the statistical implications of the samples in terms of single sample underpricing, as well as difference across samples.

7.4 Presentation of results

7.4.1 Descriptive statistics

Table 7 – Descriptive statistics of underpricing sample summarizes the descriptive statistics for the two sets of samples, standard samples and matched-pairs set of samples. The mean underpricing in the PE-backed sample is 5.25% while the mean of the non-PE backed sample is 6.34%. This points towards the existence of underpricing. As mentioned in section 7.1, the central limit theorem indicates that a normal distribution can be assumed when there are more than 20 observations in each sample. The standard and matched samples, however, show a relatively large difference between the mean and median. For the standard sample the figures result in 5.25% and 2.85% respectively, while the matched-pairs samples resulted in 6.36% and 3.31% respectively. The matched samples set of companies shows a smaller difference between the mean and median. Skewness is positive for all samples, which implies the sample is negatively skewed (left-hand skewed).

Big differences between mean and median figures tends to imply that the distributions are not normal distributed. Further tests on normality were performed and will be presented in subsequent sections to identify whether normality is a reasonable assumption. Regardless, the parametric tests will be taken into consideration with a large weight because of their robustness and overall validity, as well as the central limit theorem implications pointed out above.

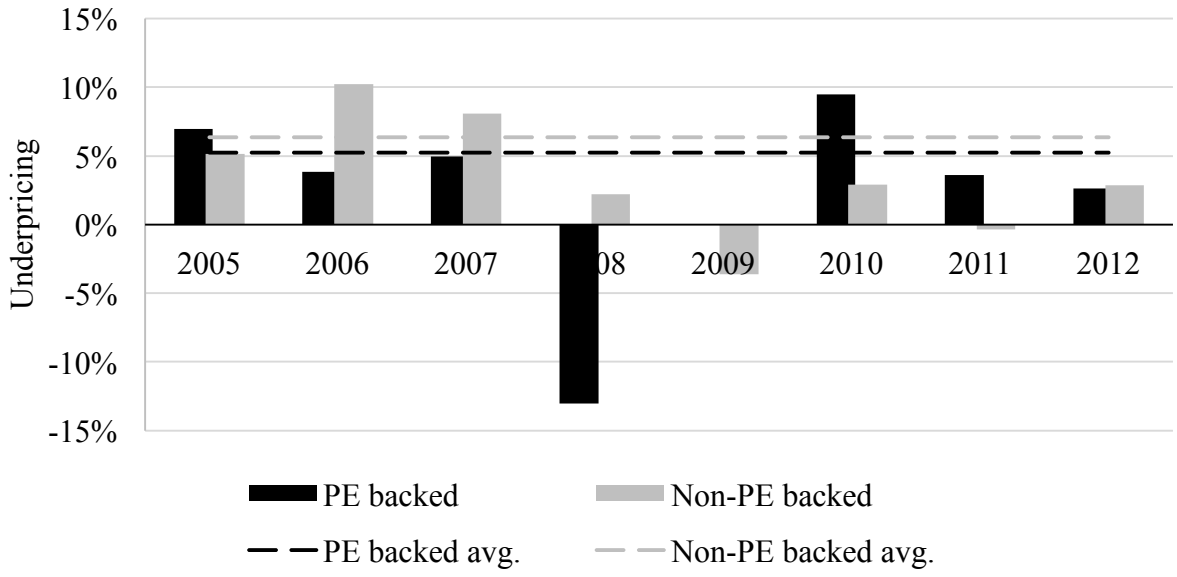
Table 7 - Descriptive statistics of underpricing sample

Sample	n	Mean	Median	Standard Dev.	Skewness	Kurtosis	Max	Min
PE-backed	82	5.25%	2.85%	8.84%	0.8279	3.2137	29.96%	-13.04%
Non-PE-backed	286	6.36%	3.31%	16.79%	4.0661	34.4126	163.47%	-51.73%
PE Matched	78	4.59%	2.60%	8.46%	0.9397	3.6283	29.96%	-13.04%
Non-PE Matched	78	4.46%	3.79%	4.80%	1.4878	6.4582	23.98%	-4.31%

Table 7 also shows relatively low values for PE-backed companies underpricing figures. In fact, the means for the PE-backed and non-PE-backed samples are below what prior literature has presented. The figures above presents results similar to what was previously presented in literature, for example (Bergström, et al., 2006) The sample presented in this thesis includes the 2008 financial crisis.

From Figure 4 below it becomes apparent that the mean has a negative trend in the period 2008-2009. When comparing these figures to the results presented in figure 5 (a breakdown of IPOs per year and by type of IPO) there seems to be a correlation between the amount of IPOs and underpricing. In 2008 there were 11 non-PE-backed IPOs and only one PE-backed IPO. In 2009 there were only 3 IPOs, all non-PE-backed. At large, the initial returns of non-PE backed IPOs were below the mean in the periods preceding the financial crisis.

Figure 4 - Underpricing by year, 2005-2012

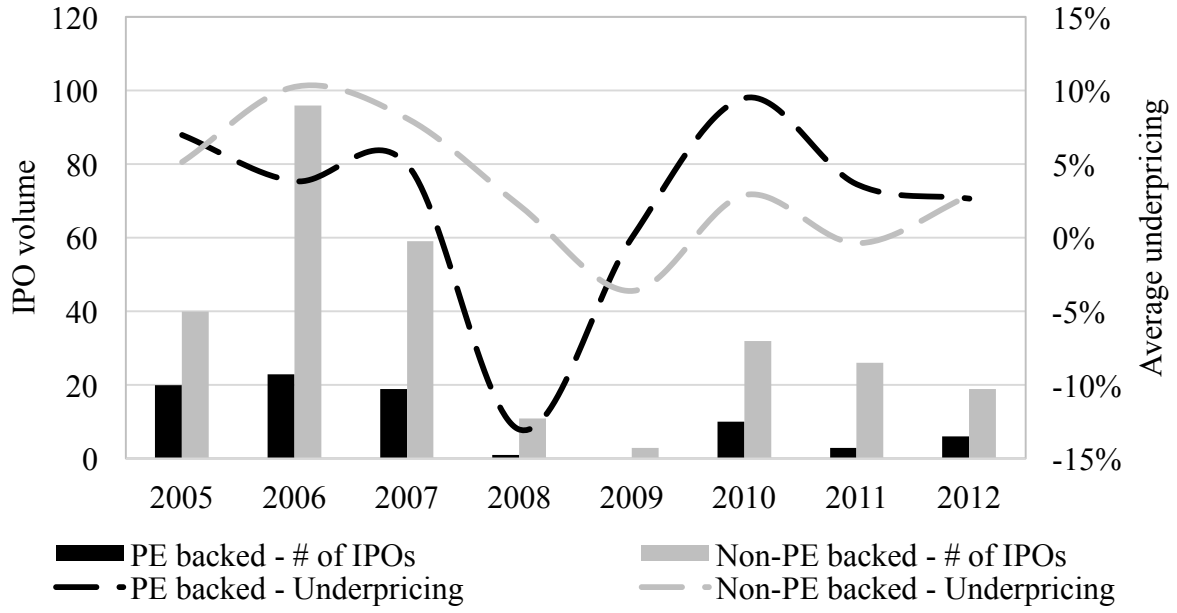


7.4.2 Hot and cold periods

The figure and points made above give a general indication of the effect of the financial crisis on underpricing. Literature tends to give more weight on identifying hot periods instead of cold periods. Usually, the mechanisms applied in literature aim at finding out what the role of periods with high IPO activity mean for IPOs in general. In this study, the focus is shifted. Instead of focusing on a hot period, what becomes relevant is researching the role of cold periods.

Figure 5 shows the amount of IPOs in both sets of companies, as well as the correspondent underpricing. It is clear that the period 2008-2009 can be interpreted as a cold period, as less than 15 companies floated shares in the given period. On these grounds, it can be safe to say that the financial crisis that started in 2008 caused a cold period lasting for (at least) a couple of years. The figure below shows that there seems to be a correlation between underpricing IPO activity across Europe's main stock exchanges.

Figure 5 - IPO volume and average underpricing per year, 2005-2012



The reasoning behind such developments can be attributed to the economic effects of the financial crisis. The crisis impacted the short term growth rate and created large uncertainty among investors. These factors (among others) decrease the investment appetite in companies, funds and investors alike, leading to a period of low activity in 2008-2009. This follows the arguments presented by Günther & Rummer (2006), who attribute changes in IPO activity to the

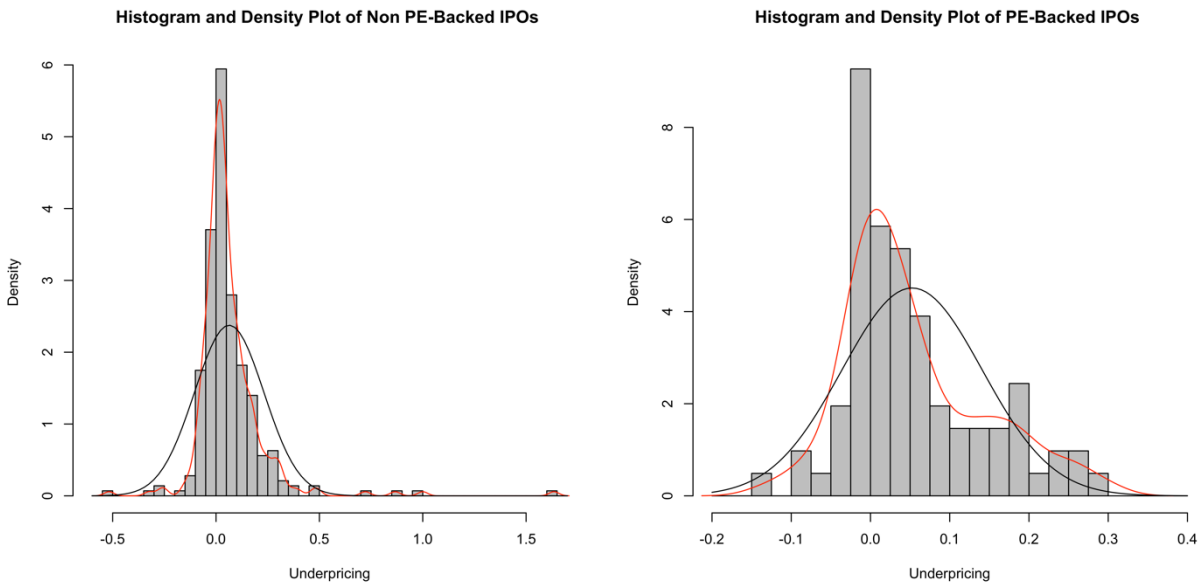
level of investment appetite. Higher investment appetite leads to hot periods, while lower appetite has the opposite effect.

In addition, the activity of IPOs in the 2008-2009 period also follow the explanations put out by Loughran & Ritter (1995) who argued that issuers try to schedule their IPOs in times where investors' optimism is high. In the case of the 2008 financial crisis, the effect is opposite. Low (or inexistent) optimism in the market and/or investors led to low levels of activity in the IPO market.

7.4.3 Identifying outliers

The data presented in 7.4.1 and presented again below shows extreme values in both directions of the sample. Furthermore, the presence of outliers becomes apparent when looking at the graphical representation of the underpricing returns.

Figure 6 - Histogram and distribution of IPO underpricing returns



Specifically, there are five extreme observations that the authors of this text identified as extreme outliers. The returns of a set of companies presented underpricing at levels higher/lower than 50% of their initial offer price. These observations stand out as that cannot be weighed against the general population.

From a theoretical point of view, the identification of outliers is a non-standardized procedure. Hawkins defined it as *"an observation which deviates so much from the other observations as to arouse suspicions that it was generated by a different mechanism* (Hawkins,

1980)". In statistical literature, outliers are often referred to as abnormalities, on the grounds that these observations deviate extremely from the rest of the observations.

To understand the role of outliers, it is important to bear in mind the type of calculations the underpricing returns will be subject to. Since averages are involved in some of the calculations, outliers can potentially lead to biases affecting the whole sample. This does not apply to the analysis of medians or population locations, but in general they still have a similar effect.

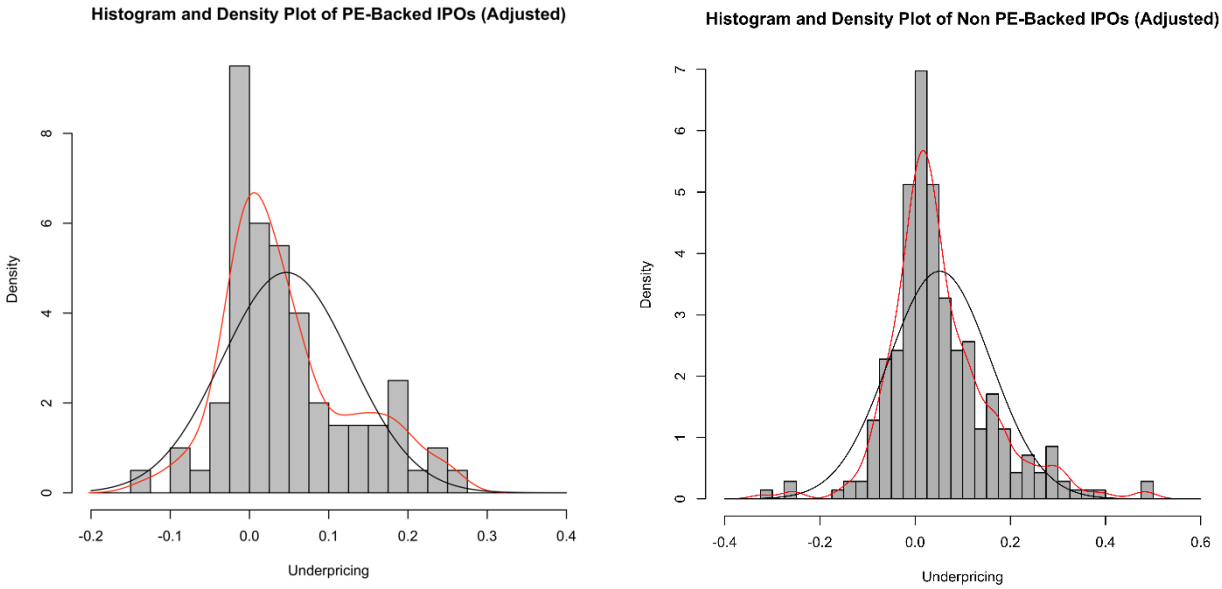
In order to increase the reliability and ease of statistical analysis, the authors of this text decided to perform analysis on adjusted sets of samples on top of the "normal" samples in order to enhance explanatory and validity of our research. Our method for removing outliers consisted of removing 1.5% of all outliers in absolute values. This meant deleting seven events from the whole sample, i.e. five events in the non-PE-backed sample and two PE-backed companies.

In the matching pairs procedure, the same companies deleted from the standard sample were deleted. Within the non-PE-backed portfolios each company deemed as an outlier was deleted, as well as deleting the overall matching pairs based on the specific PE-backed companies' outliers.

Table 8 - Descriptive statistics of underpricing after outlier elimination

Sample	n	Mean	Median	Standard dev.	Skewness	Kurtosis	Max	Min
PE-backed (trim)	80	4.67%	2.72%	8.13%	0.7084	3.0388	25.24%	-13.04%
Non-PE-backed (trim)	281	5.16%	3.11%	10.75%	0.8306	5.4196	48.90%	-32.31%
PE matched (trim)	77	4.26%	2.50%	8.00%	0.8295	3.3848	25.24%	-13.04%
Non-PE matched (trim)	77	3.90%	3.47%	4.40%	1.5149	7.6272	23.98%	-4.51%

Figure 7 - Histogram and distribution of underpricing returns of trimmed samples



The descriptive statistics for the trimmed samples are presented in Table 8. After the outliers were removed, a general decrease in mean, median and standard deviations values took place. The adjusted non-PE backed sample's standard deviation decreased significantly from 16.8% to 10.7%. The skewness also decreased, which points out that outliers were more significant on the right-hand side of the distribution. In other words, extreme outliers tended to have positive values. The implications of the elimination of outliers can be found in Figure 7. While the distribution still seems to be non-normal, the tails of the distribution is almost non-existent any more.

7.4.4 Normality assumption

It has been mentioned in previous sections that the qualities of the underpricing returns might lead to non-normal distribution of returns, which would go against one of the most basic assumptions parametric tests are based on. All the histograms and density plots are presented in a bigger scale in Appendix 3 – Distributions of returns of underpricing samples.

Figure 8 - Distribution of matched and trimmed PE-backed IPOs underpricing returns

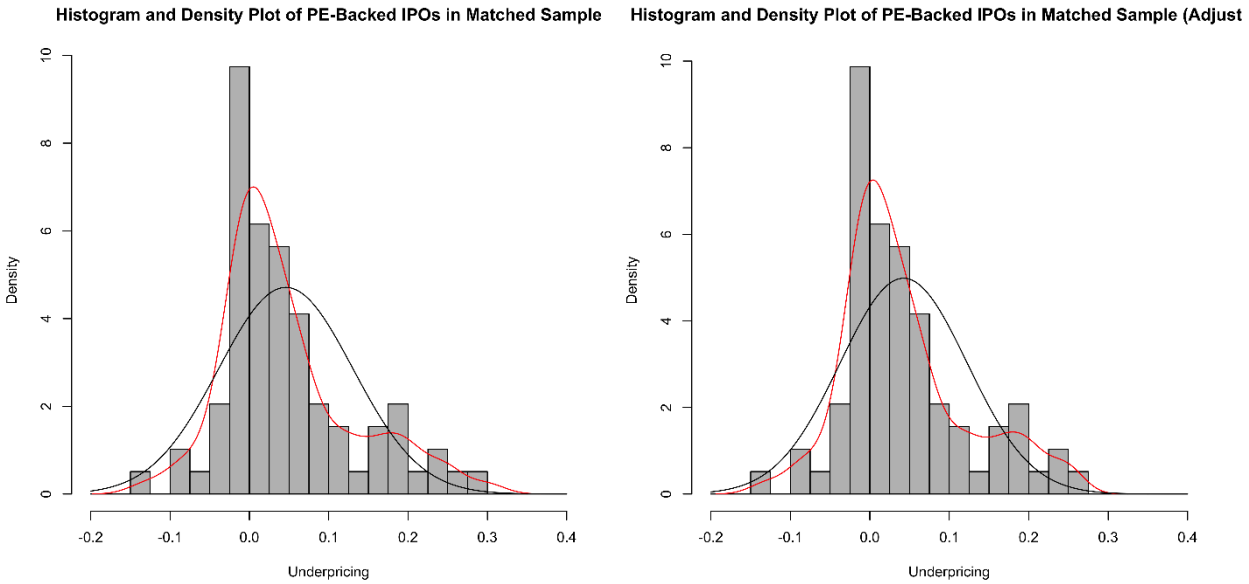
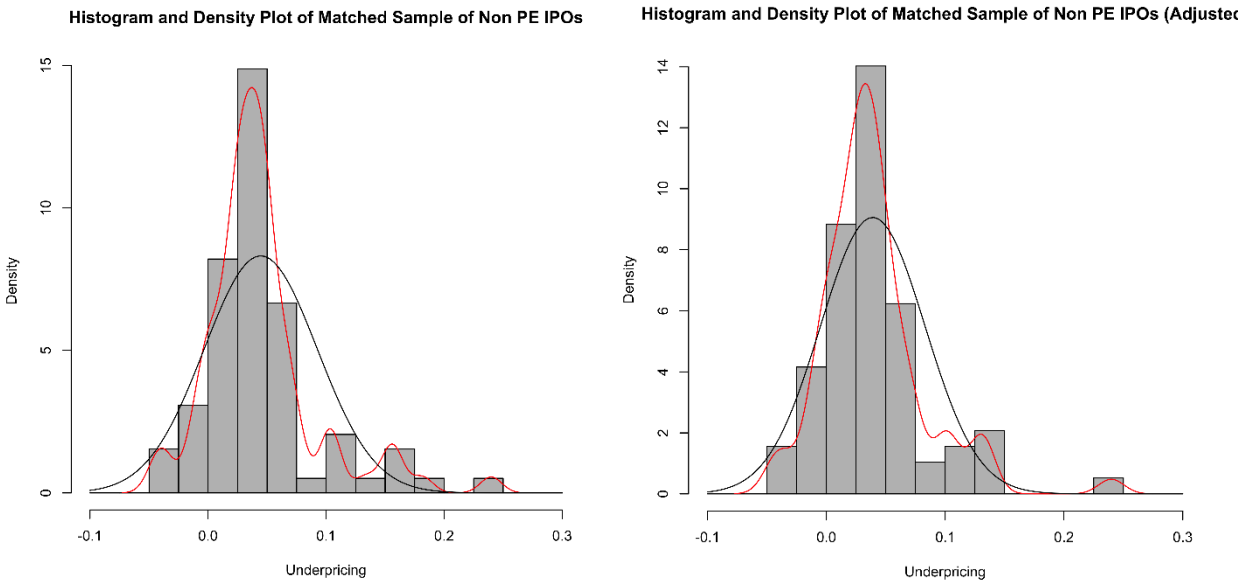


Figure 9 - Distribution of matched and trimmed Non-PE-backed IPOs underpricing returns



While Figure 7 present the graphical representation of the underpricing returns of both PE-backed and non-PE-backed companies, Figure 8 and 9show the distribution for both matched and trimmed matched samples which still show similar distributions as in terms of fat tails and positive skewness. The figures present the normal distribution and the samples approximated distribution to make the difference clear. The main impression is that the returns do not follow a normal distribution. Nevertheless, based on the central-limit-theorem, normality will be assumed based on the sample sizes.

From a statistical point of view, it is also possible to identify whether the returns follow a normal distribution or not. Testing will be performed through the Shapiro-Wilk test for normality. This test follows the intuition of testing against normality, i.e. if the test shows significance the returns do not follow a normal distribution. The tests yield the results presented in Figure 10:

Figure 10 - Shapiro-Wilk tests on underpricing samples

Sample	SW Test	p-value
PE-backed	0.9297	0.0002
Non-PE-backed	0.6803	6.4E-23
PE Matched	0.9209	0.0001
Non-PE Matched	0.8771	1.9E-06
PE-backed (trim)	0.9383	0.0008
Non-PE-backed (trim)	0.9331	6.0E-10
PE matched (trim)	0.9275	0.0003
Non-PE matched (trim)	0.8932	9.0E-06

The figure shows that normality can be rejected at the 10%, 5% and 1% significance level, which entails that none of the samples follow a normal distribution. Although none of the samples are normal distributed, the values show that the PE-backed samples are closer to following a normal distribution than the other samples. This can be assumed to be related to the notion of less underpricing in PE-backed samples, as well as the sample size of PE-backed IPOs used in this study.

In relation to the trims applied to the samples, test statistics show that the samples' normality improved when undertaken. The purpose was to understand the role of extreme values in the sample, including their role for normality. In this context further trims would have needed to be applied. The approach taken was one of trial-and-error trimming, but the authors of this thesis give more value to a reliable and untampered sampling as opposed to adjusting samples up to the point where analyses can be made in a simpler manner. This would entail data manipulation.

The process showed that the trim level needed to achieve normality was c. 8% of the most extreme value. Eliminating such a large share of returns would lead to data manipulation, and therefore only the most extreme values were deleted.

To further analyze the relationship between both set of samples, as well as the qualities of the samples, non-parametric tests will be undertaken. Thereby, underpricing will be analyzed thoroughly by covering the main statistical issues that could affect the interpretation of results.

7.4.5 Test statistics

This subsection will present the most valuable part of the underpricing analysis, i.e. the test statistics evaluation of the returns. Statistical significance tests will be applied to the standard samples as well as the matching-pairs samples laid out in preceding subsections.

The first test presented is the test performed to identify whether underperformance exists at all under an assumption of normality. In this context, the process parted by applying a Student's t-test to the multiple samples with the idea of identifying a significance difference to a mean return of zero. Table 9 below presents the results:

Table 9 - Significance testing on existence of underpricing, all samples[4]

Sample	T-test against zero	p-value
PE-backed	5.3770	3.6E-07
Non-PE-backed	6.4098	3.0E-10
PE Matched	4.7853	4.0E-06
Non-PE Matched	8.2143	2.0E-12

The table above presents substantial evidence to prove that the hypothesis that underpricing does not exist in the given sample can be rejected. All p-values are significant at the 10%, 5% and 1% level and therefore it can be determined with very high reliability that underpricing is present in all samples analyzed by this study.

Moreover, one of the central questions pertaining this master's thesis is to identify whether a difference between PE-backed IPOs or non-PE-backed IPOs exists, and if so whether it could be said that PE-backed IPOs have lower underpricing than other types of companies. As was mentioned previously, the hypothesis is based around the idea of proving underpricing is smaller in PE-backed IPOs compared to non-PE backed IPOs.

To test for differences between two samples it is important to be clear on whether equal variance is a reasonable assumption to take, otherwise test statistics need to be adjusted to conform. Once this element is defined, the right test can be used. Table 10 presents the result of

[4] The original output for the test statistics can be found in Appendix 2

the equal variance tests on both sets of samples (see also Appendix 4 – Statistics matched sample and Appendix 6 – Statistics trimmed matched sample):

Table 10 – Variance and parametric tests for difference in samples

Sample	Equal variances	p-value (variance)	t-test	p-value
Independent	0.2772	1.6E-10	-0.8009	0.2120
Matched	3.1141	6.4E-07	0.1135	0.4549
Independent (trim)	0.5725	1.9E-03	-0.4395	0.3304
Matched (trim)	3.3026	2.2E-07	0.3468	0.3649

It becomes clear from the results above that the set of samples do not have equal variances; none of the four sets presented equal variances at the 1% significance level. Therefore, a t-test for two samples with unequal variances had to be used. This test was presented in 7.3.1.2.2, and will be applied to test on the difference of the two sets of samples with an assumption of normality.

The t-test described above shows insignificant difference across all set of samples between PE-backed companies and non-PE backed companies. The sample that presented the highest degree of difference between the two types of companies was the "standard" sample. Nevertheless, at no acceptable significance level could a difference be identified. Therefore, it cannot be concluded that PE-backed companies and non-PE-backed companies differ in underpricing levels. Regardless of matching procedure or whether outliers were corrected for or not, the sample simply cannot prove a difference in underpricing performance between the two IPO samples.

If, on the other hand, the assumption of normality is relaxed, non-parametric tests provide an expansion of the testing power and validity of this study. The evidence shows that normality does not apply to the underpricing returns of the single samples in this thesis, therefore non-parametric tests become even more relevant to apply.

As previously mentioned, we utilize the Wilcoxon rank sum test for "standard" samples and the Wilcoxon signed rank sum test for the matched-pairs samples. The test statistics will prove whether the locations of the two populations are significantly different from each other.

Non-parametric tests, also known as distribution-free tests, result in inferences about the median of the samples tested, and therefore offer less statistical robustness compared to parametric tests. As was made clear in preceding sections, these tests will focus on testing

whether the median of the PE-backed samples lies to the left of the one of non-PE-backed companies. In other words, it is tests whether PE-backed companies' medians are lower than non-PE-backed ones. Table 11 provides the result of the non-parametric tests performed:

Table 11 - Non-parametric tests for difference in samples[5]

Sample	U/W value	p-value
Wilcoxon rank sum test:		
Independent	11677	0.4770
Independent (trim)	11055	0.4111
Wilcoxon signed rank sum test:		
Matched	1443	0.3145
Matched (trim)	1449	0.3959

The table above shows that, similarly to the parametric tests showed, a difference between the two types of companies cannot be identified reliably. The location of the two samples, even when controlling for outliers and when applying multiple matching procedures, cannot be said to be substantially different. Thereby it is rejected that PE-backed companies deliver lower levels of underpricing when compared to non-PE-backed companies. This is at all acceptable significance level, with a high degree of reliability.

7.5 Part conclusion

In order to be able to identify the validity and significance of underpricing present in the samples used, this study used an approach consisting of two methodological procedures. On one hand, the single samples of PE-backed and non-PE-backed companies where tested upon as a whole. On the other hand, a matching-pairs procedure where portfolios of non-PE-backed companies where paired to PE-backed companies with similar qualities to see whether there was a difference across the two sets of companies. At the 1% significance level, underpricing was proved to be present in both samples. Thereby, hypotheses one and two were confirmed with high reliability from a parametric testing viewpoint.

In terms of comparing the two sets of companies, tests were performed that determined there is no significant difference between PE-backed companies underpricing and non-PE-backed companies. This applies for the standard samples as well as matched pairs samples. This entails that the means in both sets of the two types of companies was not significantly different

[5] The code from R is provided in Appendix 7 – R code for parametric and non-parametric tests of underpricing

over the period analyzed. Even after trimming significant outliers from the samples, the difference in means still proved to be insignificant. The trimming was performed in order to achieve normality within the samples, as well as more reliable comparison across samples. Normality could not be achieved, as a higher level of outlier trimming would have compromised the validity of the sample.

The two sets of samples were statistically tested for by means of parametric and non-parametric tests. The distributional qualities of the samples' underpricing samples pointed towards non-normality, but for completeness both set of tests were applied. This was done with the purpose of increasing robustness and reliability. Nonparametric tests do not have a diminished statistical explanatory power over parametric tests. Nevertheless, even when normality was rejected, neither of the Wilcoxon tests presented a significant difference between samples (up to 5% significance level). Hence, the tests failed to prove the existence of a difference between PE-backed and non-PE backed IPOs.

Hypothesis three could not be rejected, which means that the presence of cold periods was noticeable. The number of IPOs dropped substantially from the pre-financial-crisis period to when this event took place. The period between 2008 and 2009 presented a markedly decline in number of IPOs, but also in degree of underpricing. While the analysis of hot and cold periods was not subject to statistical significance test, the overall pattern was clear. Therefore, the evaluation of hypothesis three can be deemed as valid, albeit through descriptive and qualitative analyses.

Based on the evidence on the comparison of both samples, we can conclude that hypothesis number four cannot be rejected. PE-backed and non-PE-backed did not show significant difference in underpricing in the period of 2005-2012.

8 Long-Run Performance

In order to further contextualize the effect of private equity firms on IPOs the authors of this thesis deemed a long-run analysis of stock performance necessary. While underpricing is a strong indicator of the impact of such firms on IPOs, it only shows their role from a scope that is limited in time and magnitude. Furthermore, the role of capital markets with regards to underpricing cannot be fully waged, as the access investors have to initial equity issues are bounded by their ability to purchase a share. In other words, not all investors in the market are able to acquire shares in a newly issued company because allocations of IPO shares are focused on institutional investors in its majority (Jenkinson & Ljungqvist, 2001). Therefore, an analysis that focuses on shedding light on a longer time frame will be used in order to expand the explanatory ability of this paper.

In general, there seems to be a consensus with regards to the development of IPOs in the long-run which is that, in a time frame of three to five years after becoming public, companies' stocks tend to underperform non-issuing firms (Goergen, et al., 2007), (Ritter & Welch, 2002). Long-run underperformance seems to be present across the globe, (see Ritter & Welch (2002) and Schuster (2003)) and across time with literature describing such a phenomenon for at least the last 40 years (see (Ibbotson, 1975)). While most of the literature focuses on the performance of U.S. stocks (see Ritter (1991) and Brav, et al. (2000)), literature analyzing the effect in a European context is present albeit at a lower extent (Goergen, et al., 2007).

Similarly to section 7, section 8 of this master's thesis will be structured in four subsections. First, an overall assessment of literature regarding this subject will be presented, including long-run performance theories and literature focusing on empirical analyses, which will lead to the formulation of hypothesis. This subsection will be followed by the presentation and analyses of long-run performance data, which will include methodology, data presentation and data analysis elements. Ultimately, the findings resulting from the process above will be summed up and analyzed shortly.

8.1 Literature Analysis

Of all factors subject to analysis with regards to IPOs, long-performance is one of the least well understood. Long-run performance of stocks has proved to be a challenging field of study mostly based on the distributional and cross-sectional characteristics of the returns used.

Long-term IPO analyses can apply a set of methodological and measures in order to identify if patterns are identifiable in samples of share prices across time. On these grounds, the academic articles have focused on identifying the most appropriate approach to be used in order to find trends or specific factors impacting stocks in the long-run, while shifting the focus away from empirical evidence.

The difficulty of approach can be noticed, for instance, in the analysis of phenomena. As opposed to underpricing, the phenomenon of long-run underperformance – the notion that stocks tend to perform poorly concerning the market in general in the three-to-five-year period post IPO –, has not been researched as thoroughly as other IPO-related facts (Jenkinson & Ljungqvist, 2001).

While the reasons behind underpricing as a phenomenon have been the focus of multiple research articles, long-run underperformance literature focuses mainly on methodology and empirical testing of specific events. The focus in IPO long-run performance literature is, however, not substantially different than the pattern shown in the long-run analyses of stock performance in general. Mainly, long-run performance literature is centered around the choice of methodology, the roles of metrics of performance, as well as specific events, such as equity offerings or acquisitions (Barber & Lyon, 1997), (Mitchell & Stafford, 2000).

8.1.1 Long-Run Performance Literature

In order to be able to understand the context of IPO long-term performance literature, it is important to bring up literature related to long-term analysis of stocks in general. The development in long-term stock analysis literature shapes, and is shaped, by literature related to IPOs. More importantly, the methodology used in both of them is in general terms equal, which is why it is given equal importance in the current discussion of which methodology to apply.

Presently, literature in these regards does not seem to show a general agreement of which methods are most idyllic to reliably measure the development of stocks in capital markets in the long-term. Not only is there not an overall consensus of which methods to follow, the literature has followed a trend researching the strengths and shortcomings of the current methodologies in place, as well as the metrics used. See, for example, Brav, et al. (2000), Lyon, et al. (1999) or Mitchell & Stafford (2000).

The methods of analysis of stock performance over a large span of time can be divided into two main areas, both defined by the time regime applied. On one hand there are event time

analyses, which line up all data elements into event time periods that are synced up to the time the event took place initially. On the other hand, calendar time analyses focus on returns based when the event actually took place. This means that instead of clustering all event related returns into a large sample subject to analysis, the performance of each stock is looked into based on a specific month and year within the relevant time frame.

The development of multiple methods and metrics to be applied in long-run performance analysis is a result of statistical implications. In order to establish whether stock returns underperform, a specific factor needs to be held as the "normal" return. This is usually done by analyzing stock returns against a specific benchmark. There is a general agreement that in order to be able to establish significant outcomes in the testing of long-run stock performance, methodology and metrics need to be chosen in an appropriate manner in order to be able to apply significant test statistics.

Both of these elements are susceptible to the choice of data and time frame used. In this case, returns can be analyzed by weighing observations equally, by weighing them based on market cap (or some other measure of size/book value), or by finding medians of samples. Furthermore, the choice of benchmark to which the returns will be analyzed will have a significant impact on the outcome of the tests, as it will be held as the reference point to which performance will be compared.

In concrete terms, the motivation behind the development of multiple methodological procedures is the characteristics of the data samples. Similarly to the analyses performed in section 7, tests applied in long-term analyses can be parametric or non-parametric. Parametric tests are the preferred means of testing on samples, as the possible outcomes from them give a more concrete answer to the questions being researched. However, the assumptions behind them do not always apply, and can lead to spurious or biased results (Lyon, et al., 1999) (Mitchell & Stafford, 2000).

In particular, the assumptions of normality and independence in parametric testing are real challenges when performing studies such as the one at hand. In order to mitigate, or at least control the amount of possible distortion in the tests, techniques have been developed with the idea of achieving efficient methodology procedures in long-run stock performance analysis.

8.1.1.1 Event time studies

Event time studies apply two main metrics to measure the performance of stocks over the given time period, cumulative abnormal returns ("CAR") and buy-and-hold abnormal returns ("BHR"). CARs sum monthly abnormal returns, where abnormal returns are measured as the return of the given stock over the market (i.e. the benchmark), while BHARs calculate compound single-period abnormal returns over the period analyzed. The specific equations and relevance of these metrics will be become apparent in subsection 8.2.1, together with their application in the context of this thesis.

Because CARs merely sum the single periods' abnormal returns, their relevance is sometimes diminished. Since this type of analysis applies notions that do not take place in realistic circumstances, the overall explanatory power in qualitative terms is deemed to be less than the BHARs ones. BHARs resemble the procedures of capital markets, where investors buy a specific share and hold it over a given period of time. Over that same period, the returns are compounded. Long-term analyses utilizing this metric argue that BHR tracks the actual development of stocks to a more realistic degree than CAR does.

The main reason behind the use of CAR metrics as pointed out by Fama (1998) is the ease of use from a statistical point of view. CARs do not violate the condition of normality, and can therefore yield in more significant test statistics. Meanwhile, BHRs have been empirically proved to be fat tailed, and skewed to the right (Lyon, et al., 1999). Because of this, the power of the test is diminished, which in this particular context can lead to higher rejection rates in the upper tail test and lower rejection rates in the lower tail test.

8.1.1.2 Calendar Time Analyses

Calendar time long-term analysis of stocks focus on identifying the development of share prices based on a real life time measure, as opposed to a standardized event time methodology where all returns are set in a frame where all prices (and returns) are synced up.

Calendar time long-run performance analysis is executed by forming monthly event portfolios including the returns of all the stocks that were subject to the event within the last n periods. In the case of this thesis, the event at hand is the IPO and the time frame is three years – 36 periods (i.e. 36 months). As advocated by Mitchell & Stafford (2000), by forming calendar time event portfolios (as opposed to forming event time portfolios) the cross-sectional

correlations of the individual stocks are accounted for automatically in the given portfolios in each month by the portfolio variance.

Cross-sectional correlation of abnormal returns is a vital element of long-term statistical significance analyses. The evidence as pointed out by Brav, et al. (2000), says that the effect of cross-correlation is a biased estimation of test statistics. It over estimates the true value of the sample's test significance. Therefore, Mitchell & Stafford (2000) argue that by using calendar time as the basis of the analysis, the independence condition of individual stock's abnormal returns can be preserved, which leads to an improvement in the long-term stock performance analysis.

In this thesis, the calendar time approach adopted will follow the methodology of Mitchell & Stafford (2000), adjusted for the time period deemed relevant in the context of this paper, i.e. a three-year analysis of IPOs. As such, monthly portfolios will be formed under equal weights as well as value weights. Similarly, to the event time methodology, the value weights will be formed based on the offer size. Portfolios will be formed for each month between January 2008 and December 2015, where each month's portfolio contains all companies completing an IPO within the last 36 months. Subsequently, portfolios will be rebalanced monthly, eliminating companies reaching the end of their 3-year period, and adding stocks whose IPO took place in the time frame given.

8.1.2 Theories of underperformance

Research behind the explanations of underperformance is, as mentioned above, not as widespread as the theories of underpricing. Nevertheless, underpricing and long-run underperformance have been theorized to have a connection in terms of explanatory factors, as is pointed out in Jenkinson & Ljungqvist (2001). They argue that long-run underperformance can be described through three main theoretical foundations; one is based around underpricing theories, where asymmetric information lies at the center of the reasons behind long-run underperformance. Second, long-run underperformance can be put into perspective through a behavioral explanation stance. Lastly, theories of incorrect measurement that part from the idea that long-run underperformance is not an actual occurrence, but only takes place because of measurement problems. This last string of theory is largely connected to the overall position of long-run analysis of stock performance, which over the last 20-30 years has put a large focus on

investigating the effect of long-run stock performance studies' methodology and metrics (Barber & Lyon, 1997; Jenkinson & Ljungqvist, 2001).

On the other hand, Paleari, et al. (2006) points out that, at large, long-run underperformance explanations can be divided into three main theories; theories of asymmetric information, theories of market timing and theories of window dressing. Overall, both propositions agree on the general theoretical background of underperformance.

8.1.2.1 Theories of underpricing

According to Jenkinson & Ljungqvist (2001) the two main asymmetric information theories that can be applied from an underpricing perspective to a long-term underperformance one are the signaling theory and the book building theory. Other underpricing theories with different premises, such as price support could also be applied but are less prevalent. These theories resemble somewhat what was presented in section 7.1 in relation to information mismatches.

Signaling theories present the idea that underpricing can be used as a form of signal to the markets of the quality of the company going public. According to this theory, issuing firms use underpricing as means of showing that the company has a superior quality, applying game theory to the underpricing phenomenon. In the context of long-run underperformance, this theory leads to the hypothetical situation where companies that initially used underpricing as a signal, could then issue more equity subsequently to higher returns. Empirically, this theory has been denied, and can therefore be disregarded in the context of underperformance. Furthermore, book building theories advocate for the notion that underpricing exists as a form of reward to better informed investors in order for them to reveal truthful information, so as to achieve higher first-trading day returns (upwards revision of prices based on better informed investors' revelation). For the long-run analysis at hand, this would entail for longer-run returns to be positively correlated with initial upwards revision. However, upwards revisions are generally widely available information, and therefore the long-term effect of such a phenomenon is unlikely to have a significant long-term effect (Jenkinson & Ljungqvist, 2001).

On the other hand, price support theories explain underpricing by pointing out that underwriters have an incentive to improve the prices of issuing firms following IPOs, and therefore set first-day prices artificially high. The long-run impact of this practice would be that at some point underwriters have to discontinue such practice, at which point the price would

adjust downwards. The reasoning behind this is that long-run evaluation of returns would be negatively impacted from the get-go, leading to an imminent adjust in the long-run (Jenkinson & Ljungqvist, 2001).

Ultimately, Jenkinson & Ljungqvist (2001) present agency costs as a factor in both underpricing and long-run underperformance. The effect an IPO has on ownership and control is clear, as the clear effect of such an event is the dispersion of ownership. Nevertheless, management motivation to continue running the issuing firm efficiently can be directly traced to the level of controlling shares it owns. Intuitively, if management holds the same proportional amount of shares in the given company, the personal motivation to continue running the company to their best capabilities is clear. However, if management's share of ownership decays, the private benefits diminish, leading to a conflict of interest.

Contrary to this conjecture, however, is semi-strong market efficiency. In a semi-strong efficient market, possible agency conflicts would be reflected in market prices, since changes in management ownership cannot come as a surprise. Empirically, evidence is mildly supportive of this theory. Multiple factors affect management incentives, and it is therefore unclear whether the impact is significant because of management or because of the role of other actors (Jenkinson & Ljungqvist, 2001).

While underpricing theory and long-term underperformance could under certain perspectives be connected on paper, in reality the evidence and logical connections are less clear. Other theories might have a higher explanatory power.

The valuation of a company at the time of IPO is connected to hypothetical heterogeneous expectations about it from investors in the market. As was put out in the section 7.1, only "optimistic investors" subscribe to the IPO shares, but they are not in reality representative of the market as a whole. However, in the after-market of underpricing, the valuation of the company converges in market expectations over time towards its "true" value, explaining the fall in price (Paleari, et al., 2006). In addition, in its early article Ibbotson (1975) presents the notion at the time of shares becoming public, investors buy shares at prices above the true value of a company, which presents itself by means of underpricing. Over time, the gradual dissemination of a firm's information yields in better informed investors, i.e. gradual elimination of asymmetric information among investors. The prices decrease with the increasing

amount of investor awareness of company data, as well as being impacted by decreasing investor sentiment (Goergen, et al., 2007).

8.1.2.2 Behavioral explanatory theories

One of the unifying perspectives that Jenkinson & Ljungqvist (2001) and Paleari, et al. (2006) share in relation to underperformance explanations is behavioral theories. Behavioral explanatory theories point out to reasons of underperformance related to expectations about a company's stock performance, or the company itself. The behavioral explanations presented in Jenkinson & Ljungqvist (2001) consist of three main ideas, mostly presented around the work of Miller (1977). At large, the behavioral explanations focus on heterogeneous expectations, fads, timing and window dressing as factors defining the abnormality of long-term performance.

The rationale of heterogeneous expectations as a reason for underperformance is based on the untraditional view of investors as having divergent opinions on the prospect on a specific stock's performance. This theory, as put forward by Miller (1977), explains that at the time of any specific IPO, there are always investors that will be optimistic about the firm's future cash flows and/or growth prospects. In general terms, IPOs have traditionally consisted of a large set "small" firms as a whole (cf. (Loughran & Ritter, 1995; Ritter & Welch, 2002)). When such stocks hit the market, optimistic investors will be able to cover the whole "free float" of the company, even if the market's vision (the market's homogeneous expectations) on the company's prospect does not reflect this sentiment in particular. With time, as opinion divergence gets smaller, trading prices decline which results in underpricing, i.e. heterogeneous expectations are at its peak following the IPO, but with time there is a decline of such occurrences. A noteworthy element is that even if the market agrees on average about a company's future prospects (e.g. if they are pessimistic about a company's prospects), optimistic investors will have an effect on a stock's performance in the short and long-run, resulting in underpricing and long-run underperformance.

From an empirical point of view, if a more "market efficient" point of view is taken, the expectations of a set of optimistic investors with regards to any IPO, regardless of its size, should be reflected in IPO stock prices in both the short and the long-run. Jenkinson & Ljungqvist (2001) were dubious of the empirical evidence with regards to this matter. They proposed for empiricism to further test the existence of underperformance over time in order to confirm if market efficiency would be reflected in stock prices following their book. In reality, such a

practice has still been apparent over time, so it could be assumed that such expectations have not reflected the past information revealed by academic literature. However, this could also be based on problems in measurement (see 8.1.2.3)

Fads, timing and learning explanations of underperformance are presented in Jenkinson & Ljungqvist (2001) and Paleari, et al. (2006). At the core of such a perspective lies the irrationality of investors. Similarly to the theory presented above, this point of view explains underpricing as a consequence of over-optimistic investors. Over-optimistic investors are closely tied to traditional underpricing theories. These types of investors bid offer prices up by overvaluing firms going public. In empirical literature, for instance, Brav & Gompers (1997) have proved that there is a correlation between firms going public and calendar times in different periods of time, and Jain & Kini (1994) show that when issuing firms hit the market investors value companies as having unusually high P/E and M/B ratios, but these valuations fall significantly as time goes by. Comparatively, analyst's recommendations on specific shares tend to show noteworthy over optimism with regards to newly issued shares. While this might be a coincidence, the more likely reason behind this is the practice of issuing firms to make underwriter choice based on their overall capability, including analyst recommendations as means of achieving a more successful IPO.

Furthermore, as pointed out in Paleari, et al. (2006), theories of market timing relate to the idea that the decision of entering capital markets is connected to the state of the market. These theories take timing as the defining factor of when a company becomes public, and it can either be taken as an endogenous or as an exogenous variable. Endogenous market timing theories are argued for in Ritter (1991), where the argument put out is that firms go public more often in periods where investors are more optimistic about a company's prospects. This usually is the case around hot periods, where investors are more optimistic about the prospects of not only the given IPO, but also the market in general.

On the exogenous side of the argument, Loughran & Ritter (1995) and, similarly Schultz (2003) present the decision of going public as being based on the decision of the decision makers of the firm. As such, a company's growth prospects or financing are not deemed as relevant as the control holders own decisions of the optimal time to take the company public. In Schultz (2003) a so-called "pseudo market timing" theory that analyzes the development of IPOs in an efficient market point of view is presented. In his model, it is argued that more firms go public as

stock prices increase, and less do so when they decrease, with the expectation that the issuing firms will receive a higher price for their shares, even if the market is efficient and managers have no timing ability. He argues that managers issue equity at price peaks ex-post, even though in reality they are not able to identify market peaks ex-ante. Firms issue equity when they can receive a higher price for their shares, and this alone explains underperformance, and he argues that this pattern alone does not go against the market efficiency hypothesis.

Lastly, window dressing theories are of the idea that companies tend to deliberately influence the firm's reports of performance in the period preceding the prospective IPO. Literature related to U.S. IPOs has shown that companies wanting to go public appear to show remarkable operating performance in the one- to two-year period preceding the flotation (Jenkinson & Ljungqvist, 2001). In order to do this, managers use practices like "borrowing" earnings from other periods, i.e. deferring spending or lowering prices in the given periods, or using accrual accounting practices which retroactively adjust performance reports. The result of such exercises is for operating performance to decline over time, ultimately reflecting an accurate picture of the issuing firm's operational capabilities.

8.1.2.3 Theories of measurement problems

As opposed to the picture painted above, the focus of literature on IPO underperformance over the last 10-20 years has lied in improving methodological procedures and reliable metric measurements. In fact, there is a general disagreement on whether the phenomenon of underpricing is an actual phenomenon as such, or whether statistical assumptions and/or methods can be attributed as errors in the models used to analyze them. This question was first posed in Fama (1998), where he argued that underperformance might not be an anomaly as such , but instead a result of a so-called "bad model problem". Since benchmarks are used to price securities overall, but the benchmarks themselves do not reliably reflect the desired measurement objective, underperformance becomes observable. However, Ritter & Welch (2002) are of the idea that underperformance is a market anomaly in the post-IPO time frame, and should be researched as such. The overall theory of measurement problems as foundation of long-run underperformance will be discussed in the following section, parting from an analysis of literature on long-run performance analysis of shares.

8.1.3 Literature on PE/Buyout-Backed IPOs

The proportion of PE-backed IPOs has been developing in fads over the last ten years. While in the years preceding the financial crisis the outlook of PE-backed IPOs was positive and was picking up pace, the 2008 meltdown put a halt on PE flotation activity. As such, the outlook has stayed stable since 2009 and thereby the PE-backed IPO activity has stayed constant as well. At large, this means that the literature, including the proved theories surrounding underperformance, have stayed equally stable since around then. Specifically, the literature shows a general expectation for PE-backed IPOs to show less underperformance than other IPOs. The theoretical background for this notion will be put into perspective in this subsection.

The long-term performance of IPOs is dependent mainly on two factors. The initial degree of underpricing and the allocation of shares. In the context of private equity companies, it is common for PEs to retain a large amount of shares during the IPO. However, they also tend to hold them for a short period and to gradually reduce ownership. This short-term focused strategy may lead to a pattern where shares rice over a short period of time, but eventually fall into a more stable state. When PE companies begin to reduce their share of ownership, the certification/market signaling ability is decreased, which leads to a downwards adjustment in share price. This might explain underperformance as a whole, but this also explains the less pronounced effect of underpricing on PE-backed companies when compared to non-PE-backed companies (Bergström, et al., 2006).

Another factor to keep in mind is the signaling factor that PE firms represent for IPOs. For instance, it has been pointed out that hot market IPOs lead to periods where high market valuations take place, i.e. taking advantage of windows of opportunity where IPOs can lead to higher returns. Nevertheless, the long-term effect is for expectations to be reassessed over time, leading to a fall in price (Jenkinson & Ljungqvist, 2001). In the context of PEs, investors will represent a sign for investors of reliability. Thereby, the divergence of expectations from the get-go is smaller. On these grounds, it can be expected for PE shares to stay more stable over time as the reassessment on a PE-backed companies' true value is likely to be smaller than the one non-PE-backed companies are subject to (Bergström, et al., 2006).

The role of institutional investors, as was presented in the preceding subsection, plays a large role when it comes to allocations of shares. When it comes to PE-backed companies' flotations, the demand from these type of buyers becomes even larger. Institutional investors

seem to have an even higher keenness on buying PE-backed IPO shares since doing so can ultimately lead to an ongoing relationship with the PE-funds. These investors are able to show their willingness to do so by supporting specific share prices over long periods of time, or at least longer than the one for non-PE-backed companies (Bergström, et al., 2006).

8.1.4 Empirical Literature

The development of a large part of the empirical literature in the field since the 1990s can be directly traced back to the work of Ritter. His seminal work on the analysis of IPOs' performance in the long-run has permeated the field throughout. In two of his articles, most notably Ritter (1991) and Loughran & Ritter (1995), Ritter presented the methodological standard that developed into methodological foundations for the analysis of long-run performance of stocks, including CAR and BHAR methodological procedures. .

A summary of a set of significant empirical studies of IPO long-run performance can be found in Table 12. The table mostly refers to studies applied to the U.S. stock markets, but important studies from a European point of view can be found as well.

Table 12 - Significant Literature on IPOs' Long-Run Performance

Authors (Year)	Number of IPOs	Methodology/ Metrics	Region/ Country	Key Findings
Ritter **(1991)**	1,526	CAR BHAR VW Cross-Sectional regression	U.S.	IPOs underperform listed firms in three year period. Matching firms procedure – industry and market capitalization
Loughran & Ritter **(1995)**	4,753	BHAR VW Cross-Sectional regression Time Series Regressions	U.S.	IPOs underperform in five year period. Matching firms procedure – market capitalization
Brav & Gompers **(1997)**	4,341	BHAR WR Calendar Time Cross-sectional regressions Time series regressions	U.S.	IPOs do not underperform in five year period Matching procedure – market capitalization and book-to-market ratio Small and low book-to-market firms underperform in general
Brav, et al. **(2000)**	4,622	CAR BHAR	U.S.	IPOs underperform in five year period

		WR Time series regressions		
Gompers & Lerner **(2003)**	3,661	CAR BHAR Calendar Time Time series regressions	U.S.	IPOs underperform in in three and five year using value-weighted BHAR In calendar time the return of IPOs is equal to the market
Bergström, et al. **(2006)**	1,522	CAR Cross-sectional regressions	London & Paris	PE has positive abnormal returns and outperform non-PE-backed in the long run
Zheng **(2007)**	2,493	BHAR Time series regressions	U.S.	IPOs underperform in 5 year period
Levis **(2011)**	1,595	BHAR CAR Time series regressions	U.K.	Significant positive long-run performance of PE-backed IPOs Insignificant calendar time returns

The literature above is mainly focused on U.S. data because of the sheer amount of public information and amount of listed companies on the American stock market. European studies usually present less significant results, or clear conclusions which can be traced back to the lesser amount of standardized information available, as well as the difference across European countries.

The evidence of underperformance with regards to relevant benchmarks is mixed, which can be attributed to the methodological complications mentioned above and in prior sections. There is no real methodology that can be said to be best suited for long-term performance analysis. This also applies to test statistics, since it remains unclear which ones are most ideal to analyze the properties of stocks over a long period of time. Abnormal returns tend to show positive skewness and non-normal distributions (this issue will be expanded upon in succeeding sections).

Methodological approaches are wide ranging, and the most defining factors related to the calculations methods, benchmark used, asset pricing model used, method of aggregation over time and stocks, definition of time basis (e.g. event time or calendar time) and, most importantly, statistical distribution of returns. In particular, whether normality can be assumed

Ritter (1991) and Loughran & Ritter (1995) pointed out the existence of underperformance of firms over a period of several years while controlling for market capitalization. This was in clear contradiction of the efficient market hypothesis and provoked a string of research to look into this. More recently the research has focused on methodological procedures, as can be seen in Brav & Gompers (1997), Gompers & Lerner (2003). They argue that such a conclusion could possibly be the result of a "bad model" problem. They argue that the methodological procedures, and particularly biases that impact the model might be responsible for such a result.

An important element to take away from this summary of empirical analysis of data is the duration of the IPO underperformance. Most notably in Loughran & Ritter (1995) and Ritter (1991), the underperformance phenomenon is estimated to last approximately five years. While IPOs seem to have a long-lasting effect that firstly appears within the first year, the consensus seems to show that the effects are ongoing for a period of time spanning over multiple years. It remains untested how long the time span actually is, but it is clear that underperformance is present in the long-term (one to seven years).

What pertains this study is the role of PEs in the context of IPOs. When it comes to the long.-term role of PE firms, literature has focused largely on the role of leveraged buyouts ("LBOs") and reverse leveraged buyouts ("RLBOs"). Literature on PE-backed IPOs can be more recently found in Cao & Lerner (2009) and Bergström, et al. (2006). Empirically, literature points out that PE-backed IPOs have outperformed non-PE-backed IPOs over holding periods of one to five years. Cao & Lerner (2009) focus on BHAR methodological methods, but the evidence still points out that PE firms generally have a better performance than non-PE-backed firms.

From the point of view of LBOs and RLBOs the evidence is less clear, but the majority points towards PE-backed outperformance. In some academic articles, LBOs and RLBOS show that the backing of a PE firm enhances the long-run performance of IPOs such as Holthausen & Larcker (1996) and Ritter (1991). Nevertheless, just like general literature on IPOs, significance and methodology play a big role on the conclusion. CAR and BHAR methodology are used interchangeably, as are statistical testing procedures. Perhaps the most revealing academic article from a PE-backed IPO point of view is Cao & Lerner (2009). It provides evidence for the difference in both types of flotations over a long period of time, with reliable statistical and

economic methods. However, it has to be pointed out that this academic study only focused on BHAR metrics.

8.1.5 Hypotheses formulation

Based on the theoretical and economic background presented above, this section of this study will attempt to answer some of the most interesting questions with regards to the overall context of this research.

In the context of this thesis, European literature on long-term stock performance, in particular IPOs, is not available to the same degree than American focused literature. In particular, literature testing on Western and Northern European stock exchanges is available but not updated on a constant basis. Having this in mind, this thesis will attempt to research whether patterns in long-run performance are noticeable in the above mentioned geographical area in 2005-2015.

As opposed to the literature on underpricing, the evidence presented in past underperformance literature has mixed evidence on the existence of the phenomenon. Some researchers argue that this might be the result of a bad model, while other have conflicting views on the methodological and metric approaches taken.

Nevertheless, there seems to be a consensus around the difference in performance of PE-backed companies when compared to non-PE-backed companies. The general notion points towards better performance in the long-run from PE-backed IPOs, usually in the horizon extending past the two-year post-IPO mark. We would like to identify if there is a difference between PE-backed and non-PE-backed IPOs in order to pull conclusions about both. The first hypothesis to be tested by this research in the context of long-term performance will be the following:

H5: Is there a difference in long-term performance between PE-backed IPOs and non-PE-backed IPOs?

From past studies it became clear that the role of methodology was one of the central factors defining the analyses of long-term development of stocks. Metrics and time regimes were pointed out as shaping factors of the ultimate outcome of analytical approaches. Therefore, the following hypothesis will be tested:

H6: Do differences in long-term performance show under calendar time and event time analyses for PE-backed IPOs and non-PE-backed IPOs?

Testing the hypothesis above will entail researching CAR and BHAR methodologies, as well as descriptive and regression methodologies in the context of calendar time analyses. Additionally, theoretical and qualitative interpretations will be performed on an ongoing basis.

At large, the central issue to be researched by the authors of this text is the role of private equities in capital market flotations. Furthermore, literature points towards an overall tendency for non-PE-backed companies to underperform, while PE-backed companies do not. However, conflicting the underperformance literature might be, this phenomenon is one this study would like to deepen into. Therefore, this study will try to identify the patterns of underperformance, in both sets of companies:

H7: Is underperformance present in PE-backed-IPOs and non-PE-backed IPOs?

The hypotheses set out in this subsection will be tested through statistical and economic analyses, with the support of tables and figures to illustrate how IPOs have developed in the relevant areas in the appointed time frame.

8.2 Data presentation and analysis

Following the ramifications of methodology consensus (or lack thereof) pointed out previously, this study will attempt to cover a wide spectrum of the IPO long-run performance methodological procedure alternatives. By doing so, the authors of this thesis attempt to be able to reliably trace significant differences between PE-Backed and non-PE backed companies.

Naturally, the goal is to test the hypotheses lined out above, which will be performed by means of three main procedural elements: event time studies (including CAR and BHAR), calendar time studies (including performance analysis, CAPM and Fama-French regressions).

This structure represents the most prevalent methodological procedures in literature, and should deliver an abundant set of information on which to evaluate the questions matter of this study.

8.2.1 Methodology

Methodological procedures on the analysis of abnormal returns is abundant and has multiple dimensions. Multiple metrics, benchmarks, time frames and test statistics have been put to use in order to analyze these events. There is no real consensus in literature, and in spite of substantial contribution from the academic world, research in this field remains treacherous. Most notably Barber & Lyon (1997), Fama (1998), Mitchell & Stafford (2000) and Brav, et al.

(2000) among others have set out to expand the knowledge on methods and metrics. On grounds of methodological uncertainty, the approach taken in this study is one where a wide range of methodological procedures will be performed. This will include multiple test statistics in order to have more clarity and enhance the validity of the outcomes of this research.

8.2.1.1 Event time studies

The basis of event time studies is centered on elements of abnormal returns, where the return above the "normal" is calculated in reference to a specific benchmark or a set of matching firms that resemble the stock at hand (see 4.3)

In terms of the specific metrics of long-run analysis of stocks, CAR, BHAR and wealth-relative ("WRs") metrics permeate the overall field of study. These metrics are used to capture the effect of abnormal returns (as opposed of capturing "raw" returns of issuing firm stocks). This study will focus on CAR and BHAR metrics only, as the interpretation power offered by WR metrics reflect qualitative aspects that do not differ substantially from BHAR metrics. WRs are calculated as the ratios of buy and hold returns with regards to buy-and-hold returns of a benchmark, and thereby have essentially parallel explanatory power to BHAR analyses.

Event time in IPO long-run studies is largely homologated, where the standard practice is for the starting point of the study to be defined as the first day where an aftermarket share price is available. By this is meant the first day where issuing company shares are available for all investors, and not only the set that were allocated shares in the pre-IPO period. This notion is mainly motivated by the fact that underpricing exists. If initial returns were to be included in the scope of analysis, it could potentially have a distorting effect on the outcomes of the tests.

A simple calculation explains how abnormal returns are calculated, based on the returns of a stock and the market. In this case, abnormal returns for the stock of a firm i in period t is described by:

$$AR_t^i = R_t^i - R_t^{i,B}$$

Where R_t^i is the simple (raw) return of the stock of company i in period t, and $R_t^{i,B}$ is the simple return of a benchmark B matched to company i's stock over the same period.

The above given formula can be used for all stocks in the samples for each period in order to calculate cumulative abnormal returns, a measure of long-term performance that accumulates simple abnormal returns by subtotaling them over a specific period of time.

Particularly, the cumulative abnormal return for a given stock i over the period starting in t=1 and lasting until month T ($CAR_{1,T}^{i}$) is derived by summing the single month difference of monthly returns with regards to the given benchmark for the stock of company i over time:

$$CAR_{1,T}^{i} = \sum_{t=1}^{T} (AR_{t}^{i})$$

In terms of handling the delisting of a specific stock before the T time periods are reached, this thesis follows the methodology of Holthausen & Larcker (1996) who express the idea that the given firm's stock abnormal returns after delisting can be set equal to zero in all periods up to period T. By doing this, the implicit assumption is a trading strategy that uses the proceeds of the theoretical sale of the delisted stock to invest it in the market. Based on this, when a company was delisted in our sample before the time frame threshold, abnormal returns where set to zero.

Buy-and-hold abnormal returns, as opposed to CAR metrics, do not use addition of period abnormal returns to gauge the event's long-term impact, but instead offer the compounded return of the stock of a given company over a specific period This is then adjusted by compounded returns in a benchmark reflecting similar qualities than the stock. This specific method is a more realistic indicator of what an average investor experiences in the market, and therefore usually preferred when doing long-term analyses (see Mitchell & Stafford (2000) or Barber & Lyon (1997). To illustrate, if an investor were to buy a company's stock upon flotation and hold it for the entire period, the BHAR would reflect exactly how much the investor's stock would have yielded in the given period (adjusted for market-general conditions).

Specifically, buy-and-hold abnormal returns are calculated for company i from time 1 until period T/month T ($BHAR_{1,T}^{i}$) as the difference between the monthly compounded returns of company i's stock over the given period and the compounded return of a given benchmark over the same period:

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

Where R_{t}^{i} is the simple (raw) return of the stock of company i in period t, and $R_{t}^{i,B}$ is the simple return of a benchmark B that is matched to company i's stock over the same period.

With regards to delisting in the BHAR context, this study will follow the standard practice expressed by Brav & Gompers (1997) and Gompers & Lerner (2003). These sources follow a procedure where if a company's stock is delisted from the specific stock exchange, the BHAR returns of that given company are truncated from that point onwards. Therefore, in the equation above T is the maximum of T periods and/or the portion of this time during which the given company was, in fact, listed in the stock exchange.

While one of the main advantages of the BHAR approach is the resemblance to the real life experience of investors, BHARs produce extreme outcomes. BHARs are usually right-skewed and have fat right tails which leads to problems in terms of statistical testing, e.g. BHARs tend to violate the assumptions of standard t-tests. Furthermore, since an investor cannot lose more than 100% of its investment, a lower limit is imposed. This cuts the distribution on the left-hand side.

The key characteristic of BHARs when compared against CARs is that it presents a measure equivalent to the returns that an investor following a buy-and-hold strategy would earn. Nevertheless, because of this exact characteristic, BHAR can result in extreme values as it can take very large positive return values over periods of time that expand over multiple months or years, which in turn leads to non-normal distributions (right tailed, right skewed distributions). Non-normality causes parametric tests' assumptions to be violated, which ultimately impacts the ability of test statistics to evaluate whether returns are, in fact, different from zero, e.g. standard t-test (Lyon, et al., 1999).

On the other hand, CARs have the upside that the distributional characteristics of the returns are easier to be interpreted. CARs are more apt in terms of statistical testing but are impacted by a positive bias since abnormal returns are cumulated through addition. Moreover, using CAR as metric also implies applying methods that do not reflect a realistic real life trading strategy.

Since no real theoretical consensus can be seen in past literature, both methods will be applied. Both metrics in event time analysis deliver different answers and answer different questions. Based on the study of Barber & Lyon (1997) this paper will put a higher emphasis on BHAR returns as they more closely resemble the real life experience of investors in the market.

Abnormal returns can either be aggregated through time and across stocks by means of equal weights or value weights. Equal weights give more weight to smaller firms than value

weights, and might therefore show anomalies. On the other hand, value weights can lead to faulty conclusions as well, as a small numbers of very large firms can pull the sample results to a direction different than the reality. The authors of this study will use value-weighted and equally-weighted BHARs and equally-weighted CARs. No value-weighted CAR analysis will be used because of the offer size information available, as well as the unrealistic analysis that would entail rebalancing the given portfolios monthly (high trading costs).

When abnormal returns are calculated for each even time unit and averaged across samples firms it is assumed that the returns of the firms in the sample are independent. In reality, the returns being analyzed cannot be thought to fulfill this assumption as there is cross-sectional dependence across stocks, as has been pointed out by Brav & Gompers (1997) and Gompers & Lerner (2003) among others. IPOs tend to cluster over time, and thereby the returns of the sample's stocks get overlapped in calendar time. This ultimately can lead to an overstatement of test statistics.

8.2.1.2 Calendar time studies

Calendar time studies approach the analysis of long-term performance of IPOs by researching the returns in accordance with time linearity. The approach was fashioned as a way to mitigate the cross-sectional dependence among IPO returns.

The calendar time methodology is based on the idea of calculating the returns of a set of IPOs that took place in t amount of periods prior to a specific time point. In other words, the returns of all IPOs that took place in the last t months are calculated on a monthly basis. The returns are calculated through the construction of monthly portfolios of unadjusted returns, i.e. the specific time points used as basis to set the time retroactive boundary is set month by month. Similarly to the event time approach, returns are averaged across firms in the sample by means of equal-weighting or value-weighting. The given portfolios of monthly returns can then be used as the basis of significance testing. No restrictions were levied upon the sample, which entails that no minimum (or maximum) amount of companies were deemed necessary to build a monthly portfolio.

This study applied the calendar time methodology by calculating returns of all IPOs taking place within the last three years, or 36 time units/months. This entails that calendar time returns will be calculated monthly by taking the returns of all IPOs that took place in the preceding 36 months prior to the specific month.

Nevertheless, calendar time methods may underestimate the clustering of IPOs over time, as all months are given equal weights. This can potentially be the source of biases through heteroscedasticity of returns. Since IPOs tend to take place in clusters, it is argued by authors like Loughran & Ritter (1995) that calendar time portfolios with equal monthly weights are faulty. A simple solution would entail to adjust monthly returns based on their risk (volatility). This adjustment, however, was deemed out of the scope of this paper.

Once the monthly portfolios are constructed, they will be subject to simple descriptive statistics analyses by year. More importantly, they will be used as the basis of so called "Jensen's Alpha" analyses. These types of analyses consist on making OLS regressions on the monthly portfolios. In particular, the two most generalized regression models will be used: the CAPM model and the Fama-French three-factor model.

The Fama-French Three Factor Regression Model (Fama & French, 1993) and the CAPM ((Sharpe, 1964), (Lintner, 1965)) in the context of this analyses use unadjusted returns as a dependent variable and then estimate abnormal returns through the use of risk-free returns.

The regressions are made out of portfolios in post-event time and are rebalanced every month to include the companies that are represented in each individual month (while dropping the companies which are past the 36 months post-event time) over the 8-year timeframe. The abnormal returns, i.e. the intercepts of the regressions, are then estimated on a monthly basis from the regression output and will then be calculated by multiplying with the number of months needed to retrieve the three-year long-run performance needed (Mitchell & Stafford, 2000).

The Jensen's Alpha approach is a tool used to analyze the long-term performance of stocks against the market by focusing on identifying abnormal returns by adjusting returns through market variables (usually in the form of proxies). The approach gets its name from the estimator of returns different than the market that is included in all regression equations, i.e. the alpha. The procedure relies on the use of time-series data, and is in this sense applicable to calendar time returns.

In general, the regression approach consists of estimating the abnormal returns of stocks or portfolios by identifying the difference between them and the market (or market factors). Particularly, based on "raw" returns, through the use time series data of market returns and reliable market variable returns, excess returns on portfolio/stocks are calculated and then regressed for to identify abnormality vs. the market (Cuthbertson & Nitzsche, 2004). These

models use asset pricing models that make inferences about the risk-adjusted performance of, in this case, portfolios of monthly stock returns.

The approach has been adopted in long-term stock performance analysis to calculate calendar time abnormal returns. In this case, by applying time-series regressions to the returns of IPOs in well-known asset-pricing models such as the CAPM, or a multifactor market model such as the Fama-French Three-Factor Model (Kothari & Warner, 2006).

In the context of the Jensen's alpha analyses, the risk-free rate and multifactor (non-market) figures will be taken directly from French (2016) for consistency and reliability reasons. Furthermore, in accordance to the rest of this research process, the benchmark chosen as a proxy for market returns will be the STOXX EUROPE 600 price index.

8.2.1.2.1.1.1 CAPM regressions

The Capital Asset Pricing Model is used to calculate the abnormal return in calendar time using market risk as the only parameter to identify abnormal returns. The well-known CAPM equation is presented below.

Under market-efficient conditions, i.e. when $\alpha_p = 0$, the given stock/portfolio has no abnormal return over the market. On the other hand, if α_p is higher than zero the stock/portfolio return is above what the market expects based on its risk measure. This entails that, in a security market line (SML) context, the stock/portfolio differs from the "line" and can be said to have presented an abnormal return (it is placed above the SML) (Cuthbertson & Nitzsche, 2004).

$$(R_{pt} - R_{ft}) = \alpha_p + \beta_p(R_{Mkt} - R_{ft})$$

The equation above is the foundation of the CAPM (and the CAPM regressions). It uses a single factor regression model with time-series data to estimate whether stocks/portfolios generate abnormal returns with regards to a market index. In the context of calendar time studies, R_{pt} takes the form of monthly unadjusted portfolio returns, R_{Mkt} is represented through a market benchmark and R_{ft} is the monthly risk-free return in the given market. Ultimately, the goal is to identify a non-zero alpha in order to prove abnormal returns.

8.2.1.2.1.1.2 The Fama-French Three-Factor Model

The Fama-French Three-Factor Model was developed by Fama and French (Fama & French, 1993), and is often used in finance to test for portfolio performance. The model deviates

from CAPM as it uses two more explanatory variables, rather than just the market parameter, to describe performance. The two additional variables are the market capitalization and book-to-market ratios, which the model uses to control for value and size effects in stocks.

Fama & French (1993) use the additional variables to add explanatory power to the regressions, but mostly to control for qualities in stocks that have been empirically tested. The model points out that the growth prospects of a company, as well as the size of the market-to-book ratios are ultimately related to stock returns.

The Fama-French three-factor model is shown below:

$$(R_{pt} - R_{ft}) = \alpha_p + \beta_{1p}(R_{Mkt} - R_{ft}) + \beta_{2p} * SMB + \beta_{3p} * HML + \varepsilon_{pt}$$

Similarly to the CAMP-model, the intercept α_p determines the abnormal return of stocks/portfolios over the market. Identically than in the previous subsection, when $\alpha_p = 0$ there are zero abnormal returns, and when α_p is positive, the return of a stock/portfolio can be said to deliver a return above the market.

In this case, R_{pt} stands for the portfolio/stock return, while R_{ft} represents the risk-free rate observed in the beginning of the month. R_{MKT} is the return on the market portfolio. SMB is the return on a portfolio controlling for the size factor, while HML is similarly the return of a portfolio controlling for the value factor. Both of these factors are constructed as zero-investment portfolios. The portfolios' structure is presented below. The methodology applied in this paper follows the one applied by Fama & French (1993).

The SMB portfolio returns consists of the average return of three portfolios, each reflecting the returns of companies with different size qualities:

1/3 (small, value + small, neutral + small, growth) - 1/3 (big, value + big, neutral + big, growth)

Meanwhile, the return on an HML consists of the average return of two portfolios controlling for the return of a portfolio with high book-to-market ratio and one with low book-to-market ratio:

1/2 (small, value + big, value) - 1/2 (small, growth + big, growth)

This asset-pricing model should, ceteris paribus, result in a model that explains a wider amount of variation around the portfolios of monthly returns, thereby giving a more specific interpretation tool of the abnormality of stock returns.

8.2.1.3 Test statistics

This research paper will take two main approaches to test the significance of the results at the core of this paper. The assumption of normality cannot be applied constantly because of the nature of some of the return metrics. Having this in mind, alternatives of test statistic that do not rely on specific assumptions will have to be used. Similarly to what was mentioned in the underpricing section of this thesis, non-parametric test statistics will be used in order to assist in the evaluation of the given samples.

In terms of AR returns, the work of Ritter (1991) will be used as inspiration for test statistics methodological procedure. Ritter used methods that take cross-sectional dependence into account (to some degree) but still can be thought of as a source of possible bad model bias. The test statistic used is as follows:

$$t = \frac{\overline{AR_T}}{\sigma(AR_T)/\sqrt{n}}$$

Where $\overline{AR_T}$ is the sample mean and $\sigma(AR_T)$ is the cross-sectional standard deviation of the abnormal returns in the sample of n firms. This test statistic will be used to confirm the overall significance of abnormal returns, regardless of the ultimate methodological application.

Specific parametric tests will be applied in the context of CAR returns to test for cross-sectional significance. This metric will be applied in the exact same context as was presented by Ritter (1991). This approach applies controls for cross-sectional correlation, however this bias cannot be completely controlled for:

$$t = \frac{\overline{CAR_{1,t}}}{csd_t/\sqrt{n_t}}$$

Where $\overline{CAR_{1,t}}$ is the cumulative abnormal return in month t, csd_t is the cross-sectional standard deviation over the period and n_t is the numbers of firms trading each month.

On the other hand, BHAR returns have specific distributional characteristics that make them unapt for standard statistical testing. This paper will adopt the above mentioned AR test statistic to validate the significance of single period returns, but in general terms will focus on non-parametric tests to verify significance. As was previously mentioned, BHAR returns have

statistical qualities that make the normality assumption in general terms inapplicable. The Wilcoxon signed rank test (see section 7.3.1.2) will be used in order to take into consideration the possible non-normal distribution of the long-term abnormal returns in BHAR. For completeness, CAR returns will also be subject to this test.

In terms of calendar time methodology, the significance of the results will be based on the regressions performed. The regressions include standard t-tests on single factors including in the model, as well as of the returns itself. These test statistics are not exposed to cross-sectional dependence, and can therefore be thought of as reliable to a higher degree than the above methods applied. Regardless, the factual significance of the test statistics in this section of the study should be taken cautiously, as multiple biases affect them and make the level of trustworthiness lower.

8.2.2 Data Description

This section of the study uses a sample of 361 firms. The analysis performed on the sample needed an aftermarket period of three years. At large, the sample used resembles the characteristics of the sample used in section 7..

The reason for delisting was not researched in this study, but can include acquisition, bankruptcy or inability to maintain stock exchange requirements (e.g. accounting procedures).

Inspired by the work of Gompers & Lerner (2003), shows the survival rate of the companies included in the sample over the three-year aftermarket period. Companies that were delisted were accounted for and presented for both types of companies. In general, the attrition rate is relatively low, as less than 8% of the total sample got delisted within three years of flotation. In particular, for the PE-backed part of the sample, attrition is barely existent as only three companies in the whole sample got delisted during the given period. On the other hand, most of the companies that got delisted belong to the non-PE-backed part of the sample.

The fact that PE-backed companies tend to maintain their shares in the given exchanges may relate to the fact that the operation qualities they have are optimized to a higher level than other types of companies. The role of PEs becomes clear through the results presented, as one of the core competences of such entities is their ability to enhance the financial and managerial performance of firms under their umbrella. It should come as no surprise that the stability imparted by PEs is kept in the three-year post-flotation span.

Table 13 - Survival and Attrition of companies performing IPOs

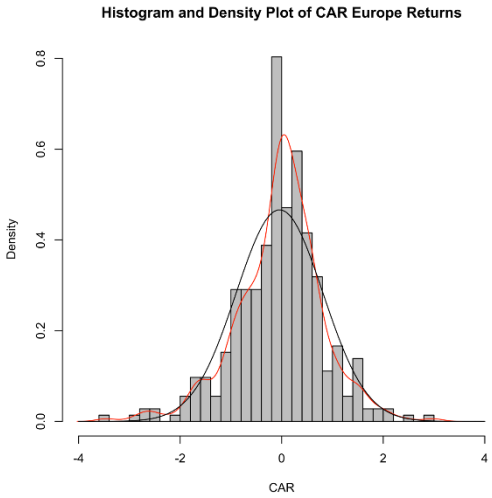
Years After IPO	Whole Sample				PE-Backed				Non-PE-backed			
	Surviving Firms		Defunct Firms		Surviving Firms		Defunct Firms		Surviving Firms		Defunct Firms	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0	361	100%	0	0%	82	100%	0	0%	279	100%	0	0%
1	359	99.45%	2	0.55%	82	100%	0	0%	277	99.45%	2	0.55%
2	345	95.57%	16	4.43%	81	99.72%	1	0.28%	264	95.84%	15	4.16%
3	334	92.52%	27	7.48%	79	99.17%	3	0.83%	255	93.35%	24	6.65%

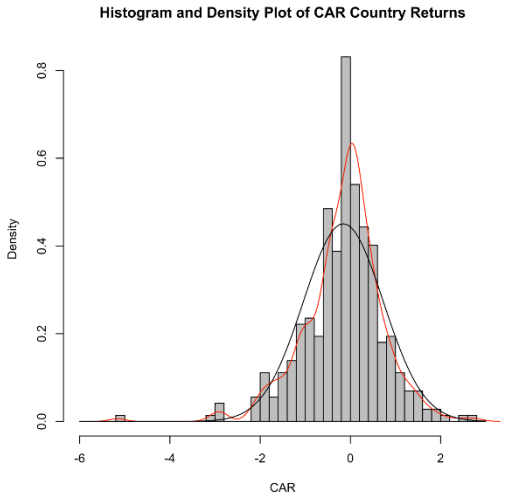
Overall, companies only began to delist after the first year of selling their shares in the market. After this point, the general attrition rate was of approximately 4% per year for all companies.

Table 14 and Table 15 show the distribution of the benchmark-adjusted returns for the whole sample. Table 14 shows the distribution of CARs adjusted by the European, Country and Industry benchmarks, while Table 15shows the distribution of the BHARs adjusted by those benchmarks. The illustrations show the normal distribution curve and the curve that approximates the distribution of the sample and can be found in larger dimensions in Appendix 9.

If clear outliers are disregarded, CARs resemble a normal distribution to a higher degree than BHARs. Nevertheless, CARs also present a slight positive skewness and distributions centered around the mean. On the other hand, BHARs are cut off on the left-hand side as negative returns lower than -100% are not possible. Based on the nature of BHARs, i.e. compounded returns, the distribution of the returns is more extreme and left-hand skewed.

Table 14 - Distribution of CARs, all benchmarks





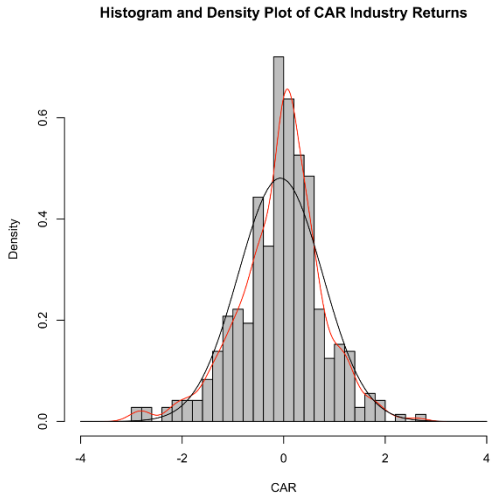
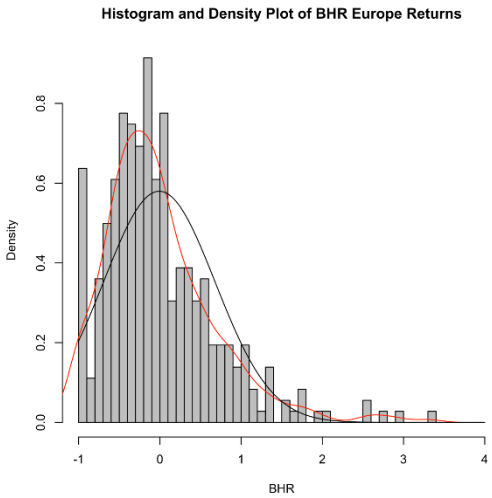
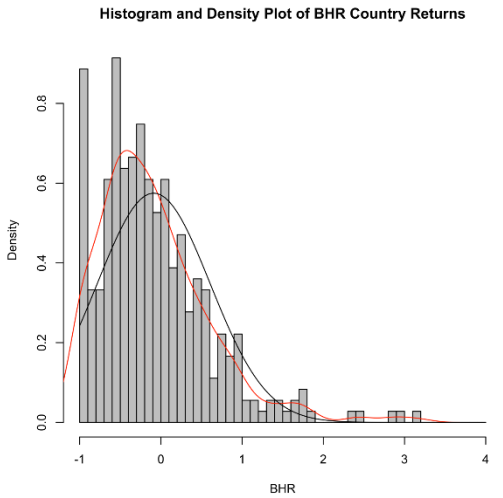


Table 15 - Distribution of BHARs, all benchmarks





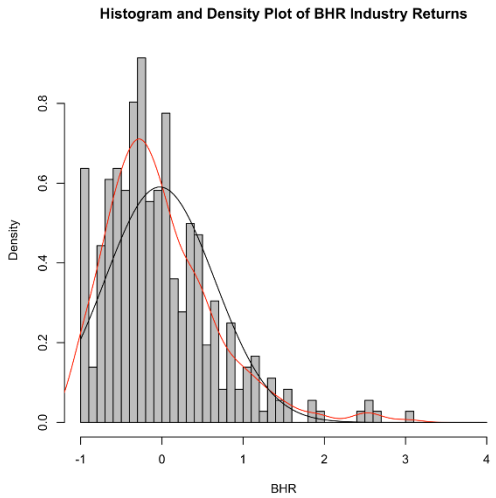


Table 16 - Abnormal returns measures, three-year abnormal returns

Abnormal return	Mean	Median	Skewness	Kurtosis
Three-year CAR vs. European Benchmark	-4.22%	0%	-0.38	1.55
Three-year CAR vs. Country Benchmark	-15.65%	-1.59%	-0.74	3.34
Three-year CAR vs. Industry Benchmark	-6.43%	0.00%	-0.40	1.16
Three-year BHAR vs. European Benchmark	-0.74%	-14.58%	1.41	3.26
Three-year BHAR vs. Country Benchmark	-8.86%	-20.94%	1.42	3.24
Three-year BHAR vs. Industry Benchmark	-2.55%	-16.25%	1.27	2.50

Table 16 presents the distributional qualities and the descriptive statistics of the abnormal returns using CAR and BHAR metrics, for all three types of benchmarks used. CARs present qualities of normal distribution, with lower levels of skewness and kurtosis. On the other hand, BHARs are dominated by the extreme values of a few companies.

The main takeaway of the table above is that caution should be taken when applying test statistics based around normality assumptions for BHAR returns. Therefore, non-parametric tests will be applied to BHARs to test on medians as opposed to means.

In the context of calendar time studies, regressions use parametric tests, in particular t-test, to test for the significance of the regressed values. Alpha and beta estimates are tested for significance in order to show their validity and applicability.

8.2.3 Presentation of results

8.2.3.1 Event time

Tbale 18 and Table 19 show the performance of PE-backed IPOs and non-PE-backed IPOs. In general, the performance of PE-backed IPOs seems to show less underperformance (and even positive performance) over the given period of time.

At large, the equally-weighted returns in both CAR and BHAR show an initial underperformance for all companies within the first 12 months of IPO. From this point onwards, the performance for both sets of companies differs wildly in both median and average returns. Non-PE-backed companies tend to underperform after the first year of flotation, tending to deliver negative results after the two-year and three-year mark. On the other hand, PE-backed IPOs show an overall positive development towards 12-month-mark post-IPO.

CARs show results significant from a non-parametric point of view. As was previously discussed, normality cannot be taken for granted and therefore the sample should be looked into from a non-parametric, as well as a parametric, significance testing point of view. CARs show significant results for non-parametric tests while it shows mixed results of significance when parametric testing is applied.

Table 17 - CAR returns with parametric tests

		European Benchmark			Country Benchmark			Industry Benchmark		
	Months	**6**	**12**	**36**	**6**	**12**	**36**	**6**	**12**	**36**
Non- PE	n	279	278	258	279	278	258	279	278	258
	CAR	-1.08%	-0.04%	-13.89%	-2.23%	-3.84%	-24.78%	-1.02%	0.86%	-14.85%
	t-test	-1.5504	0.0199	-0.9419	-0.4563	-0.5234	-1.7464	-0.2092	0.1472	-1.0382
	p-value	0.1222	0.0159	0.3471	0.3515	0.3989	0.0819	0.1655	0.1169	0.3002
PE	n	82	82	79	82	82	79	82	82	79
	CAR	-1.63%	1.39%	28.67%	-3.87%	-2.93%	15.39%	-0.80%	1.56%	22.21%
	t-test	-0.3361	0.1828	2.2363	-0.7760	-0.3793	1.3036	-0.1618	0.2161	1.7548
	p-value	0.2624	0.1446	0.0282	0.4400	0.2945	0.1962	0.1281	0.1706	0.0832

The most reliable results come from non-parametric test which imply that PE-backed IPOs significantly perform at a higher level than their non-PE counterparts. While this result might have been expected, the magnitude difference is substantial. At the 36-month mark, PE-backed firms presented significant and positive results, while non-PE-backed companies presented negative results. Even though CAR metrics tend to paint an unrealistic picture of the real-world experience investors have, it is still important to point out that the results clearly point towards an overall better performance of PE-backed companies over non-PE backed ones.

In event time, both sets of samples tend to have similar performance in the first 15 months after flotation, after which point PE-backed companies start outperforming their counterparts up to the three-year mark. Once the analysis period ends, PE-backed companies show a significant positive performance in the range of 15-30% of mean CAR values, while median CARs range from 12-20% for all three benchmarks.

Table 18 - Cumulative Abnormal Returns

Cumulative Abnormal Returns vs. European Benchmark				
	Holding period in months			
	6	12	24	36
Non-PE-backed IPOs				
Average Equally-Weighted CAR	-1.08%	-0.04%	-10.13%	-13.89%
Median CAR	-2.59%	2.01%	-3.75%	0.00%
p-value from Wilcoxon Signed Rank Test	0.40	0.05	0.21	0.03
PE-backed IPOs				
Average Equally-Weighted CAR	-1.63%	1.39%	9.26%	28.67%
Median CAR	-3.07%	2.48%	1.04%	29.15%
p-value from Wilcoxon Signed Rank Test	0.42	0.20	0.32	0.00
Cumulative Abnormal Returns vs. Country Benchmark				
Non-PE-backed IPOs				
Average Equally-Weighted CAR	-2.23%	-3.84%	-17.69%	-24.78%
Median CAR	-2.39%	-0.06%	-9.86%	-9.98%
p-value from Wilcoxon Signed Rank Test	0.21	0.25	0.00	0.00
PE-backed IPOs				
Average Equally-Weighted CAR	-3.87%	-2.93%	0.12%	15.39%
Median BHAR	-3.50%	-1.96%	-4.14%	12.46%
p-value from Wilcoxon Signed Rank Test	0.18	0.38	0.14	0.07
Cumulative Abnormal Returns vs. Industry Benchmark				
Non-PE-backed IPOs				
Average Equally-Weighted CAR	-1.02%	0.86%	-10.31%	-14.85%
Median BHAR	-1.35%	3.76%	-2.69%	0.00%
p-value from Wilcoxon Signed Rank Test	0.39	0.23	0.02	0.02
PE-backed IPOs				
Average Equally-Weighted CAR	-0.80%	1.56%	6.72%	22.21%
Median BHAR	-1.35%	-1.49%	2.44%	22.46%
p-value from Wilcoxon Signed Rank Test	0.26	0.27	0.40	0.01

Figure 11 - CAR vs. European Benchmark

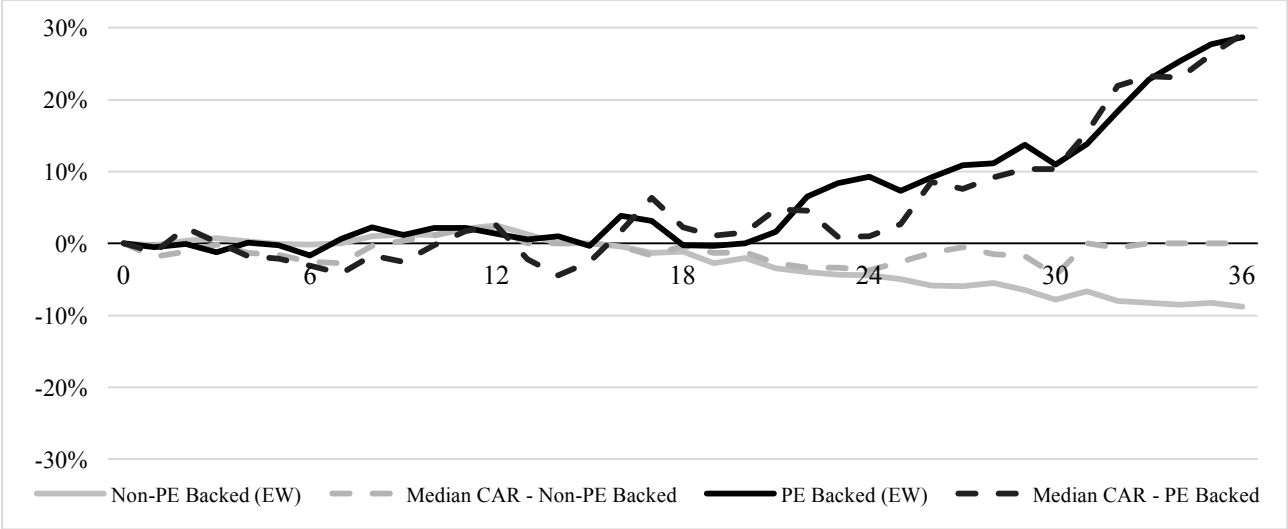


Figure 12 - CAR vs. Country Benchmark

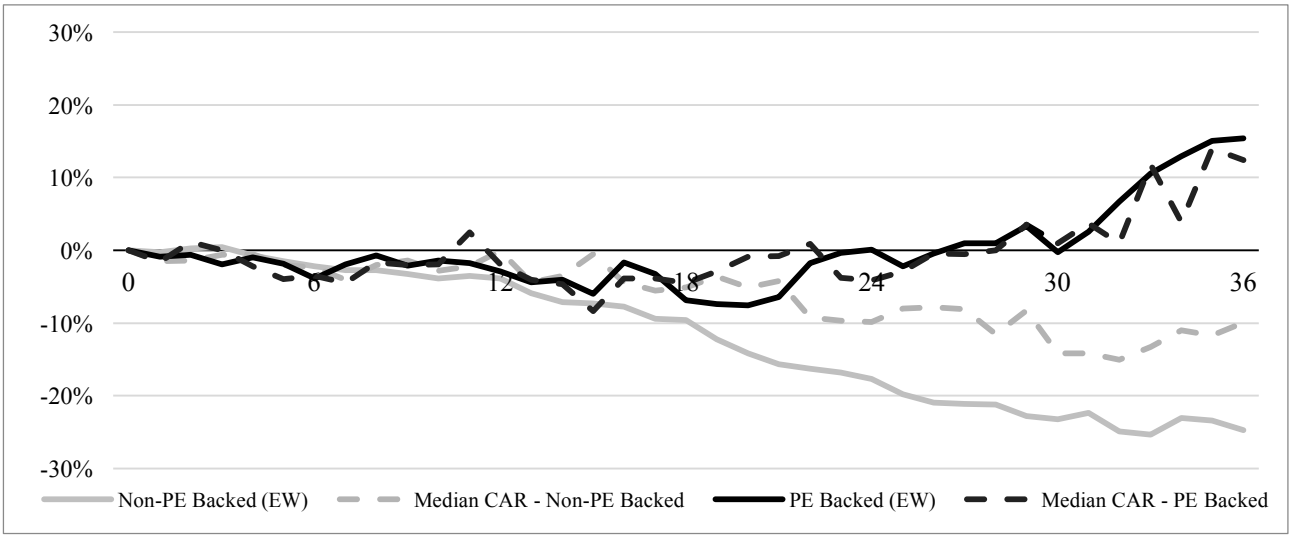
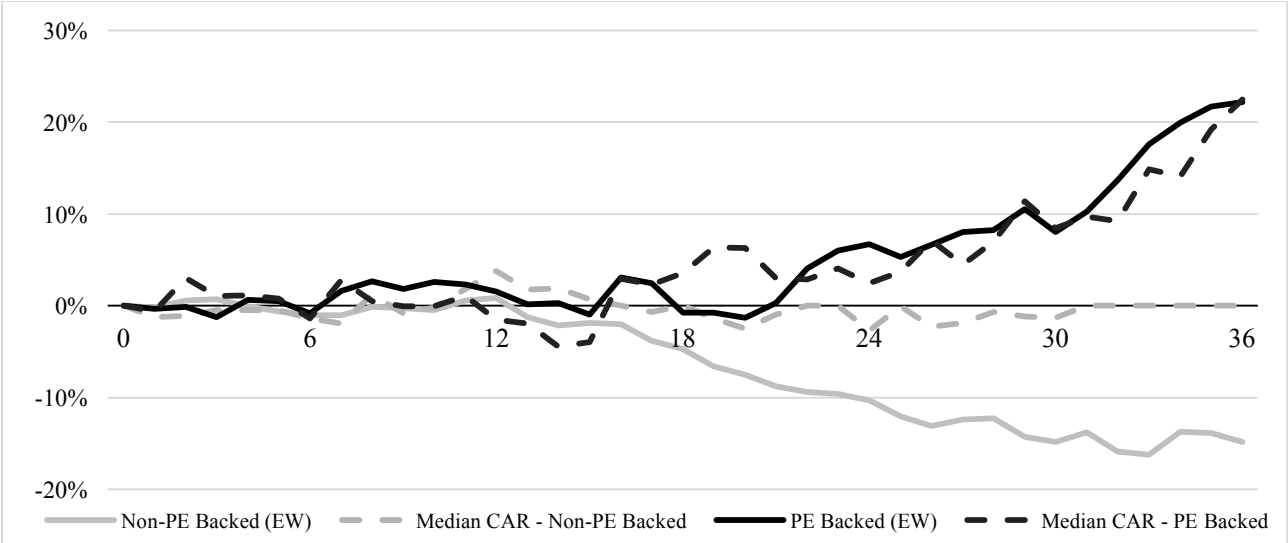


Figure 13 - CAR vs. Industry Benchmark



Oppositely, CARs for non-PE-backed IPOs show mean CARs in the range of negative 13-25% values after three years for all three benchmarks, and median CARs in the range of 0% to negative 10%. Based on significant values from a non-parametric point of view, this entails that PE-backed companies not only outperform the market in the three year post-IPO aftermarket period, they also outperform non-PE-backed companies by a wide margin. On the contraire, non-PE-backed companies underperform the market and show that underperformance does exist in this context.

Table 19 - Buy-and-Hold Abnormal Returns

Buy-and-Hold Abnormal Returns vs. European Benchmark				
	Holding period in months			
	6	**12**	**24**	**36**
Non-PE-backed IPOs:				
Average Equally-Weighted BHAR	-0.19%	2.49%	-4.39%	-8.77%
Average Value-Weighted BHAR	17.37%	20.99%	56.75%	40.65%
Median BHAR	-2.59%	2.01%	-3.75%	0.00%
p-value from Wilcoxon Signed Rank Test	0.08	0.14	0.01	0.00
PE-backed IPOs:				
Average Equally-Weighted BHAR	0.00%	7.65%	11.28%	26.60%
Average Value-Weighted BHAR	-0.10%	-0.15%	3.81%	17.92%
Median BHAR	-4.49%	-4.76%	-11.96%	-0.49%
p-value from Wilcoxon Signed Rank Test	0.29	0.47	0.36	0.20

Buy-and-Hold Abnormal Returns vs. Country Benchmark				
	Holding period in months			
	6	**12**	**24**	**36**
Non-PE-backed IPOs:				
Average Equally-Weighted BHAR	-1.38%	-0.75%	-9.86%	-16.40%
Average Value-Weighted BHAR	17.46%	20.96%	52.35%	36.12%
Median BHAR	-3.26%	-0.92%	-11.65%	-16.35%
p-value from Wilcoxon Signed Rank Test	0.01	0.13	0.00	0.00
PE-backed IPOs:				
Average Equally-Weighted BHAR	-2.17%	3.56%	4.41%	16.79%
Average Value-Weighted BHAR	-0.23%	-8.61%	-0.91%	11.74%
Median BHAR	-6.02%	-6.73%	-16.45%	-9.82%
p-value from Wilcoxon Signed Rank Test	0.15	0.21	0.33	0.22

Buy-and-Hold Abnormal Returns vs. Industry Benchmark				
	Holding period in months			
	6	12	24	36
Non-PE-backed IPOs:				
Average Equally-Weighted BHAR	-0.12%	2.78%	-5.11%	-9.42%
Average Value-Weighted BHAR	14.09%	11.91%	29.21%	15.67%
Median BHAR	-2.25%	0.12%	-10.95%	-20.70%
p-value from Wilcoxon Signed Rank Test	0.14	0.30	0.01	0.00
PE-backed IPOs:				
Average Equally-Weighted BHAR	0.82%	8.05%	9.17%	20.82%
Average Value-Weighted BHAR	7.64%	3.24%	5.54%	16.47%
Median BHAR	-2.06%	-5.31%	-9.41%	-6.64%
p-value from Wilcoxon Signed Rank Test	0.34	0.18	0.18	0.4735

A very clear pattern shown in the given set of companies is the role of large companies in samples that are relatively small. In the case of this study, a couple of companies pulled the overall result of the non-PE-backed companies sample upwards in a substantial manner. It was identified that the two companies were listed as a result of a privatization effort from the French government. Such companies are not often involved in IPOs, but when they do their market capitalization is substantial. As such, the given companies signified almost 40% of the whole sample's market capitalization.

Figure 15 - BHAR vs. European Benchmark

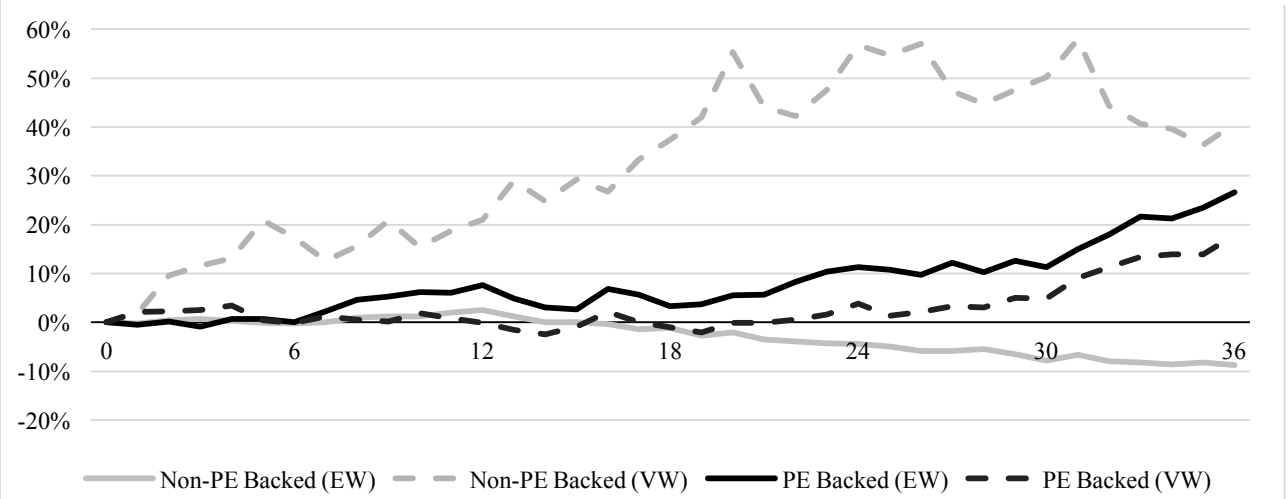


Figure 16 - BHAR vs. Country Benchmark

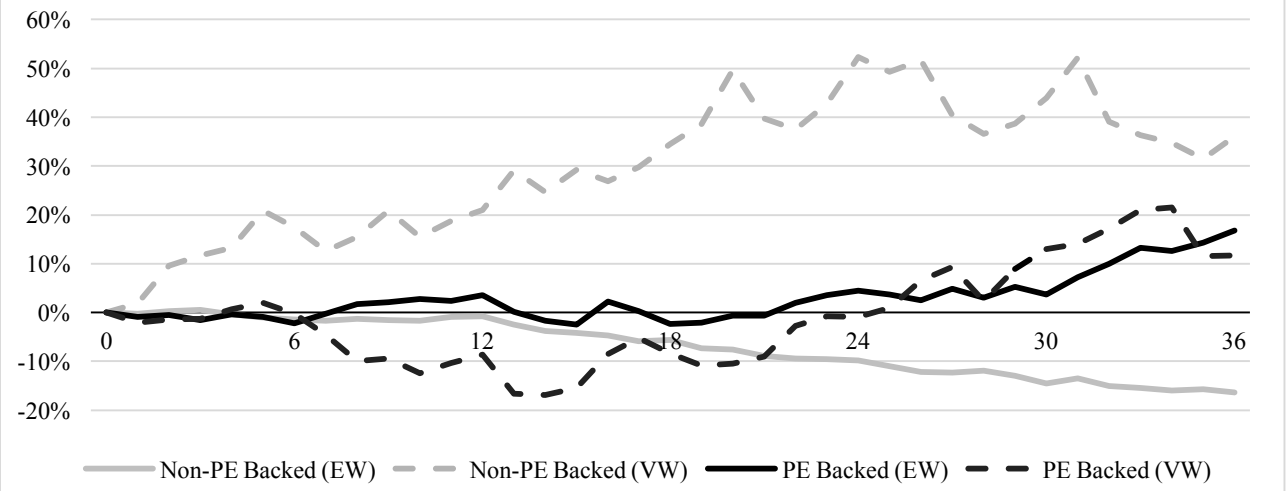
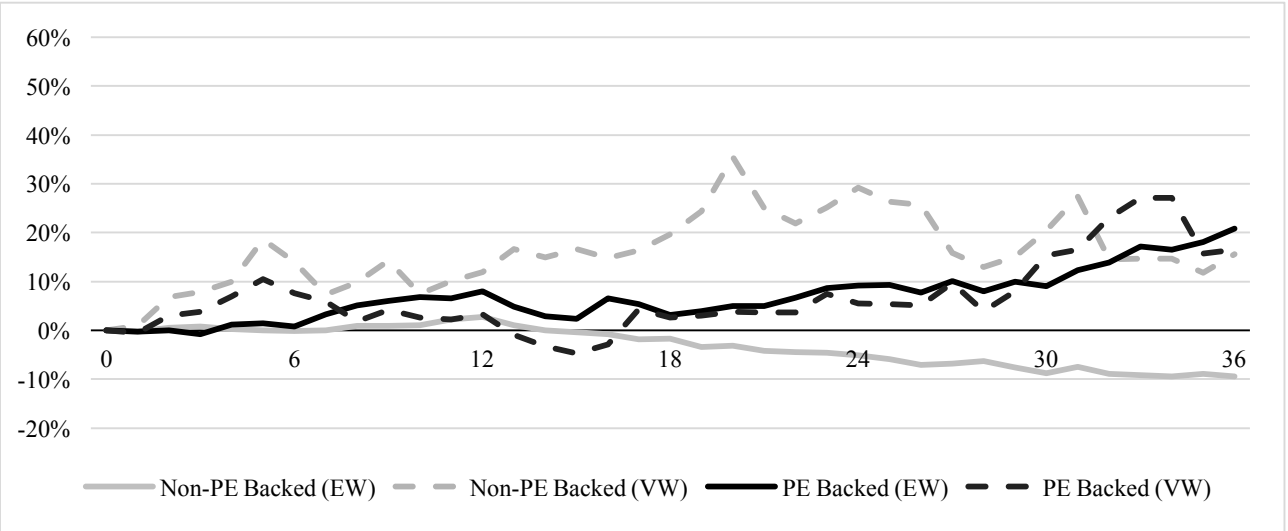


Figure 14 - BHAR vs. Industry Benchmark



An approach that could have been taken was to eliminate those two companies from the sample, but relatively large companies remained in the sample and the outcome would have been similar. While the value-weighted BHAR should not be disregarded, it is encouraged that the results presented on this front to be taken as complementary information. In this specific case, equally-weighted samples seem to present a better reflection of the aftermarket performance of IPOs in the given period. We are referring to Appendix 10 and Appendix 11 for the calculations for both parametric and non-parametric tests.

8.2.3.2 Calendar time

The calendar time approach in this study is used to analyze the unadjusted stock returns of the sample as means of mitigating the effect of cross-sectional correlation across companies. The methodology used in this subsection was previously described, and it can be broken down to a simple construction of monthly portfolios of returns as the basis of abnormality inferences. The portfolios are rebalanced each month, and includes all IPOs performed in the last 36 months at time unit (each month) between 2008 and 2015.

Table 21 provides a simple summary of the returns resulting from the construction of the given monthly portfolios. It describes the unadjusted returns, as well as abnormal returns (through the use of the European benchmark used throughout this paper). The whole sample, as well as both types of companies are presented to contextualize the situation of returns in a calendar time approach. One thing that becomes apparent from the table above is the great amounts of fluctuations over time. In particular, the periods preceding and succeeding the financial crisis show large levels of negative and positive returns, even when adjusted for by market developments. More specifically, it becomes apparent that the returns during 2008 (with the exception of VW PE-backed IPOs) are clearly negative for all companies in the sample. This can be attributed to negative impacts of financial and macroeconomic factors.

In terms of the existence of underperformance, when looking at whole sample mean and median, it becomes unclear what the evidence shows. While the mean and median abnormal returns of the single samples point towards a rejection of this hypothesis, e.g. the only sample that shows underperformance is EW non-PE-backed IPOs, the abnormal returns of whole sample calendar time returns are divided in equal parts of years showing underperformance in relation to the market.

When comparing PE-backed IPOs with non-PE-backed IPOs, it becomes apparent that the performance of PE-backed companies in calendar time shows better results in median, mean and overall year-to-year comparisons. Not only do unadjusted returns show significantly higher returns, the same applies to abnormal returns. While this could be attributed to the actual performance of PE-backed companies, it should be kept in mind that the sample of PE-backed IPOs is not large and it lacks in comparison to its non-PE-backed counterpart. In fact, some PE-backed monthly portfolios contained no returns. Therefore, the evidence provided in Table 21 should be taken with caution.

While it has been previously pointed out that weighing each month under equal terms might negatively reflect the real life occurrence of hot and cold periods, this study has been performed ignoring such circumstance. While it is clear that the period 2008-2010 is impacted by developments in the market as a whole, the authors of this paper decided to disregard possible adjustments to the monthly weights as they were deemed out of the scope of this thesis.

8.2.3.2.1 CAPM single factor regressions

The time-series regressions for all three types of samples was ran two times, first using equally-weighted returns and after using value-weighted returns. The number of observations differs between samples as there are two months without portfolio returns of PE-backed IPOs, while returns for all months are available in the non-PE-backed sample. The original regression output for both weighted samples are to presented in Appendix 11 – Calendar time CAPM regressions of abnormal returns.

Table 20 - Calendar time Capital Asset Pricing Model portfolio regressions of abnormal returns

		Value-weighted			*Equally-weighted*	
		p-value (t-statistics)	**R squared (R^2) (N)**		**p-value (t-statistics)**	**R squared (R^2) (N)**
Full sample of IPOs:						
Intercept, α_p	0.0054	0.2170	0.4729	0.009	0.8148	0.4599
		(1.2429)	(95)		(0.2348)	(95)
Mkt-Rf	0.7669*	1.38E-14		0.6339*	4.38E-14	
		(9.1352)			(8.8984)	
Non-PE backed IPOs:						
Intercept, α_p	0.0028	0.5465	0.4248	-0.0043	0.2252	0.4808
		(0.6052)	(95)		(-1.2208)	(95)
Mkt-Rf	0.7320*	8.47E-13		0.6349*	6.81E-15	
		(8.2875)			(9.2805)	
PE backed IPOs:						
Intercept, α_p	0.0513*	6.33E-13	0.0075	0.0219*	0.0049	0.1740
		(8.3766)	(93)		(2.8825)	(93)
Mkt-Rf	0.0986	0.4080		0.6425*	3.19E-05	
		(0.8312)			(4.3786)	

Note: P-values denoted by *, ** and *** are significant on the 1%, 5% and 10% level respectively.
The model underlying the CAPM regression is $R_{pt} - R_{ft} = \alpha_p + \beta_p(R_{Mkt} - R_{ft})$

Table 21 - Annual returns on calendar time portfolios, 2008-2015

	Unadjusted returns						Benchmark	Abnormal returns					
	Whole Sample		PE-Backed		Non-PE-backed			Whole Sample		PE-Backed		Non-PE-backed	
Year	Equally-Weighted IPOs	Value-Weighted IPOs	Equally-Weighted IPOs	Value-Weighted IPOs	Equally-Weighted IPOs	Value-Weighted IPOs	Stoxx 600	Equally-Weighted IPOs	Value-Weighted IPOs	Equally-Weighted IPOs	Value-Weighted IPOs	Equally-Weighted IPOs	Value-Weighted IPOs
2008	-59.2%	-40.4%	-58.0%	14.0%	-59.6%	-36.1%	-43.2%	-15.9%	2.8%	-14.8%	57.2%	-16.4%	7.2%
2009	47.1%	59.3%	64.1%	29.4%	42.4%	58.5%	26.0%	21.1%	33.2%	38.1%	3.4%	16.4%	32.5%
2010	15.5%	31.3%	40.4%	39.3%	9.8%	27.1%	7.9%	7.6%	23.4%	32.5%	31.4%	1.9%	19.2%
2011	-15.2%	-39.6%	10.3%	44.1%	-21.1%	-42.2%	-11.1%	-4.1%	-28.5%	21.4%	55.2%	-10.0%	-31.1%
2012	10.5%	16.2%	13.6%	44.4%	9.8%	7.7%	0.9%	9.6%	15.3%	12.7%	43.5%	8.9%	6.8%
2013	7.8%	21.7%	35.1%	85.1%	1.3%	12.3%	14.2%	-6.4%	7.5%	20.9%	71.0%	-12.9%	-1.9%
2014	14.2%	13.2%	113.7%	217.2%	-12.1%	8.3%	4.8%	9.5%	8.5%	108.9%	212.4%	-16.9%	3.5%
2015	0.6%	7.1%	-12.7%	6.5%	1.6%	5.5%	12.6%	-12.0%	-5.5%	-25.3%	-6.1%	-11.0%	-7.0%
% of negative returns	25%	25%	25%	0%	38%	25%	25%	50%	25%	25%	13%	63%	38%
Mean	2.7%	8.6%	25.8%	60.0%	-3.5%	5.1%	1.5%	1.2%	7.1%	24.3%	58.5%	-5.0%	3.6%
Median	9.1%	14.7%	24.3%	41.7%	1.4%	8.0%	6.3%	1.8%	8.0%	21.1%	49.3%	-10.5%	5.1%

The regressions show insignificant abnormal returns for the whole sample (insignificant alphas) in both equally-weighted and value-weighted terms, which can be interpreted as no long-term underperformance. Similarly, no significant abnormal returns were found for the two sets of non-PE-backed samples, which leads to the same conclusion as for the whole sample. What stands out from the results presented above, however, is that bothm equally-weighted and value-weighted abnormal returns of PE-backed companies showed significance with a high degree of reliability. The positive intercept was estimated to be 5.1% per month, or 184.7% over the whole 3-year period for value-weighted portfolios, while it was 2.2% and 78.84% respectively for equally-weighted portfolios. What this shows is that, while underperformance did not appear to be present in the given sample, PE-backed IPOs performed above all other samples. The absolute values of abnormal returns of PE-backed companies are also substantially higher than the estimated non-PE-backed abnormal returns.

While the interpretation above could lead to implications for the hypotheses set out in this sections, it is important to bear in mind two factors, the explanatory power of the regressions above and the sample sizes. The R^2 value is relatively low for both PE-samples. While the equally-weighted portfolio regressions have an explanatory power of 17%, the value-weighted model barely accounts for 0.75% of the models variation. Therefore, the results should be taken with extreme caution and put into context. The inability of the models to explain variation can be attributed to the sample size of PE-backed companies. Some monthly portfolios did contain an overall diminished amount of companies, which could have lead the model to test the returns of a single company, as opposed to an array of returns.

With relation to the beta coefficients, they are all significant except for the equally-weighted PE-backed sample. The beta ranges from 0.63-0.78. This can be interpreted as the returns to not be completely correlated to the market, which is a reasonable inference based on the situation of the stocks at hand (recent entry to capital markets).

8.2.3.2.2 Fama-French Three Factor Model regressions

The Fama-French asset pricing model introduces, as was set out previosuly, two factors to account for market anomalies that could potentially enhance the explanatory power of the model. The two factors accounting for so-called “size” and “value” qualities of portfolios are included. Consequently, the natural implication of including these factors would be an increase of R^2 values.

Table 22 presents the results of the regressions performed on the monthly unadjusted returns portfolios. The approach is identical to the one taken in the CAPM context, namely all three samples (whole sample, sample of non-PE-backed companies and sample of PE-backed companies) where analyzed for equally-weighted returns and value-weighted returns.

The results presented in the table paint a similar picture to what was identified in the CAPM regression model. Whole sample alphas are postive, but not significant, which can be interpreted as no existence of underperformance. On the other hand, this regression shows a significantly negative long-term performance of equally-weighted non-PE-backed IPOs (10% significance level). This is the main difference to the other model, as the Fama-French regressions also point towards a highly significant positive performance of PE-backed IPOs.

From a non-PE-backed IPOs point of view, equally-weighted portfolios resulted in an intercept of -0.5%, i.e a monthly negative return of 0.5% or -19.8% over a three-year period. On the other hand, value-weighted results showed no significant development. Thus, it can be inferred that under the context laid out above, non-PE-backed IPOs underperform when compared to the market.

In terms of PE-backed portfolios, both weigthing procedures shows singificant positive returns. Both samples are statistically significant, and show abnormal montly returns of 5.2% (185.8% over three years) and 2.2% (78.2% over three years) respectively. This is in line with what the previous regression model has shown.

As expected, the explanatory power of the model as a whole increased through the addition of the two other factors. Nevertheless, the complications in terms of PE-backed IPOs seem to still apply, even if to a lesser degree. The full sample, the sample of non-PE backed portfolios and the sample of PE-backed portfolios in equally-weighted termshave a R^2 of 0.70, 0.69 and 0.34 respectively. This is a significant increase of the explanatory power when compared to the CAPM model.

Table 22 – Calendar time Fama-French Three Factor Model portfolio regressions of abnormal returns

		Value-weighted			*Equally-weighted*	
		p-value (t-statistics)	**R squared (R^2) (N)**		**p-value (t-statistics)**	**R squared (R^2) (N)**
Full sample of IPOs:						
Intercept, α_p	0.0051	0.2161	0.5598	0.0002	0.9477	0.7012
		(1.2457)	(95)		(0.0658)	(95)
Mkt-Rf	0.8100*	9.5E-14		0.7102*	1.11E-18	
		(8.7713)			(11.1375)	
SMB	0.8473*	0.0001		1.2064*	1.41E-12	
		(3.9817)			(8.2097)	
HML	0.2320	0.1997		0.2671**	0.0339	
		(1.2918)			(2.1536)	
Non-PE backed IPOs:						
Intercept, α_p	0.0023	0.6007	0.4939	-0.0053***	0.0619	0.6980
		(0.5252)	(95)		(-1.8907)	(95)
Mkt-Rf	0.7827*	7.84E-12		0.7263*	1.45E-19	
		(7.8495)			(11.5670)	
SMB	0.7775**	0.0011		1.1438*	6.01E-12	
		(3.3837)			(7.9054)	
HML	0.1657	0.3950		0.1730	0.1599	
		(0.8546)			(1.4169)	
PE backed IPOs:						
Intercept, α_p	0.0516*	1.07E-12	0.0217	0.0217*	0.0023	0.3444
		(8.2955)	(93)		(3.1373)	(93)
Mkt-Rf	0.0855	0.5495		0.6242*	0.0002	
		(0.6009)			(3.9484)	
SMB	-0.3456	0.2887		1.4820*	8.43E-05	
		(-1.0673)			(4.1214)	
HML	-0.0988	0.7210		0.7224**	0.0205	
		(-0.3582)			(2.3592)	

Note: p-values denoted by *, ** and *** are significant on the 1%, 5% and 10% level respectively.
The equation is: $(R_{pt} - R_{ft}) = \alpha_p + \beta_{1p}(R_{Mkt} - R_{ft}) + \beta_{2p} * SMB + \beta_{3p} * HML + \varepsilon_{pt}$

The R^2 values of the other samples in the regressions point towards good explanatory power. While the alpha intercepts are in general insignificant, it should be noted that these models tend to show good responsiveness with regards to explanation of returns.

When focusing on beta values, all samples show positive exposures to the risk premium, with the exception of the value-weighted PE-backed sample. Furthermore, SMB and HML coefficients follow the same pattern. All SMB coefficients are significant, while HML coefficients are only significant at the 10% level for equally-weighted full sample and PE-backed sample regressions.

Focusing on only the equally-weighted portfolios, with the highest R^2 for the PE-backed sample, the model implies an abnormal three year long-run performance of the PE-backed IPOs. The three-year abnormal returns are of 78.1% against a -19.1% three-year abnormal long run underperformance of the non-PE backed IPOs.

The results presented above are in line with the results presented by Levis (2011), where the abnormal returns of the PE-backed IPOs are higher than their non-PE backed counterparts. Similary to the CAPM regression, an output for the Fama French regressions can be found in Appendix 12 – Calendar time Fama-French regressions of abnormal returns.

8.3 Part conclusion

This section set out to find evidence to test three main hypotheses: a possible difference in long-term performance between PE-backed IPOs and non-PE-backed IPOs, the importance of methodological approaches to find such differences (if any) and the presence of the phenomenon of underperformance in both samples of companies.

The overall conclusion of section 8 is mixed. While a set of results presented evidence to make significant inferences about the hypotheses, the evaluation of data as a whole is relatively unclear.

Event study methodology proved that there was a difference in returns of PE-backed companies and non-PE-backed companies, but the significance of the tests applied was mixed. On one hand, CAR returns presented significant results to prove that PE-backed companies have better performance in the long-run, specifically in the three-year post-IPO period, when compared to non-PE-backed companies. Oppositely, BHAR returns presented evidence that resembled the CAR data in magnitude, but significance did not validate this.

In terms of calendar time methodology, descriptive methodologies, as well as regressions based on asset-pricing models (CAPM, Fama-French), provided evidence of differences in performance across both samples. The most reliable information came from Fama-French regressions, where the explanatory power of the model provided a valid set of samples (i.e. relatively high levels of R^2). In Fama-French regressions, equally-weighted PE-backed samples presented positive performance from a time-linear point of view, while non-PE-backed samples presented underperformance.

One noteworthy element of the calendar time regressions was the low levels of explanatory power in terms of R^2 for the CAPM regressions, in particular for PE-backed IPOs. This can be attributed to the relatively small sample size.

Overall, value-weighted analyses of stocks presented somewhat unreliable results. In the event time methodology, BHAR value-weighted samples of non-PE-backed companies were highly impacted by the results of a couple of companies. In calendar time methodology, PE-backed samples showed low levels of R^2 which made the analyses on this front unreliable.

Based on the summary above, the hypotheses presented in 8.1.5 can be evaluated as follows: there seems to be a definite difference in performance between PE-backed IPOs and non-PE backed IPOs as the evidence in CAR (event time studies) and Fama-French regressions (calendar time studies) point out. Significant positive results of PE-backed IPOs over a three-year period after the flotation of shares were proved through parametric and non-parametric testing, and significant alpha values in Fama-French regressions respectively, which can be deemed as sufficent evidence.

H5 can therefore be accepted. There is a difference in long-term performance between PE-backed IPOs and non-PE-backed IPOs. Additionally, the foundation of the notion above, i.e. testing through calendar time and event time methodologies leads to acceptance of H6 also. The difference in performance was shown through both an event time and a calendar time approach.

Lastly, CARs and Fama-French regressions proved at reliable significance levels that underperformance is present in equal-weighted non-PE-backed samples. On the contraire, these same measures provided confirmation of the opposite development in PE-backed samples. Namely, PE-backed IPOs presente positive performance in the long-run. These leads to a two way conclusion with regards to H7. Underperformance is present in non-PE-backed samples, while PE-backed IPOs present positive stock performance (i.e. overperformance).

While the hypotheses testing above was fruitful in terms of acceptance and rejections, the conclusion should be taken with precaution. As the samples size of PE-backed IPOs could be a potential source of faulty results. Furthermore, value-weighted results delivered proof a possible bad model bias, and should be regarded in equal terms.

9 Discussion

This academic study set out to expand the theoretical knowledge on IPOs, as well as the role of PEs in capital markets, by means of two main areas of analyses. On one hand, a short-term approach was adopted with the focus of identifying underpricing. On the other hand, a long-term analysis with a focus on underperformance was applied.

At large, the analyses delivered significant results that were successful in testing the hypotheses, and thereby the problem statement of this master's thesis. Nevertheless, the choice of methods taken could have been a different one. Other academic literature has, for instance, set out to make causal-relationship analyses of IPOs, as well as the role of PEs, so as to find reasons for phenomena such as underpricing or underperformance. In these regards, multi-factor regression models were applied with the hopes of identifying factors that impact the development of stock prices in post-IPO markets.

With limitations of length at the center of reason, the authors of this text decided to disregard that string of methodological approaches to IPO research. While it was evaluated as an important analysis tool to make inferences about short-term and long-term developments of stocks, multi-factor regressions had to be left aside. The reason behind this was that the level of thoroughness needed to make significant and valid inferences about the samples used would not have fulfilled the level of quality levied on this academic study.

Furthermore, this thesis decided to give weight to an in-depth analysis of theoretical literature. Through the development of this study, it became apparent that a large set of past academic literature presented mixed results, or a lack of consensus with regards to patterns in IPO performance. In particular, the role of private equity firms was assessed through multiple approaches with no clearly generalizable factors identified.

On these grounds, it was assessed that a thorough contextualization of the theoretical plane with regards to IPOs and PEs was necessary. This method pragmated the overall writing process of the text, and became the foundation of all empirical analyses. While other studies

focus largely on the empirical field of knowledge, the authors of this thesis adopted a methodology where an ideal balance of theory and empiricism could be struck.

This master's thesis approached the examination of private equities and IPOs in the most thorough manner possible, while upkeeping a high level of quality. Nevertheless, all studies are bound by scope and time frame, and can therefore not reach all lines of research possible. Because of this, the authors would like to recommend a set of lines of questioning that future literature could look into. This could be in the form of an extension of this study, or as the foundation of a different field of study all together.

To what extensions of this thesis pertains, future literature could expand the findings presented by applying the multi-factor regression models mentioned above. For instance, the categorization used on the samples could be used as the basis for the identification of relevant factors impacting short- and long-term performance of stocks. In this regard, PE-specific variables could be adopted in order to find out which factors make PE-backed companies differ from non-PE-backed ones in the long run. Another alternative would be to find the origin behind the influence of PEs in IPOs in particular, e.g. role of management or operational factors.

On the side of the expansion into new fields of research, the specific effect of the 2008 financial crisis could be a highly relevant area to research, especially in light of the evidence provided in this study. It became clear that the crisis had an effect on underpricing, in addition to initiating a cold period. The concrete impact factors of this period is something the authors of this thesis would urge researchers to expand on in future studies.

10 Conclusion

The central issue at the heart of this paper was to identify the role of PEs in capital markets. The focus was to find in quantitative terms how big of a role such companies play through the analysis of IPOs. By means of a study on short-term and long-term performance of PE-backed and non-PE-backed IPOs, the authors of this thesis attempted to find factors pointing out the significance of PE-firms. In particular, the role of such entities in a Northern and Western European was emphasised. Additionally, the effort was to update the academic literature by analyzing the most recent available information.

PEs are prestigious entities with the capacity of overturning firms through above par operational and managerial capacities. As such, they are regarded as a signal to capital markets of stability and a guarantee of high quality performance. Because of this, it was researched whether such factors play a role when these companies decide to exit their investments through IPOs. This was performed through a short-term and a long-term perspective.

The methodological approach applied in this study covered the most relevant approaches used in prior academic literature. Furthermore, a thorough presentaiton of theoretical literature provided a solid basis to understand the context of IPOs and PEs, as well as the factors impacting them in the short- and long-term

In the short-run, the evidence showed that PE companies did not perform above non-PE-backed companies. The data provided proof that there is not substantial difference between the two set of companies. While the phenomenon of underpricing was confirmed for the time frame chosen, PE firms did not appear to have a significant impact on the initial impresison of the markets.

In the long-run, the data gathered provided reliable indications of the significance of PE firms. In a time span of one to three years post-flotation, PE-backed companies presented an overall better performance than their non-PE counterparts. In fact, the returns of non-PE-backed companies yielded in underperformance when compared to the market. This is in line with past theoretical and empirical literature on the subject.

In the given time frame, based on all evidence considered, it can be said that PE firms do not appear to have had an impact in Northern and Western European markets in the short-run. On the other hand, the role of such entities proved to be vital in the long-run.

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12 Appendix

Appendix 1 – Overview of sample

USB attached with full data set and calculations

PE-backed sample:

Company	Offer Price	IPO date	Industry	Stock Exchange	ISIN	Bloom ticker
Ig Group Holdings	120	28-04-2005	Financials	London	GB00B06QFB75	IGG LN Equity
Galapagos	7	06-05-2005	Health Care	Amsterdam	BE0003818359	GLPG NA Equity
Micro Focus International	130	12-05-2005	Technology	London	GB00BQY7BX88	MCRO LN Equity
Meilleurtaux	13.7	23-05-2005	Industrials	Paris	FR0010187096	MEX FP Equity
Mtu Aero Engines Holding	21	06-06-2005	Industrials	Frankfurt	DE000A0D9PT0	MTX GR Equity
Prostrakan Group	100	14-06-2005	Health Care	London	GB00B09STF21	PSK LN Equity
Inmarsat	245	17-06-2005	Telecommunications	London	GB00B09LSH68	ISAT LN Equity
Saft	26	30-06-2005	Industrials	Paris	FR0010208165	SAFT FP Equity
Entrepose Contracting	23	01-07-2005	Oil & Gas	Paris	FR0010204321	ENTC FP Equity
Ersol Solar Energy	42	30-09-2005	Technology	Frankfurt	DE0006627532	ES6 GR Equity
Petrofac	215	04-10-2005	Oil & Gas	London	GB00B0H2K534	PFC LN Equity
Q-Cells	38	05-10-2005	Oil & Gas	Frankfurt	DE0005558662	QCE GR Equity
NextRadioTv	19	07-10-2005	Consumer Services	Paris	FR0010240994	NXTV FP Equity
Telenet Group Holding	21	11-10-2005	Consumer Services	Brussels	BE0003826436	TNET BB Equity
Jerini	3.2	01-11-2005	Health Care	Frankfurt	DE0006787476	JI4 GR Equity
Thielert	13.5	17-11-2005	Industrials	Frankfurt	DE0006052079	T3C GR Equity
Zetes Industries	23	22-11-2005	Technology	Brussels	BE0003827442	ZTS BB Equity
Eutelsat Communication	12	02-12-2005	Consumer Services	Paris	FR0010221234	ETL FP Equity
Ipsen	22.2	07-12-2005	Health Care	Paris	FR0010259150	IPN FP Equity
Bioalliance Pharma	13.3	08-12-2005	Health Care	Paris	FR0010095596	ONXEO FP Equity
Store Electronics	15.5	03-02-2006	Industrials	Paris	FR0010282822	SESL FP Equity
KappAhl Holdings	56	23-02-2006	Consumer Services	Stockholm	SE0001630880	KAHL SS Equity
Magix	16.4	06-04-2006	Technology	Frankfurt	DE0007220782	MGX GR Equity
Saf	17.6	06-04-2006	Technology	Frankfurt	CH0024848738	S4X GR Equity
Legrand	19.8	07-04-2006	Industrials	Paris	FR0010307819	LR FP Equity
Modelabs	9.6	07-04-2006	Technology	Paris	FR0010060665	MDL FP Equity
Debenhams	195	04-05-2006	Consumer Services	London	GB00B126KH97	DEB LN Equity
Schmack Biogas	31	24-05-2006	Oil & Gas	Frankfurt	DE000SBGS111	SB1 GR Equity
Demag Cranes	22	23-06-2006	Industrials	Frankfurt	DE000DCAG010	D9C GR Equity
Klöckner & Co. AG	16	28-06-2006	Basic Materials	Frankfurt	DE000KC01000	KCO GR Equity
Ability Group	47	03-07-2006	Oil & Gas	Oslo	NO0010277171	AGR NO Equity
Sothern Cross Healthcare Group	225	07-07-2006	Health Care	London	GB00B14RYC39	SCHE LN Equity
Aleo Solar	13.5	14-07-2006	Oil & Gas	Frankfurt	DE000A0JM634	AS1 GR Equity
Biovitrum	100	15-09-2006	Health Care	Stockholm	SE0000872095	SOBI SS Equity
Hogg Robinson Group	90	09-10-2006	Industrials	London	GB00B1CM8S45	HRG LN Equity
Gagfah	19	19-10-2006	Financials	Frankfurt	LU0269583422	GFJ GR Equity
LHS	8	25-10-2006	Technology	Frankfurt	DE000LHS4000	LHS GR Equity
Delticom	36	26-10-2006	Consumer Goods	Frankfurt	DE0005146807	DEX GR Equity
Eitzen Chemical ASA	28	02-11-2006	Industrials	Oslo	NO0010729841	ECHEM NO Equity
Wilex	13.8	13-11-2006	Health Care	Frankfurt	DE000A11QVV0	WL6 GR Equity
Francotyp-Postalia Holdings	19	30-11-2006	Industrials	Frankfurt	DE000FPH9000	FPH GR Equity

Company	Offer Price	IPO date	Industry	Stock Exchange	ISIN	Bloom ticker
Lindab International	110	01-12-2006	Industrials	Stockholm	SE0001852419	LIAB SS Equity
Seloger	22.5	01-12-2006	Consumer Services	Paris	FR0010294595	SLG FP Equity
Safestore Holding	240	09-03-2007	Financials	London	GB00B1N7Z094	SAFE LN Equity
Outremer Telecom	17	14-03-2007	Telecommunications	Paris	FR0010425587	OMT FP Equity
Adenclassified	35	22-03-2007	Consumer Services	Paris	FR0004053932	ADEN FP Equity
Electromagnetic Geoservices	135	30-03-2007	Oil & Gas	Oslo	NO0010358484	EMGS NO Equity
Suomen Terveystalo	2.16	03-04-2007	Health Care	Helsinki	FI0009012413	SUT1V FH Equity
Metabolic Explorer	8.4	11-04-2007	Basic Materials	Paris	FR0004177046	METEX FP Equity
Versatel	29	27-04-2007	Technology	Frankfurt	DE000A0M2ZK2	VTW GR Equity
Wacker Construction Equipment	22	15-05-2007	Industrials	Frankfurt	DE000WACK012	WAC GR Equity
Nederman	87	16-05-2007	Industrials	Stockholm	SE0002000083	NMAN SS Equity
Aerocrine	25	15-06-2007	Health Care	Stockholm	SE0000434292	AEROB SS Equity
Vtg	18	28-06-2007	Industrials	Frankfurt	DE000VTG9999	VT9 GR Equity
Tognum	24	02-07-2007	Industrials	Frankfurt	DE000A0N4P43	TGM GR Equity
Superglass Holding	180	12-07-2007	Industrials	London	GB00B7VSCQ18	SPGH LN Equity
Homag	31	13-07-2007	Industrials	Frankfurt	DE0005297204	HG1 GR Equity
Saf-Holland S.A.	19	26-07-2007	Consumer Goods	Frankfurt	LU0307018795	SFQ GR Equity
Bureau Veritas	37.8	24-10-2007	Industrials	Paris	FR0006174348	BVI FP Equity
Telecity	220	24-10-2007	Technology	London	GB00B282YM11	TCY LN Equity
Abl Ynx	7	07-11-2007	Health Care	Brussels	BE0003877942	ABLX BB Equity
Duni Ab	50	14-11-2007	Consumer Goods	Stockholm	SE0000616716	DUNI SS Equity
Cadogan Petroleum	230	18-06-2008	Oil & Gas	London	GB00B12WC938	CAD LN Equity
Medica	13	10-02-2010	Health Care	Paris	FR0010372581	MDCA FP Equity
Kabel Deutschland Holding AG	22	22-03-2010	Consumer Services	Frankfurt	DE000KD88880	KD8 GR Equity
CHR Hansen Holding	90	03-06-2010	Health Care	Copenhagen	DK0060227585	CHR DC Equity
Jupiter Fund Management Plc	165	16-06-2010	Financials	London	GB00B53P2009	JUP LN Equity
Ströer Out-of-Home Media AG	20	15-07-2010	Consumer Services	Frankfurt	DE0007493991	SAX GR Equity
Novagali Pharma	3.4	22-07-2010	Health Care	Paris	FR0010915553	NOVA FP Equity
Pandora	210	05-10-2010	Consumer Goods	Copenhagen	DK0060252690	PNDORA DC Equity
Stentys	12	25-10-2010	Health Care	Paris	FR0010949404	STNT FP Equity
AZ Electronic Materials SA	240	29-10-2010	Basic Materials	London	LU0552383324	AZEM LN Equity
Wellstream Holding	320	14-02-2011	Oil & Gas	London	GB00B1VWM162	WSM LN Equity
FinnvedenBulten	49	20-05-2011	Consumer Goods	Stockholm	SE0003849223	BULTEN SS Equity
Adler Modermärkte	10	22-06-2011	Consumer Services	Frankfurt	DE000A1H8MU2	ADD GR Equity
Eos Imaging	6.87	16-02-2012	Health Care	Paris	FR0011191766	EOSI FP Equity
Adocia	15.9	20-02-2012	Health Care	Paris	FR0011184241	ADOC FP Equity
Ziggo	18.5	21-03-2012	Telecommunications	Amsterdam	NL0006294290	ZIGGO NA Equity
Dbv Technologies	8.86	29-03-2012	Health Care	Paris	FR0010417345	DBV FP Equity
Id Logistics	21	18-04-2012	Industrials	Paris	FR0010929125	IDL FP Equity
Nanobiotix	6	29-10-2012	Health Care	Paris	FR0011341205	NANO FP Equity

Non-PE-backed sample:

Company	Offer Price	IPO date	Industry	Stock Exchange	ISIN	Bloom ticker
Cafom	13.5	27-01-2005	Consumer Services	Paris	FR0010151589	CAFO FP Equity
Carter & Carter Group	235	02-02-2005	Industrials	London	GB00B05K7697	CART LN Equity
Paion	8	11-02-2005	Health Care	Frankfurt	DE000A0B65S3	PA8 GR Equity
Ardana	128	09-03-2005	Health Care	London	GB00B065JS90	ARA LN Equity
Premiere	28	09-03-2005	Consumer Services	Frankfurt	DE000SKYD000	SKYD GR Equity
Conergy	54	17-03-2005	Oil & Gas	Frankfurt	DE000A1KRCK4	CGYK GR Equity
RHJ International	19.3	24-03-2005	Financials	Brussels	BE0003815322	BHFKB BB Equity
Sanef	40	24-03-2005	Industrials	Paris	FR0004151561	SNF FP Equity
Akka Technologies	24.8	15-04-2005	Industrials	Paris	FR0004180537	AKA FP Equity
Foseco	100	12-05-2005	Industrials	London	GB00B0784Q08	FOSE LN Equity
Poncin Yachts	9.8	18-05-2005	Consumer Goods	Paris	FR0010193052	CATG FP Equity
Tom Tom	17.5	27-05-2005	Technology	Amsterdam	NL0000387058	TOM2 NA Equity
Agcert International	140	03-06-2005	Industrials	London	IE00B0764647	AGC LN Equity
Devgen	7.5	07-06-2005	Health Care	Brussels	BE0003821387	DEVG BB Equity
Mapeley	2300	16-06-2005	Financials	London	GB00B0BHCR03	MAY LN Equity
Elia	26.5	20-06-2005	Utilities	Brussels	BE0003822393	ELI BB Equity
Z Group	108	21-06-2005	Industrials	London	GB00B09LQS34	SPA LN Equity
Partygaming	116	27-06-2005	Consumer Services	London	GI000A0MV757	BPTY LN Equity
Gaz de France	23.2	08-07-2005	Utilities	Paris	FR0010208488	ENGI FP Equity
Gpe Groupe Pizzorno	30	14-07-2005	Industrials	Paris	FR0010214064	GPE FP Equity
Rhm	275	19-07-2005	Consumer Goods	London	GB00B09Z0V67	3014039Q LN Equity
Land of Leather Holdings	149	21-07-2005	Consumer Goods	London	GB00B39TSN74	LAN LN Equity
888 Holdings	175	29-09-2005	Consumer Services	London	GI000A0F6407	888 LN Equity
Rue du Commerce	15.6	30-09-2005	Consumer Services	Paris	FR0004053338	RDC FP Equity
Hci Capital	20.5	06-10-2005	Financials	Frankfurt	DE000A161077	HXCK GR Equity
Kazakhmys	540	07-10-2005	Basic Materials	London	GB00B0HZPV38	KAZ LN Equity
Mercialys	18.1	12-10-2005	Financials	Paris	FR0010241638	MERY FP Equity
Tipp24	20.5	12-10-2005	Consumer Services	Frankfurt	GB00BHD66J44	TIM GR Equity
Meetic	22.3	13-10-2005	Consumer Services	Paris	FR0004063097	MEET FP Equity
Lloyds Fonds	16	28-10-2005	Financials	Frankfurt	DE000A12UP29	L1OA GR Equity
Hikma Pharmaceuticals	290	01-11-2005	Health Care	London	GB00B0LCW083	HIK LN Equity
Gondola Hlds	320	03-11-2005	Consumer Services	London	GB00B0LS7T03	GND LN Equity
Sthree	200	11-11-2005	Industrials	London	GB00B0KM9T71	STHR LN Equity
EDF	32	21-11-2005	Utilities	Paris	FR0010242511	EDF FP Equity
Endemol	9	22-11-2005	Consumer Services	Amsterdam	NL0000345692	EML NA Equity
Praktiker Bau & Heimwerkermärkte	14.5	22-11-2005	Consumer Services	Frankfurt	DE000A0F6MD5	PRA GR Equity
Finanzhaus Rothmann	1.55	23-11-2005	Financials	Frankfurt	DE000HNC2034	RTMK GR Equity
Britvic	230	09-12-2005	Consumer Goods	London	GB00B0N8QD54	BVIC LN Equity
Vectrane	14	14-12-2005	Financials	Paris	FR0010262287	VEC FP Equity
Paref	71.5	22-12-2005	Financials	Paris	FR0010263202	PAR FP Equity
KapitalPleje	100	08-02-2006	Financials	Copenhagen	DK0060020485	KAP DC Equity
Optos	250	10-02-2006	Health Care	London	GB00B0WHW246	OPTS LN Equity
Qinetiq Group	200	10-02-2006	Industrials	London	GB00B0WMWD03	QQ/ LN Equity

Company	Offer Price	IPO date	Industry	Stock Exchange	ISIN	Bloom ticker
cBrain	5	22-02-2006	Technology	Copenhagen	DK0060030286	CBRAIN DC Equity
Captura	9.1	27-02-2006	Technology	Oslo	NO0010305089	CAPTU NO Equity
Rightmove	335	10-03-2006	Consumer Services	London	GB00B0MFTM73	RMV LN Equity
Salcomp	3.2	13-03-2006	Technology	Helsinki	FI0009013924	SAL1V FH Equity
Ahlstrom	22	14-03-2006	Basic Materials	Helsinki	FI0009010391	AHL1V FH Equity
Scott Wilson Group	158	15-03-2006	Industrials	London	GB00B0WM2V87	SWG LN Equity
Block Watne Gruppen	33	17-03-2006	Consumer Goods	Oslo	NO0010298300	BWG NO Equity
Zublin Immobiliere	13.7	22-03-2006	Financials	Paris	FR0010298901	ZIF FP Equity
Paris Idf	113	27-03-2006	Financials	Paris	FR0010304329	FPF FP Equity
Gant Company	141	28-03-2006	Consumer Goods	Stockholm	SE0001664210	GANT SS Equity
Amboise Absa	12.2	29-03-2006	Financials	Paris	FR0010307348	AMB FP Equity
Cegereal	31.8	29-03-2006	Financials	Paris	FR0010309096	CGR FP Equity
Patrizia Immobilien	18.5	31-03-2006	Financials	Frankfurt	DE000PAT1AG3	P1Z GR Equity
Goldenport Holdings	235	03-04-2006	Industrials	London	MHY274991394	GPRT LN Equity
Renovo Group	87	07-04-2006	Financials	London	GB00B081NX89	INSC LN Equity
Wacker Chemie	80	10-04-2006	Basic Materials	Frankfurt	DE000WCH8881	WCH GR Equity
Icade	27.9	12-04-2006	Financials	Paris	FR0010308841	ICA FP Equity
FIM Group	5.75	13-04-2006	Financials	Helsinki	FI0009013593	FIM1V FH Equity
Dolphin Interconnect Solutions	17.5	20-04-2006	Technology	Oslo	NO0010170921	DOLP NO Equity
C.A.T. Oil	15	04-05-2006	Oil & Gas	Frankfurt	AT0000A00Y78	O2C GR Equity
Renewable Energy Corporation	95	09-05-2006	Oil & Gas	Oslo	NO0010112675	REC NO Equity
Viscom	18.5	10-05-2006	Industrials	Frankfurt	DE0007846867	V6C GR Equity
Air Berlin	12	11-05-2006	Consumer Services	Frankfurt	GB00B128C026	AB1 GR Equity
Sns Reaal	17	18-05-2006	Financials	Amsterdam	NL0000390706	SR NA Equity
Diös Fastigheter	31	22-05-2006	Financials	Stockholm	SE0001634262	DIOS SS Equity
Curalogic	75	01-06-2006	Health Care	Copenhagen	DK0060040756	CUR DC Equity
Le Noble Age	10	07-06-2006	Health Care	Paris	FR0004170017	LNA FP Equity
Adp	44	16-06-2006	Industrials	Paris	FR0010340141	ADP FP Equity
Clinphone	148	23-06-2006	Technology	London	GB00B0ZL4M73	CNP LN Equity
Parrot	23.5	28-06-2006	Technology	Paris	FR0004038263	PARRO FP Equity
Puricore	66	30-06-2006	Health Care	London	GB00B3XBCR18	PURI LN Equity
Teekay Petrojarl	43	30-06-2006	Oil & Gas	Oslo	NO0010309560	TPO NO Equity
Bauer	16.8	04-07-2006	Industrials	Frankfurt	DE0005168108	B5A GR Equity
Trolltech	16	05-07-2006	Technology	Oslo	NO0010317647	TROLL NO Equity
Clavis Pharma	45.5	07-07-2006	Health Care	Oslo	NO0010308240	WEIFA NO Equity
Thrombogenics	4.5	07-07-2006	Health Care	Brussels	BE0003846632	THR BB Equity
Standard Life	230	10-07-2006	Financials	London	GB00BVFD7Q58	SL/ LN Equity
EmQtec	6.1	14-07-2006	Industrials	Frankfurt	DE000A0JL529	EMQ GR Equity
Smartrac	17	20-07-2006	Technology	Frankfurt	NL0000186633	SM7 GR Equity
OVB Holdings	21	21-07-2006	Financials	Frankfurt	DE0006286560	O4B GR Equity
ItN Nanovation	20	28-07-2006	Basic Materials	Frankfurt	DE000A0JL461	I7N GR Equity
Tesfran	20	28-07-2006	Financials	Paris	FR0010358812	TEF FP Equity
Napo Pharmaceuticals	83	31-07-2006	Health Care	London	USU629901039	NAPL LN Equity
Melker Schörling	93.2	05-09-2006	Financials	Stockholm	SE0001785270	MELK SS Equity
Crop Energies	8	29-09-2006	Oil & Gas	Frankfurt	DE000A0LAUP1	CE2 GR Equity
GWB Immobilier	12.5	04-10-2006	Financials	Frankfurt	DE000A0JKHG0	G7B GR Equity
Experian Group	560	09-10-2006	Industrials	London	GB00B19NLV48	EXPN LN Equity
Selectirente	38.5	09-10-2006	Financials	Paris	FR0004175842	SELER FP Equity
Outokumpu Technology	12.5	10-10-2006	Industrials	Helsinki	FI0009014575	OTE1V FH Equity
P/F Atlantic Petroleum	550	11-10-2006	Oil & Gas	Copenhagen	FO000A0DN9X4	ATLA DC Equity
Ashmore Group	170	12-10-2006	Financials	London	GB00B132NW22	ASHM LN Equity
Marine Farms	14	12-10-2006	Consumer Goods	Oslo	NO0010049059	MAFA NO Equity

Company	Offer Price	IPO date	Industry	Stock Exchange	ISIN	Bloom ticker
Verbio Vereinigte BioEnergie	14.5	16-10-2006	Oil & Gas	Frankfurt	DE000A0JL9W6	VBK GR Equity
Codfarmers	26	19-10-2006	Consumer Goods	Oslo	NO0010160484	COD NO Equity
Dunelm Group	170	19-10-2006	Consumer Services	London	GB00B1CKQ739	DNLM LN Equity
Hotel.de	21.5	20-10-2006	Consumer Services	Frankfurt	DE0006910938	HTL GR Equity
Neuf Cegetel	22.1	25-10-2006	Telecommunications	Paris	FR0004166072	NEUF FP Equity
Plaza Centers	180	27-10-2006	Financials	London	NL0000686772	PLAZ LN Equity
HAHN	10	30-10-2006	Financials	Frankfurt	DE0006006703	H4I GR Equity
Innate Pharma	4.5	01-11-2006	Health Care	Paris	FR0010331421	IPH FP Equity
Hochschild Mining	350	03-11-2006	Basic Materials	London	GB00B1FW5029	HOC LN Equity
Petrotec	17	06-11-2006	Oil & Gas	Frankfurt	DE000PET1111	PT8 GR Equity
Styles & Wood Group	150	07-11-2006	Industrials	London	GB00BLG2TG58	STY LN Equity
LifeCycle Pharma	44	13-11-2006	Health Care	Copenhagen	DK0060048148	VELO DC Equity
Norweigan Property	53.5	15-11-2006	Financials	Oslo	NO0010317811	NPRO NO Equity
LNC	21	16-11-2006	Consumer Goods	Paris	FR0004023208	LNC FP Equity
Lsl Property Services	203	16-11-2006	Financials	London	GB00B1G5HX72	LSL LN Equity
Bluebay Asset Management	300	17-11-2006	Financials	London	GB00B1G52761	BBAY LN Equity
Veto	21	17-11-2006	Health Care	Paris	FR0004186856	VETO FP Equity
BE Group	62	24-11-2006	Basic Materials	Stockholm	SE0001852211	BEGR SS Equity
Korian	34.5	24-11-2006	Health Care	Paris	FR0010386334	KORI FP Equity
Rezidor Hotel Group	52	28-11-2006	Consumer Services	Stockholm	SE0001857533	REZT SS Equity
EDF Energies	28	29-11-2006	Utilities	Paris	FR0010400143	EEN FP Equity
Punch Telematix	13	29-11-2006	Industrials	Brussels	BE0003855724	PTX BB Equity
Salamander Energy	250	30-11-2006	Oil & Gas	London	GB00B1GC5238	SMDR LN Equity
Griffin III Berlin	2	01-12-2006	Financials	Copenhagen	DK0060052843	ADMCAPB DC Equity
SKW Staihl-Metallurgie Holdings	29	01-12-2006	Basic Materials	Frankfurt	DE000SKWM021	SK1A GR Equity
Sparekassen Himmerland	250	01-12-2006	Financials	Copenhagen	DK0060050045	JUTBK DC Equity
Rovsing	10.7	05-12-2006	Industrials	Copenhagen	DK0060400398	ROV DC Equity
Open Business Club	30	07-12-2006	Technology	Frankfurt	DE000XNG8888	O1BC GR Equity
Faktor Eiendom	35	08-12-2006	Financials	Oslo	NO0010340391	FAKTOR NO Equity
Fonciere Inea	40	08-12-2006	Financials	Paris	FR0010341032	INEA FP Equity
Klemurs	20	08-12-2006	Financials	Paris	FR0010404780	KMU FP Equity
First Farms	105	12-12-2006	Consumer Goods	Copenhagen	DK0060056166	FFARMS DC Equity
LinkMed	70	12-12-2006	Health Care	Stockholm	SE0000619181	ALNX SS Equity
Metris	12	12-12-2006	Technology	Brussels	BE0003859767	MTRS BB Equity
Spits	16	12-12-2006	Consumer Services	Oslo	NO0010340003	SPITS NO Equity
Hansard Global	260	13-12-2006	Financials	London	IM00B1H1XF89	HSD LN Equity
Tilgin	25	15-12-2006	Technology	Stockholm	SE0001131269	TILG SS Equity
ChemoMetec	8.35	18-12-2006	Health Care	Copenhagen	DK0060055861	CHEMM DC Equity
Groupe Vial	23.9	18-12-2006	Industrials	Paris	FR0010340406	VIA FP Equity
Comendo	7.5	20-12-2006	Technology	Copenhagen	DK0060055515	CPHNW DC Equity
Terreis	8.88	22-12-2006	Financials	Paris	FR0010407049	TER FP Equity
OL Groupe	24	09-02-2007	Consumer Services	Paris	FR0010428771	OLG FP Equity
Ariston Real Estate	7.5	14-02-2007	Financials	Frankfurt	DE000A0F5XM5	A3E GR Equity
Gem Diamonds	950	14-02-2007	Basic Materials	London	VGG379591065	GEMD LN Equity
Sports Direct Intl	300	27-02-2007	Consumer Services	London	GB00B1QH8P22	SPD LN Equity
Kromi Logistik	20	08-03-2007	Industrials	Frankfurt	DE000A0KFUJ5	K1R GR Equity
Hanseyachts	33	09-03-2007	Financials	Frankfurt	GB00B1VZ0M25	H9Y GR Equity
Polis Immobilien	14.5	21-03-2007	Financials	Frankfurt	DE0006913304	PQL GR Equity
Tigenix Wi	5	22-03-2007	Health Care	Brussels	BE0003864817	TIG BB Equity
Algeta	47	27-03-2007	Health Care	Oslo	NO0010239437	ALGETA NO Equity
Vita 34 International	15	27-03-2007	Health Care	Frankfurt	DE000A0BL849	V3V GR Equity
Dreamnex	35	02-04-2007	Technology	Paris	FR0010436584	DNX FP Equity

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Estavis	28	02-04-2007	Financials	Frankfurt	DE000A0KFKB3	E7S GR Equity
Aseana Properties	1	05-04-2007	Financials	London	JE00B1RZDJ41	ASPL LN Equity
Smt Scharf	9.5	11-04-2007	Industrials	Frankfurt	DE0005751986	S4A GR Equity
Xchanging	240	25-04-2007	Industrials	London	GB00B1VK7X76	XCH LN Equity
Cineworld	170	27-04-2007	Consumer Services	London	GB00B15FWH70	CINE LN Equity
Salmar	39	08-05-2007	Consumer Goods	Oslo	NO0010310956	SALM NO Equity
Hargreaves Lansdown	160	15-05-2007	Financials	London	GB00B1VZ0M25	HL/ LN Equity
Alfacam	15.8	16-05-2007	Consumer Services	Brussels	BE0003868859	ALFA BB Equity
Hilton Food	150	17-05-2007	Consumer Goods	London	GB00B1V9NW54	HFG LN Equity
Exiqon	40	29-05-2007	Health Care	Copenhagen	DK0060077758	EXQ DC Equity
Talvivara Mining	250	30-05-2007	Basic Materials	Helsinki	FI0009014716	TALV LN Equity
Pv Crystalox Solar	130	06-06-2007	Oil & Gas	London	GB00BFTDG626	PVCS LN Equity
Eaga	181	07-06-2007	Utilities	London	GB00B1P75854	EAGA LN Equity
Nordic Tankers	85	12-06-2007	Oil & Gas	Copenhagen	DK0060083996	NORDIC DC Equity
Srv	9	12-06-2007	Industrials	Helsinki	FI0009015309	SRV1V FH Equity
Transics	17.5	13-06-2007	Technology	Brussels	BE0003869865	TRAN BB Equity
Ferrexpo	140	15-06-2007	Basic Materials	London	GB00B1XH2C03	FXPO LN Equity
Invision Software	32	18-06-2007	Technology	Frankfurt	DE0005859698	IVX GR Equity
Amt Holding	10	20-06-2007	Health Care	Amsterdam	NL0000886968	AMT NA Equity
Føroya Banki	189	21-06-2007	Financials	Copenhagen	FO0000000088	BNORDIK DC Equity
Banimmo	21	26-06-2007	Financials	Brussels	BE0003870871	BANI BB Equity
Vivalis	10.5	29-06-2007	Health Care	Paris	FR0004056851	VLA FP Equity
Europacorp	15.5	06-07-2007	Consumer Services	Paris	FR0010490920	ECP FP Equity
Zhongde Waste Technology	26	06-07-2007	Industrials	Frankfurt	DE000ZDWT018	ZEF GR Equity
Envitec Biogas	47	12-07-2007	Industrials	Frankfurt	DE000A0MVLS8	ETG GR Equity
Paris Re	19.4	13-07-2007	Financials	Paris	CH0032057447	PRI FP Equity
Moneysupermarket.com	170	26-07-2007	Consumer Services	London	GB00B1ZBKY84	MONY LN Equity
Sepura	145	31-07-2007	Technology	London	GB00B1ZBLD47	SEPU LN Equity
Symphony International Holding	1	31-07-2007	Financials	London	VGG548121059	SIHL LN Equity
Pronova Biopharma	23	11-10-2007	Health Care	Oslo	NO0010382021	PRON NO Equity
Centrotherm Photovaltaics	34.5	12-10-2007	Oil & Gas	Frankfurt	DE000A1TNMM9	CTNK GR Equity
Systemair	78	12-10-2007	Industrials	Stockholm	SE0002133975	SYSR SS Equity
Sparekassen Lolland	250	15-10-2007	Financials	Copenhagen	DK0060090777	SPALOL DC Equity
Hms Networks	74	19-10-2007	Technology	Stockholm	SE0002136242	HMS SS Equity
Nyrstar	20	29-10-2007	Basic Materials	Brussels	BE0003876936	NYR BB Equity
Nøtterø Sparebank	110	29-10-2007	Financials	Oslo	NO0010391295	NTSG NO Equity
Hamburger Hafen und Logistik	53	02-11-2007	Industrials	Frankfurt	DE000A0S8488	HHFA GR Equity
Central Rand Gold	125	08-11-2007	Basic Materials	London	GG00B92NXM24	CRND LN Equity
Erria	90	08-11-2007	Industrials	Copenhagen	DK0060101483	ERRI DC Equity
East Capital Explorer	100	09-11-2007	Financials	Stockholm	SE0002158568	ECEX SS Equity
Asian Bamboo	17	16-11-2007	Basic Materials	Frankfurt	DE000A0M6M79	5AB GR Equity
Mevis Medical Solutions	55	16-11-2007	Technology	Frankfurt	DE000A0LBFE4	M3V GR Equity
Sparekassen Hvetbo	200	23-11-2007	Financials	Copenhagen	DK0060100592	HVETBO DC Equity
Record	160	28-11-2007	Financials	London	GB00B28ZPS36	REC LN Equity
Eurasian Natural Resources Corp.	540	07-12-2007	Basic Materials	London	GB00B29BCK10	ENRC LN Equity
Vgp	15.3	07-12-2007	Financials	Brussels	BE0003878957	VGP BB Equity
New Britain Palm Oil	250	17-12-2007	Consumer Goods	London	PG0009239032	NBPO LN Equity
Trifork	8.5	20-12-2007	Technology	Copenhagen	DK0060102887	TRIFOR DC Equity
Immobiliere Frey	16.4	02-04-2008	Financials	Paris	FR0010588079	FREY FP Equity
Fresnillo	555	09-05-2008	Basic Materials	London	GB00B2QPKJ12	FRES LN Equity
NunaMinerals	435	04-06-2008	Basic Materials	Copenhagen	DK0060492577	NUNA DC Equity
4Energy Inv	6.25	13-06-2008	Utilities	Brussels	BE0974275076	ENIN BB Equity

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DGC	33	16-06-2008	Telecommunications	Stockholm	SE0002571539	DGC SS Equity
Norway Pelagic ASA	40	24-06-2008	Consumer Goods	Oslo	NO0010373384	NPEL NO Equity
SMA Solar Technology	47	27-06-2008	Oil & Gas	Frankfurt	DE000A0DJ6J9	S92 GR Equity
Bergen Group ASA	31	30-06-2008	Oil & Gas	Oslo	NO0010379779	BERGEN NO Equity
Prime Office A/S	104	10-07-2008	Financials	Copenhagen	DK0060137594	PRIMOF DC Equity
Global Health Partner	14	03-10-2008	Health Care	Stockholm	SE0002579912	GHP SS Equity
Fonciere Sepric	6	24-12-2008	Financials	Paris	FR0004031292	SPRIC FP Equity
Atlantic Airways	261	09-01-2009	Consumer Services	Iceland	FO0000000062	FOAIR IR Equity
Vtion Wireless Technology	10.8	01-10-2009	Technology	Frankfurt	DE000CHEN993	V33 GR Equity
RIB Software	9.25	12-11-2009	Technology	Frankfurt	DE000A0Z2XN6	RIB GR Equity
Gds (S) Rusal	19.9	27-01-2010	Basic Materials	Paris	US9098832093	RUSAL FP Equity
Helikos S.E.	10	02-02-2010	Financials	Frankfurt	LU0472835155	EXC GR Equity
Horizon Acquisition Co Plc	1000	04-02-2010	Industrials	London	GB00B58D4C52	APR LN Equity
Promethean World Plc	200	12-03-2010	Technology	London	GB00B60B6S45	PRW LN Equity
African Barrick Gold Ltd	575	19-03-2010	Basic Materials	London	GB00B61D2N63	ACA LN Equity
Cpp Group Plc	235	19-03-2010	Industrials	London	GB00B5W55H93	CPP LN Equity
Supergroup Plc	500	24-03-2010	Consumer Goods	London	GB00B60BD277	SGP LN Equity
P/f Bakkafrost	31	26-03-2010	Consumer Goods	Oslo	FO0000000179	BAKKA NO Equity
TOM TAILOR Holding AG	13	26-03-2010	Consumer Services	Frankfurt	DE000A0STST2	TTI GR Equity
Brenntag AG	50	29-03-2010	Basic Materials	Frankfurt	DE000A1DAHH0	BNR GR Equity
Joyou AG	13	30-03-2010	Industrials	Frankfurt	DE000A0WMLD8	JY8 GR Equity
AB Science	12.7	26-04-2010	Health Care	Paris	FR0010557264	AB FP Equity
Avangardco Investments Public	15	30-04-2010	Consumer Goods	London	US05349V2097	AVGR LI Equity
Essar Energy Plc	420	04-05-2010	Oil & Gas	London	GB00B5SXPF57	ESSR LN Equity
Capital Drilling Ltd	61.5	07-06-2010	Industrials	London	BMG022411000	CAPD LN Equity
Panoro Energy	12.6	08-06-2010	Oil & Gas	Oslo	NO0010564701	PEN NO Equity
Wilh. Wilhelmsen	24.2	24-06-2010	Industrials	Oslo	NO0010571680	WWASA NO Equity
Morpol	22	30-06-2010	Consumer Goods	Oslo	NO0010577299	MORPOL NO Equity
Edenred	11.4	02-07-2010	Industrials	Paris	FR0010908533	EDEN FP Equity
Vallar Plc	1000	09-07-2010	Basic Materials	London	JE00B61G4Z19	ARMS LN Equity
Ocado Group Plc	180	21-07-2010	Consumer Services	London	GB00B3MBS747	OCDO LN Equity
European CleanTech	10	20-10-2010	Financials	Frankfurt	LU0538936351	EWI GR Equity
Betfair Group PLC	1300	22-10-2010	Consumer Services	London	GB00BSPL1J93	BET LN Equity
Statoil Fuel & Retail	39	22-10-2010	Oil & Gas	Oslo	NO0010584063	SFR NO Equity
O'Key Group SA	11	03-11-2010	Consumer Services	London	US6708662019	OKEY LI Equity
Transcontainer Ojsc	8	09-11-2010	Industrials	London	RU000A0JPRX9	TRCN LI Equity
Jk Wohnbau AG	8	10-11-2010	Consumer Goods	Frankfurt	DE000A1E8H38	IWB GR Equity
Zealand Pharma	86	23-11-2010	Health Care	Copenhagen	DK0060257814	ZEAL DC Equity
Seabird Exploration	20	29-11-2010	Oil & Gas	Oslo	CY0101162119	SBX NO Equity
Floatel International	14	01-12-2010	Oil & Gas	Oslo	BMG3597X1039	FLOAT NO Equity
Gjensidige Forsikring	59	10-12-2010	Financials	Oslo	NO0010582521	GJF NO Equity
Cdon Group	15.5	15-12-2010	Consumer Services	Stockholm	SE0003652163	QLRO SS Equity
Marwyn Management Partners	100	12-01-2011	Financials	London	GB00B4NF3F57	MMP LN Equity
Aperam	28	26-01-2011	Basic Materials	Amsterdam	LU0569974404	APAM NA Equity
Derby Cycle	12.5	04-02-2011	Consumer Goods	Frankfurt	DE000A1H6HN1	DCT GR Equity
Norway Royal Salmon ASA	21	29-03-2011	Consumer Goods	Oslo	NO0010331838	NRS NO Equity
NORMA Group	21	08-04-2011	Consumer Goods	Frankfurt	DE000A1H8BV3	NOEJ GR Equity
Perform Group Ltd	260	08-04-2011	Consumer Services	London	GB00B3M55Q47	PER LN Equity
Powerland	15	11-04-2011	Consumer Goods	Frankfurt	DE000PLD5558	1PL GR Equity
GSW Immobilien	19	15-04-2011	Financials	Frankfurt	DE000GSW1111	GIB GR Equity
Karolinska Development	40	15-04-2011	Health Care	Stockholm	SE0002190926	KDEV SS Equity
Dedicare	16	04-05-2011	Health Care	Stockholm	SE0003909282	DEDI SS Equity

Company	Offer Price	IPO date	Industry	Stock Exchange	ISIN	Bloom ticker
Moberg Derma	29	26-05-2011	Health Care	Stockholm	SE0003613090	MOB SS Equity
Transmode Holding	53	27-05-2011	Technology	Stockholm	SE0001471103	TRMO SS Equity
United Power Technology	9	10-06-2011	Industrials	Frankfurt	DE000A1EMAK2	UP7 GR Equity
Concentric	75	16-06-2011	Industrials	Stockholm	SE0003950864	COIC SS Equity
Boule Diagnostics	49	23-06-2011	Health Care	Stockholm	SE0000437402	BOUL SS Equity
China Specialty Glass	9	01-07-2011	Industrials	Frankfurt	DE000A1EL8Y8	8GS GR Equity
Höegh LNG Holdings Ltd.	38	05-07-2011	Industrials	Oslo	BMG454221059	HLNG NO Equity
Mauna Kea Technologies	13	06-07-2011	Health Care	Paris	FR0010609263	MKEA FP Equity
Dankse Andelskassers Bank	25	07-07-2011	Financials	Copenhagen	DK0060299063	DAB DC Equity
SHW	26	07-07-2011	Consumer Goods	Frankfurt	DE000A1JBPV9	SW1 GR Equity
Kvaerner ASA	14	08-07-2011	Oil & Gas	Oslo	NO0010605371	KVAER NO Equity
Phosagro OJSC	14	13-07-2011	Basic Materials	London	RU000A0JRKT8	PHOR LI Equity
Youbisheng Green Paper	6.5	13-07-2011	Basic Materials	Frankfurt	DE000A1KRLR0	YB1 GR Equity
Polymetal Intl Plc	920	28-10-2011	Basic Materials	London	JE00B6T5S470	POLY LN Equity
Ultrasonic AG	9	09-12-2011	Consumer Goods	Frankfurt	DE000A1KREX3	US5 GR Equity
Hagar	13.5	16-12-2011	Consumer Services	Iceland	IS0000020121	HAGA IR Equity
Ruspetro	134	19-01-2012	Oil & Gas	London	GB00B4ZH7J18	RPO LN Equity
Inside Secure	8.3	20-02-2012	Technology	Paris	FR0010291245	INSD FP Equity
Energy Assets Group	210	22-03-2012	Industrials	London	GB00B78CNY10	EAS LN Equity
Nmc Health	210	02-04-2012	Health Care	London	GB00B7FC0762	NMC LN Equity
Haikui Seafood	10	15-05-2012	Consumer Goods	Frankfurt	DE000A1JH3F9	H8K GR Equity
Selvaag Bolig	20	14-06-2012	Financials	Oslo	NO0010612450	SBO NO Equity
Reginn	8.2	02-07-2012	Financials	Iceland	IS0000021301	REGINN IR Equity
Lotto24	2.5	03-07-2012	Consumer Services	Frankfurt	DE000LTT0243	LO24 GR Equity
Ming Le Sports	13	06-07-2012	Consumer Goods	Frankfurt	DE000A1MBEG8	ML2 GR Equity
Fast Casualwear	5	09-07-2012	Consumer Services	Frankfurt	DE000A1PHFG5	FCA GR Equity
Talanx	18.3	02-10-2012	Financials	Frankfurt	DE000TLX1005	TLX GR Equity
Direct Line Insurance Group	175	11-10-2012	Financials	London	GB00BY9D0Y18	DLG LN Equity
Borregaard	21	18-10-2012	Basic Materials	Oslo	NO0010657505	BRG NO Equity
Hess	15.5	25-10-2012	Industrials	Frankfurt	DE000A0N3EJ6	HEAG GR Equity
Acorn Minerals	20	29-10-2012	Basic Materials	London	GB00B6QZLQ32	ACO LN Equity
Telefónica Deutschland Holding	5.6	30-10-2012	Telecommunications	Frankfurt	DE000A1J5RX9	O2D GR Equity
Firstextile	10	12-11-2012	Consumer Goods	Frankfurt	DE000A1PG8V8	FT8 GR Equity
Fjarskipti (Vodafone Iceland)	31.5	18-12-2012	Telecommunications	Iceland	IS0000020485	VOICE IR Equity
Inland Zdp	100	20-12-2012	Financials	London	GB00B99R1Q79	INLZ LN Equity

Appendix 2 – Statistics original sample

Descriptive	
PE Backed	
Mean	0.052492
Standard Error	0.009762
Median	0.028484
Mode	0
Standard Deviation	0.088401
Sample Variance	0.007815
Kurtosis	0.304245
Skewness	0.843400
Range	0.430074
Minimum	-0.130435
Maximum	0.299639
Sum	4.304327
Count	82

t-test (against zero)	
	5.37700
Critical one tail	
	1.00000
P-value, one sided	
	0.00000

Descriptive	
Non-PE Backed	
Mean	0.063643
Standard Error	0.009929
Median	0.033060
Mode	0.040000
Standard Deviation	0.167916
Sample Variance	0.028196
Kurtosis	31.990084
Skewness	4.087583
Range	2.152064
Minimum	-0.517333
Maximum	1.634731
Sum	18.202004
Count	286

t-test (against zero)	
	6.40980
Critical one tail	
	1.00000
P-value, one sided	
	0.00000

F-Test Two-Sample for Variances

	PE Backed	*Non-PE Backed*
Mean	0.052492	0.063643
Variance	0.007815	0.028196
Observations	82	286
df	81	285
F	0.277161	
P(F<=f) one-tail	0.000000	
F Critical one-tail	0.734742	

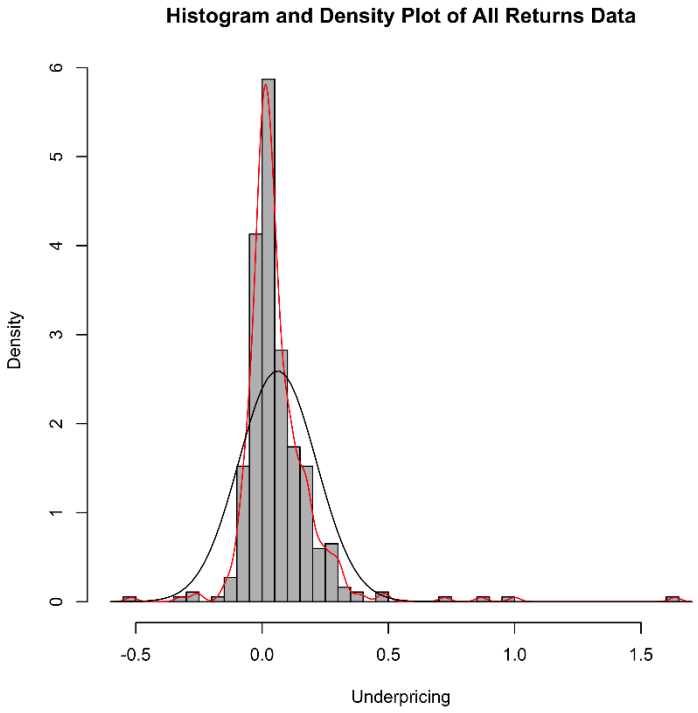
Equally weighted two sample test
t-Test: Two-Sample Assuming Unequal Variances

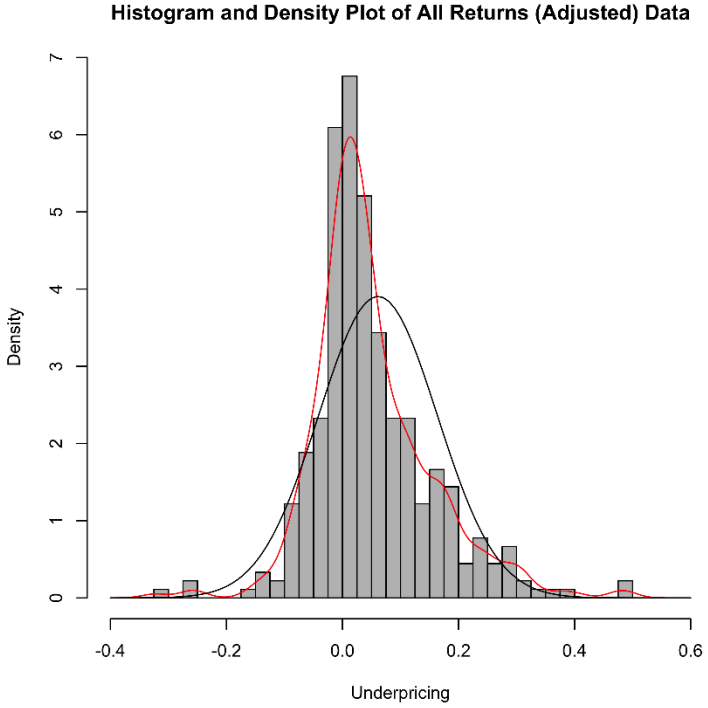
	PE-Backed	*Non-PE Backed*
Mean	0.052492	0.063643
Variance	0.007815	0.028196
Observations	82	286
Hypothesized Mean Difference	0	
df	257	
t Stat	-0.800867	
P(T<=t) one-tail	0.211974	
t Critical one-tail	1.650804	
P(T<=t) two-tail	0.423948	
t Critical two-tail	1.969237	

Value-Weighted two sample test
t-Test: Two-Sample Assuming Unequal Variances

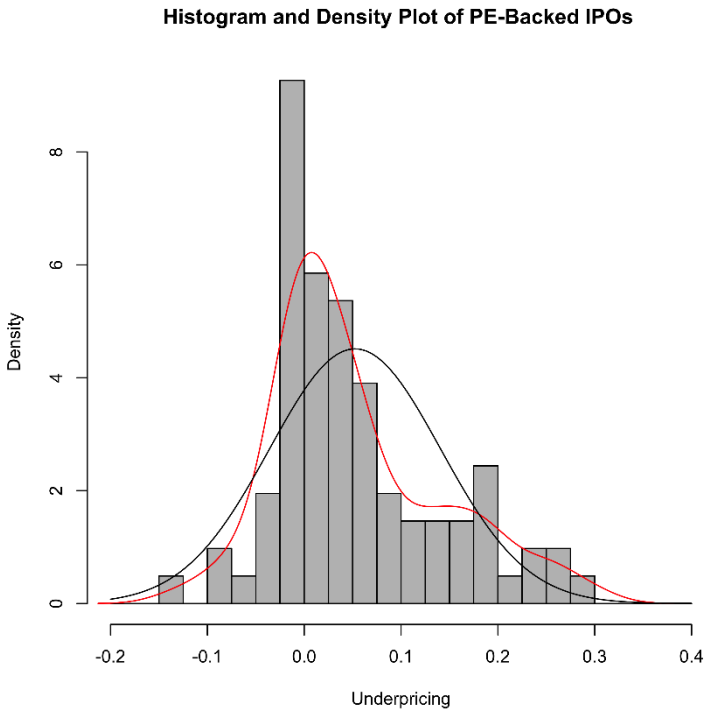
	PE-Backed	*Non-PE Backed*
Mean	0.001169	0.000187
Variance	0.000012	0.000002
Observations	82	286
Hypothesized Mean I	0	
df	87	
t Stat	2.524285	
P(T<=t) one-tail	0.006704	
t Critical one-tail	1.662557	
P(T<=t) two-tail	0.013408	
t Critical two-tail	1.987608	

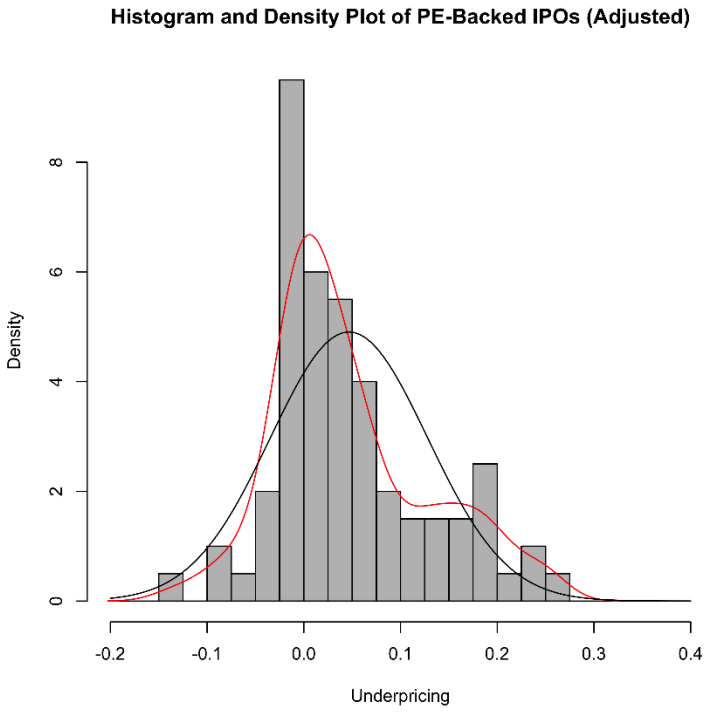
Appendix 3 – Distributions of returns of underpricing samples



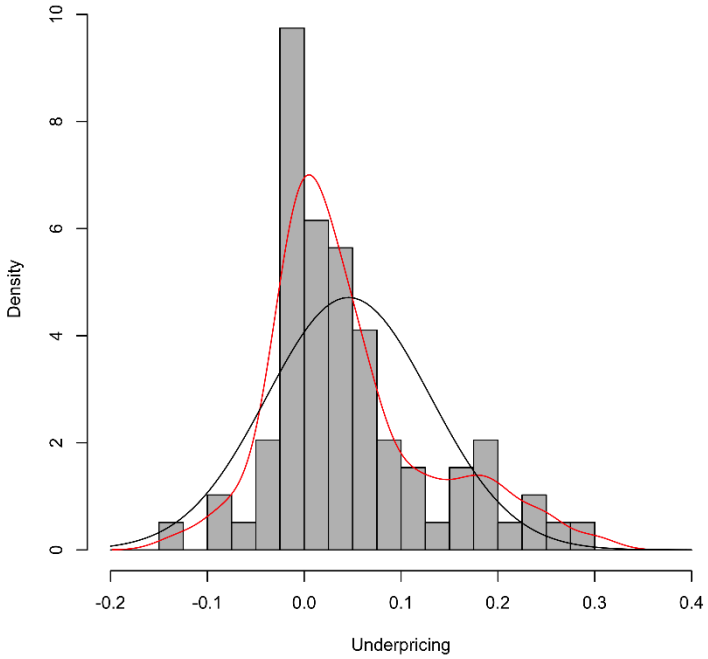


X

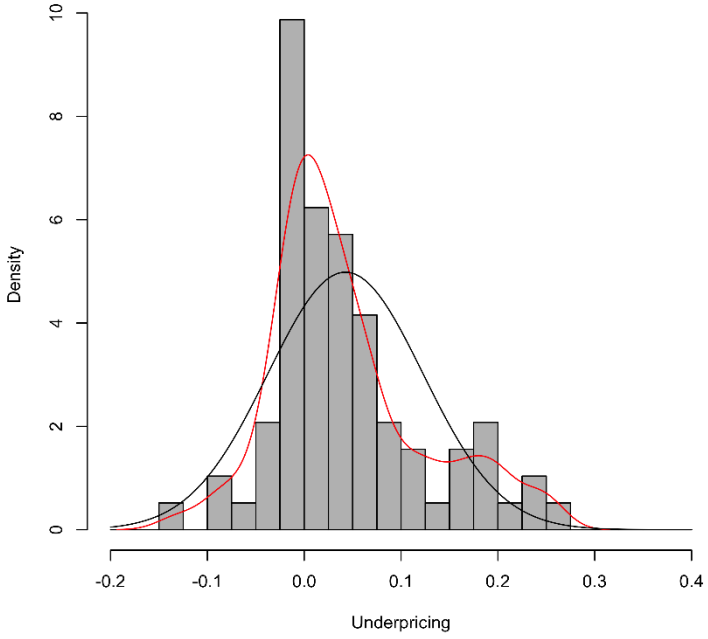

Histogram and Density Plot of PE-Backed IPOs
Density
0
2
4
6
8
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
Underpricing

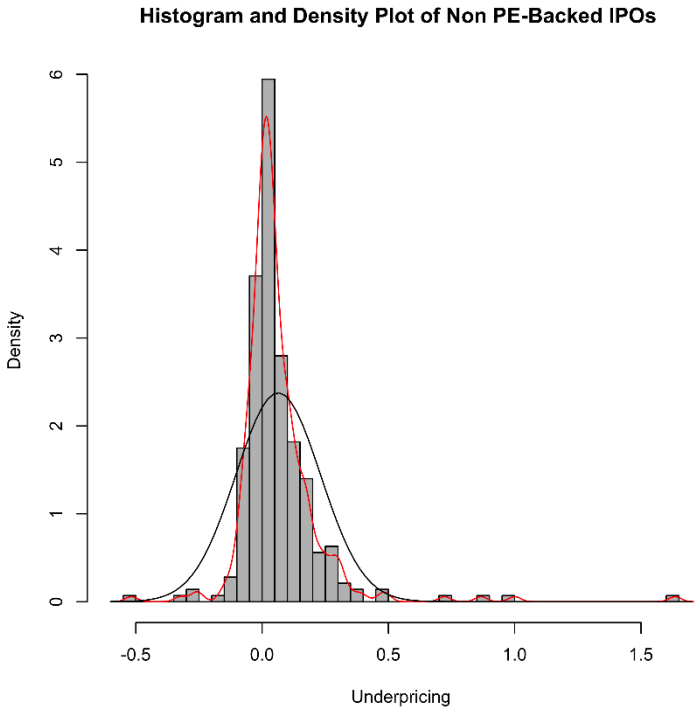

Histogram and Density Plot of PE-Backed IPOs (Adjusted)
Density
0
2
4
6
8
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
Underpricing

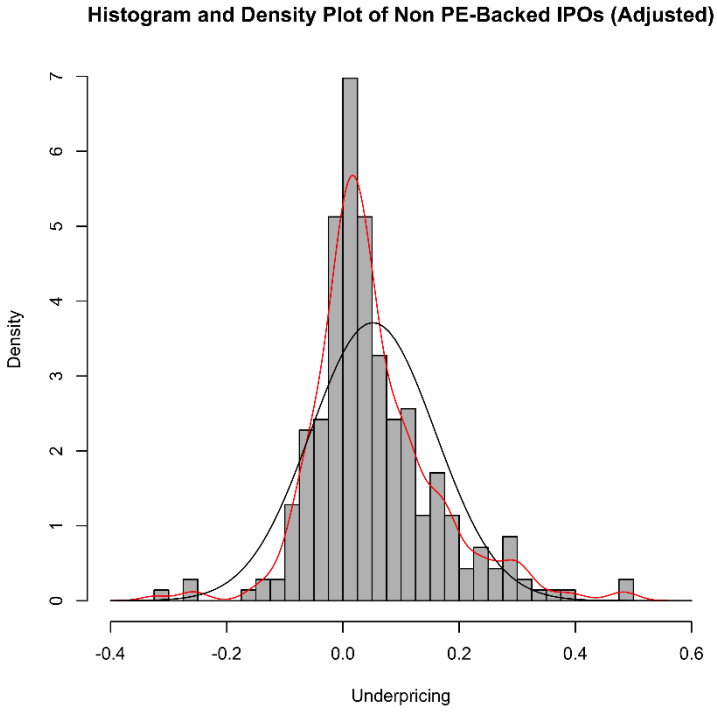
Histogram and Density Plot of PE-Backed IPOs in Matched Sample



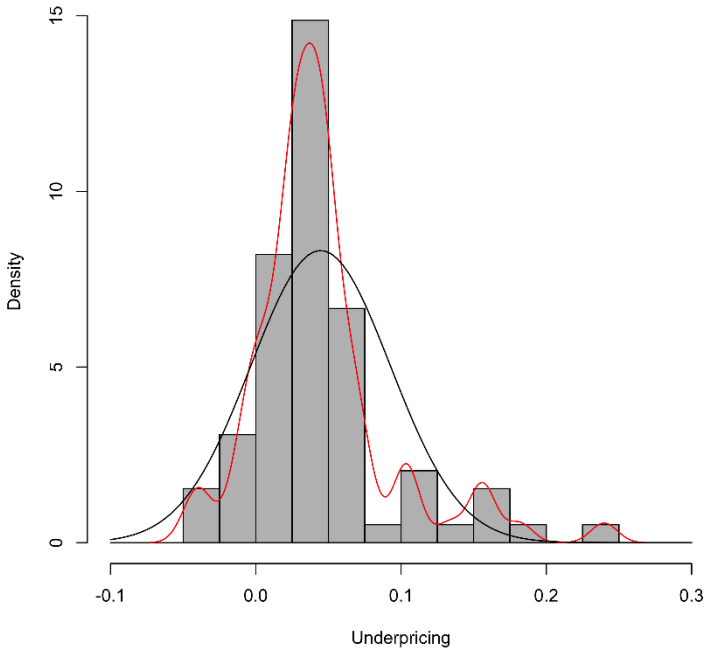
Histogram and Density Plot of PE-Backed IPOs in Matched Sample (Adjust



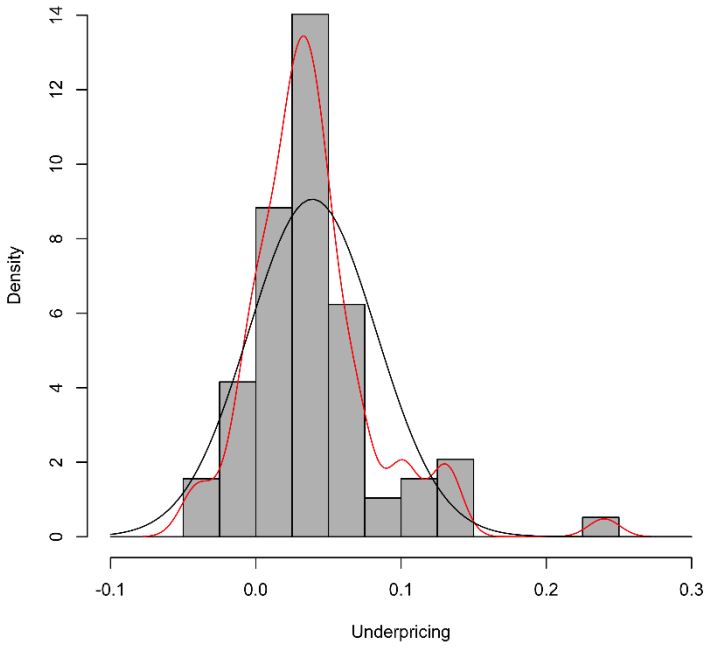

Histogram and Density Plot of Non PE-Backed IPOs
Density
0
1
2
3
4
5
6
-0.5
0.0
0.5
1.0
1.5
Underpricing


Histogram and Density Plot of Non PE-Backed IPOs (Adjusted)
Density
0
1
2
3
4
5
6
7
-0.4
-0.2
0.0
0.2
0.4
0.6
Underpricing

Histogram and Density Plot of Matched Sample of Non PE IPOs



Histogram and Density Plot of Matched Sample of Non PE IPOs (Adjustec



Appendix 4 – Statistics matched sample

Descriptives			Descriptives		
PE backed			*Matched non-PE Backed*		
Mean	0.04587	t-test (against zero)	Mean	0.04461	t-test (against zero)
Standard Error	0.00958	4.78531	Standard Error	0.00543	8.21427
Median	0.02596	Critical one tail	Median	0.03792	Critical one tail
Mode	0	1.00000	Mode	0.06786	1.00000
Standard Deviation	0.08465	4.04E-06	Standard Deviatic	0.04797	1.97E-12
Sample Variance	0.00717		Sample Variance	0.00230	
Kurtosis	0.75158		Kurtosis	3.77162	
Skewness	0.95823		Skewness	1.51716	
Range	0.43007		Range	0.28491	
Minimum	-0.13043		Minimum	-0.04510	
Maximum	0.29964		Maximum	0.23981	
Sum	3.57750		Sum	3.47994	
Count	78		Count	78	

F-Test Two-Sample for Variances

	PE backed	*Matched non-PE Backed*
Mean	0.04587	0.04461
Variance	0.00717	0.00230
Observations	78	78
df	77	77
F	3.11410	
P(F<=f) one-tail	0.00000	
F Critical one-tail	1.45823	

t-Test: Two-Sample Assuming Unequal Variances

	PE backed	*Matched non-PE Backed*
Mean	0.04587	0.04461
Variance	0.00717	0.00230
Observations	78	78
Hypothesized Mean Difference	0	
df	122	
t Stat	0.11353	
P(T<=t) one-tail	0.45490	
t Critical one-tail	1.65744	
P(T<=t) two-tail	0.90979	
t Critical two-tail	1.97960	

Appendix 5 – Statistics trimmed sample

Descriptives	
PE Backed	
Mean	0.046697
Standard Error	0.009091
Median	0.027239
Mode	0
Standard Deviatio	0.081316
Sample Variance	0.006612
Kurtosis	0.120240
Skewness	0.722019
Range	0.382816
Minimum	-0.130435
Maximum	0.252381
Sum	3.735740
Count	80

Descriptives	
Non-PE backed	
Mean	0.051586
Standard Error	0.006411
Median	0.031111
Mode	0.04
Standard Deviation	0.107467
Sample Variance	0.011549
Kurtosis	2.484852
Skewness	0.835086
Range	0.812109
Minimum	-0.323077
Maximum	0.489032
Sum	14.495718
Count	281

F-Test Two-Sample for Variances

	PE Backed	*Non-PE backed*
Mean	0.046697	0.051586
Variance	0.006612	0.011549
Observations	80	281
df	79	280
F	0.572541	
P(F<=f) one-tail	0.001910	
F Critical one-tail	0.731886	

t-Test: Two-Sample Assuming Unequal Variances

	PE Backed	*Non-PE backed*
Mean	0.046697	0.051586
Variance	0.006612	0.011549
Observations	80	281
Hypothesized Mea	0	
df	166	
t Stat	-0.439519	
P(T<=t) one-tail	0.330428	
t Critical one-tail	1.654085	
P(T<=t) two-tail	0.660857	
t Critical two-tail	1.974358	

Appendix 6 – Statistics trimmed matched sample

Descriptives		**Descriptives**	
PE Backed		*Matched non-PE Backed*	
Mean	0.04257	Mean	0.03900
Standard Error	0.00912	Standard Error	0.00502
Median	0.02500	Median	0.03474
Mode	0	Mode	0.06786
Standard Deviation	0.08001	Standard Deviation	0.04403
Sample Variance	0.00640	Sample Variance	0.00194
Kurtosis	0.49312	Kurtosis	5.02455
Skewness	0.84603	Skewness	1.54514
Range	0.38282	Range	0.28491
Minimum	-0.13043	Minimum	-0.04510
Maximum	0.25238	Maximum	0.23981
Sum	3.27786	Sum	3.00310
Count	77	Count	77

t-Test: Paired Two Sample for Means

	PE Backed	*Matched non-PE Backed*
Mean	0.04257	0.03900
Variance	0.00640	0.00194
Observations	77	77
Pearson Correlation	0.02638	
Hypothesized Mean D	0	
df	76	
t Stat	0.34676	
P(T<=t) one-tail	0.36486	
t Critical one-tail	1.66515	
P(T<=t) two-tail	0.72973	
t Critical two-tail	1.99167	

F-Test Two-Sample for Variances

	PE Backed	*Matched non-PE Backed*
Mean	0.04257	0.03900
Variance	0.00640	0.00194
Observations	77	77
df	76	76
F	3.30264	
P(F<=f) one-tail	0.00000	
F Critical one-tail	1.46188	

Appendix 7 – R code for parametric and non-parametric tests for underpricing

```
rm(list=ls())

require(openxlsx)
require(moments)
require(psych)
require(stats)
require(Cairo)

UP.data = read.xlsx("/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/Underpricing Final.xlsx",sheet=1,startRow=2,colNames=TRUE,skipEmptyRows =
TRUE)

WholeSample = as.matrix(na.omit(UP.data[,9]))
WholeSampleAdj = as.matrix(na.omit(UP.data[,10]))
shapiro.test(WholeSample)

PETwo = as.matrix(na.omit(UP.data[,3]))
NPETwo = as.matrix(na.omit(UP.data[,4]))
PEMatch = as.matrix(na.omit(UP.data[,1]))
NPEMatch = as.matrix(na.omit(UP.data[,2]))
PETwoAdj = as.matrix(na.omit(UP.data[,7]))
NPETwoAdj = as.matrix(na.omit(UP.data[,8]))
PEMatchAdj = as.matrix(na.omit(UP.data[,5]))
NPEMatchAdj = as.matrix(na.omit(UP.data[,6]))

PEMaTests = c(skewness(PEMatch),kurtosis(PEMatch),shapiro.test(PEMatch))
NPEMaTests = c(skewness(NPEMatch),kurtosis(NPEMatch),shapiro.test(NPEMatch))
PE2Tests = c(skewness(PETwo), kurtosis(PETwo), shapiro.test(PETwo))
NPE2Tests = c(skewness(NPETwo), kurtosis(NPETwo),shapiro.test(NPETwo))
PEMaAdjTests = c(skewness(PEMatchAdj),kurtosis(PEMatchAdj),shapiro.test(PEMatchAdj))
NPEMaAdjTests =
c(skewness(NPEMatchAdj),kurtosis(NPEMatchAdj),shapiro.test(NPEMatchAdj))
PE2AdjTests = c(skewness(PETwoAdj), kurtosis(PETwoAdj), shapiro.test(PETwoAdj))
NPE2AdjTests = c(skewness(NPETwoAdj), kurtosis(NPETwoAdj),shapiro.test(NPETwoAdj))

PEMaSum = as.vector(describe(PEMatch,na.rm=FALSE,trim=0,type=2))
NPEMaSum = as.vector(describe(NPEMatch,na.rm=FALSE,trim=0,type=2))
PE2Sum = as.vector(describe(PETwo,na.rm=FALSE,trim=0,type=2))
```

```
NPE2Sum = as.vector(describe(NPETwo,na.rm=FALSE,trim=0,type=2))
PEMaAdjSum = as.vector(describe(PEMatchAdj,na.rm=FALSE,trim=0,type=2))
NPEMaAdjSum = as.vector(describe(NPEMatchAdj,na.rm=FALSE,trim=0,type=2))
PE2AdjSum = as.vector(describe(PETwoAdj,na.rm=FALSE,trim=0,type=2))
NPE2AdjSum = as.vector(describe(NPETwoAdj,na.rm=FALSE,trim=0,type=2))

n =
as.vector(c(PE2Sum[2],NPE2Sum[2],PEMaSum[2],NPEMaSum[2],PE2AdjSum[2],NPE2AdjS
um[2],PEMaAdjSum[2],NPEMaAdjSum[2]))
stdDev =
as.vector(c(PE2Sum[4],NPE2Sum[4],PEMaSum[4],NPEMaSum[4],PE2AdjSum[4],NPE2AdjS
um[4],PEMaAdjSum[4],NPEMaAdjSum[4]))
Mean =
as.vector(c(PE2Sum[3],NPE2Sum[3],PEMaSum[3],NPEMaSum[3],PE2AdjSum[3],NPE2AdjS
um[3],PEMaAdjSum[3],NPEMaAdjSum[3]))
Median =
as.vector(c(PE2Sum[5],NPE2Sum[5],PEMaSum[5],NPEMaSum[5],PE2AdjSum[5],NPE2AdjS
um[5],PEMaAdjSum[5],NPEMaAdjSum[5]))
Skewness =
as.vector(c(PE2Tests[1],NPE2Tests[1],PEMaTests[1],NPEMaTests[1],PE2AdjTests[1],NPE2A
djTests[1],PEMaAdjTests[1],NPEMaAdjTests[1]))
Kurtosis =
as.vector(c(PE2Tests[2],NPE2Tests[2],PEMaTests[2],NPEMaTests[2],PE2AdjTests[2],NPE2A
djTests[2],PEMaAdjTests[2],NPEMaAdjTests[2]))
SWTest =
as.vector(c(PE2Tests[3],NPE2Tests[3],PEMaTests[3],NPEMaTests[3],PE2AdjTests[3],NPE2A
djTests[3],PEMaAdjTests[3],NPEMaAdjTests[3]))
PVals =
as.vector(c(PE2Tests[4],NPE2Tests[4],PEMaTests[4],NPEMaTests[4],PE2AdjTests[4],NPE2A
djTests[4],PEMaAdjTests[4],NPEMaAdjTests[4]))

UPResults =
matrix(ncol=8,nrow=8,c(n,stdDev,Mean,Median,Skewness,Kurtosis,SWTest,PVals),dimnames
=list(c("PE 2","NPE2","PE Match","NPE Match","PE 2 Adj","NPE 2 Adj","PE Match Adj",
NPE Match Adj),c("n","Standard Dev.","Mean","Median","Skewness","Kurtosis","SW
Test","p-Value")))
print(UPResults)

#Wilcoxon Tests against zero
a = wilcox.test(PETwo)
b = wilcox.test(NPETwo)
c = wilcox.test(PEMatch)
d = wilcox.test(NPEMatch)
e = wilcox.test(PETwoAdj)
f = wilcox.test(NPETwoAdj)
```

```
g = wilcox.test(PEMatchAdj)
h = wilcox.test(NPEMatchAdj)

WilcoxSingleResults = matrix(ncol=2,nrow=8,dimnames = list(c("PE 2","NPE2","PE
Match","NPE Match","PE 2 Adj","NPE 2 Adj","PE Match Adj","NPE Match Adj"),c("V","p-
Value")))
WilcoxSingleResults[,1] =
c(a$statistic,b$statistic,c$statistic,d$statistic,e$statistic,f$statistic,g$statistic,h$statistic)
WilcoxSingleResults[,2] =
c(a$p.value,b$p.value,c$p.value,d$p.value,e$p.value,f$p.value,g$p.value,h$p.value)
print(WilcoxSingleResults)

#Wilcoxon Tests of Pairs
Two = as.vector(wilcox.test(PETwo,NPETwo,alternative="less",paired=FALSE))
Paired = as.vector(wilcox.test(PEMatch,NPEMatch,alternative="less",paired=TRUE))
TwoAdj = as.vector(wilcox.test(PETwoAdj,NPETwoAdj,alternative="less",paired=FALSE))
PairedAdj =
as.vector(wilcox.test(PEMatchAdj,NPEMatchAdj,alternative="less",paired=TRUE))

WilcoxonPairs =
matrix(byrow=FALSE,nrow=4,ncol=2,c(Two[3],Paired[3],TwoAdj[3],PairedAdj[3],Two[1],Pai
red[1],TwoAdj[1],PairedAdj[1]),dimnames=list(c("PE vs. Non-Pe","PE (matched) vs. Matches -
Paired","Adjusted PE vs Non-PE","Adjusted PE (matched) vs. Matches - Paired"),c("p-
value","U/W Value")))
print(WilcoxonPairs)

#HISTOGRAMS
#Whole Sample
bins = c(seq(from = -0.6, to = 1.7, by = 0.05))
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/WholeSample.tiff", res=600, compression = "lzw", height=6, width=6, units="in",
pointsize = 10)
WholeSampleDens = density(WholeSample)
plot(WholeSampleDens)
hist(main = 'Histogram and Density Plot of All Returns Data', WholeSample,bins,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(WholeSampleDens,col='red')
curve(dnorm(x, mean=mean(WholeSample), sd=sd(WholeSample)), add=TRUE)
dev.off()

#PE-Backed
bins1 = c(seq(from=-0.2, to = 0.4, by = 0.025))
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/WholeSamplePE.tiff"
```

```
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
PETwodens = density(PETwo)
plot(PETwodens)
hist(main = 'Histogram and Density Plot of PE-Backed IPOs ', PETwo,bins1,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(PETwodens, col='red')
curve(dnorm(x, mean=mean(PETwo), sd=sd(PETwo)), add=TRUE)
dev.off()

#Non PE
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/WholeSampleNonPE.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
NPETwodens = density(NPETwo)
plot(NPETwodens)
hist(main = 'Histogram and Density Plot of Non PE-Backed IPOs ', NPETwo,bins,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(NPETwodens, col='red')
curve(dnorm(x, mean=mean(NPETwo), sd=sd(NPETwo)), add=TRUE)
dev.off()

#Matched Pairs
#PE
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final Calculations/MatchedPE.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
PEMatchdens = density(PEMatch)
plot(PEMatchdens)
hist(main = 'Histogram and Density Plot of PE-Backed IPOs in Matched Sample',
PEMatch,bins1,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(PEMatchdens, col='red')
curve(dnorm(x, mean=mean(PEMatch), sd=sd(PEMatch)), add=TRUE)
dev.off()

#Matching Sample of Non-PEs
bins2 =  c(seq(from=-0.1, to = 0.3, by = 0.025))
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/MatchedPairsNPE.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
NPEMatchdens = density(NPEMatch)
plot(NPEMatchdens)
hist(main = 'Histogram and Density Plot of Matched Sample of Non PE IPOs',
NPEMatch,bins2,col='grey',
```

```
    prob=TRUE,xlab = 'Underpricing')
lines(NPEMatchdens, col='red')
curve(dnorm(x, mean=mean(NPEMatch), sd=sd(NPEMatch)), add=TRUE)
dev.off()

#TRIMS APPLIED
#Whole Sample
bins3 = c(seq(from=-0.4, to=0.6, by = 0.025))
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/WholeSampleTrims.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
WholeSampleAdjDens = density(WholeSampleAdj)
plot(WholeSampleAdjDens)
hist(main = 'Histogram and Density Plot of All Returns (Adjusted) Data',
WholeSampleAdj,bins3,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(WholeSampleAdjDens,col='red')
curve(dnorm(x, mean=mean(WholeSample), sd=sd(WholeSampleAdj)), add=TRUE)
dev.off()

#PE-Backed
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/WholeSamplePETrim.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
PETwoAdjdens = density(PETwoAdj)
plot(PETwoAdjdens)
hist(main = 'Histogram and Density Plot of PE-Backed IPOs (Adjusted)',
PETwoAdj,bins1,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(PETwoAdjdens, col='red')
curve(dnorm(x, mean=mean(PETwoAdj), sd=sd(PETwoAdj)), add=TRUE)
dev.off()

#Non PE
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/WholeSampleNonPETrim.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
NPETwoAdjdens = density(NPETwoAdj)
plot(NPETwoAdjdens)
hist(main = 'Histogram and Density Plot of Non PE-Backed IPOs (Adjusted)',
NPETwoAdj,bins3,
    col='grey',prob=TRUE,xlab = 'Underpricing')
lines(NPETwoAdjdens, col='red')
curve(dnorm(x, mean=mean(NPETwoAdj), sd=sd(NPETwoAdj)), add=TRUE)
```

```
dev.off()

#Matched Pairs
#PE
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/MatchedPETrim.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
PEMatchAdjdens = density(PEMatchAdj)
plot(PEMatchAdjdens)
hist(main = 'Histogram and Density Plot of PE-Backed IPOs in Matched Sample (Adjusted)',
PEMatchAdj,bins1,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(PEMatchAdjdens, col='red')
curve(dnorm(x, mean=mean(PEMatchAdj), sd=sd(PEMatchAdj)), add=TRUE)
dev.off()

#Matching Sample of Non-PEs
bins4 = c(seq(from=-0.1, to=0.3, by=0.025))
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/MatchedNonPETrim.tiff"
    , res=600, compression = "lzw", height=6, width=6, units="in", pointsize = 10)
NPEMatchAdjdens = density(NPEMatchAdj)
plot(NPEMatchAdjdens)
hist(main = 'Histogram and Density Plot of Matched Sample of Non PE IPOs (Adjusted)',
NPEMatchAdj,bins4,col='grey',
    prob=TRUE,xlab = 'Underpricing')
lines(NPEMatchAdjdens, col='red')
curve(dnorm(x, mean=mean(NPEMatchAdj), sd=sd(NPEMatchAdj)), add=TRUE)
dev.off()
```

Appendix 8 – R code for parametric tests for long-term event studies

```
rm(list=ls())

require(Matrix)
require(openxlsx)
require(nlme)

Raw.data = read.xlsx("/Users/Christian/Dropbox/1A Master Thesis/Long
Term.xlsx",sheet=3,colNames=TRUE,rowNames = TRUE,rows = c(4:365), skipEmptyRows =
TRUE)
Eur.data = read.xlsx("/Users/Christian/Dropbox/1A Master Thesis/Long
Term.xlsx",sheet=3,colNames=TRUE,rowNames = TRUE,rows = c(376:737), skipEmptyRows
= TRUE)
Co.data = read.xlsx("/Users/Christian/Dropbox/1A Master Thesis/Long
Term.xlsx",sheet=3,colNames=TRUE,rowNames = TRUE,rows = c(748:1109),
skipEmptyRows = TRUE)
Ind.data = read.xlsx("/Users/Christian/Dropbox/1A Master Thesis/Long
Term.xlsx",sheet=3,colNames=TRUE,rowNames = TRUE,rows = c(1120:1481),
skipEmptyRows = TRUE)

PE = as.matrix(Eur.data[,73])
Raw = as.matrix(Raw.data[,1:36])

EurCAR=as.matrix(Eur.data[,1:36])
EurCAR[is.na(EurCAR)]=0
CoCAR=as.matrix(Co.data[,1:36])
CoCAR[is.na(CoCAR)]=0
IndCAR=as.matrix(Ind.data[,1:36])
IndCAR[is.na(IndCAR)]=0

EuIndex = as.matrix(Eur.data[,37:72])
CoIndex = as.matrix(Co.data[,37:72])
IndIndex = as.matrix(Ind.data[,37:72])

nrow = nrow(Raw)
ncol = ncol(Raw)

#Start of Calculations
CARSummary = matrix(ncol=3,nrow=9, dimnames = list(c("CAR Europe","Var
Europe","Autocovariance Europe","CAR Country","Var Country","Autocovariance
Country","CAR Industry","Var Industry","Autocovariance Industry"),c("6 months","12
months","36 months")))
```

```
# 6 months stock Analyis
ncol = 6
z=1
CAR_6m = matrix(ncol=6,nrow=nrow, dimnames = list(c(1:nrow),c("Eur CAR","Variance
Eur","Country CAR","Variance Country","Industry CAR","Variance Industry")))

for (i in 1:nrow){CAR_6m[i,1] = sum(EurCAR[i,1:ncol])}
for (i in 1:nrow){CAR_6m[i,3] = sum(CoCAR[i,1:ncol])}
for (i in 1:nrow){CAR_6m[i,5] = sum(IndCAR[i,1:ncol])}

I= matrix(0,ncol=ncol,nrow = ncol)
for (i in 1:ncol) {I[i,i]=1}
gamma = vector(mode="numeric",length=ncol)
gamma[]=1

for (i in 1:nrow){
  vector = as.vector(EurCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(EuIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_6m[i,2] = t(gamma)%*%V_i%*%gamma
  vector = as.vector(CoCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(CoIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_6m[i,4] = t(gamma)%*%V_i%*%gamma
  vector = as.vector(IndCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(IndIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_6m[i,6] = t(gamma)%*%V_i%*%gamma
}

CARSummary[1,z] = sum(CAR_6m[,1])/nrow
CARSummary[4,z] = sum(CAR_6m[,3])/nrow
CARSummary[7,z] = sum(CAR_6m[,5])/nrow
```

```
CARSummary[2,z] = sum(CAR_6m[,2])*(1/(nrow)^2)
CARSummary[5,z] = sum(CAR_6m[,4])*(1/(nrow)^2)
CARSummary[8,z] = sum(CAR_6m[,6])*(1/(nrow)^2)

hey = acf(EurCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[3,z] = sum(hey$acf)/ncol
hey = acf(CoCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[6,z] = sum(hey$acf)/ncol
hey = acf(IndCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[9,z] = sum(hey$acf)/ncol


# 12 months stock Analyis
ncol = 12
z=2
CAR_12m = matrix(ncol=6,nrow=nrow, dimnames = list(c(1:nrow),c("Eur CAR","Variance
Eur","Country CAR","Variance Country","Industry CAR","Variance Industry")))

for (i in 1:nrow){CAR_12m[i,1] = sum(EurCAR[i,1:ncol])}
for (i in 1:nrow){CAR_12m[i,5] = sum(IndCAR[i,1:ncol])}
for (i in 1:nrow){CAR_12m[i,3] = sum(CoCAR[i,1:ncol])}

I= matrix(0,ncol=ncol,nrow = ncol)
for (i in 1:ncol) {I[i,i]=1}
gamma = vector(mode="numeric",length=ncol)
gamma[]=1

for (i in 1:nrow){
 #Europe
   vector = as.vector(EurCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(EuIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_12m[i,2] = t(gamma)%*%V_i%*%gamma
 #Country
   vector = as.vector(CoCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(CoIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
```

```
  CAR_12m[i,4] = t(gamma)%*%V_i%*%gamma
#Industry
    vector = as.vector(IndCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(IndIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_12m[i,6] = t(gamma)%*%V_i%*%gamma
}

CARSummary[1,z] = sum(CAR_12m[,1])/nrow
CARSummary[4,z] = sum(CAR_12m[,3])/nrow
CARSummary[7,z] = sum(CAR_12m[,5])/nrow

CARSummary[2,z] = sum(CAR_12m[,2])*(1/(nrow)^2)
CARSummary[5,z] = sum(CAR_12m[,4])*(1/(nrow)^2)
CARSummary[8,z] = sum(CAR_12m[,6])*(1/(nrow)^2)

hey = acf(EurCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[3,z] = sum(hey$acf)/ncol
hey = acf(CoCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[6,z] = sum(hey$acf)/ncol
hey = acf(IndCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[9,z] = sum(hey$acf)/ncol


# 36 months stock Analyis
z=3
ncol = 36
CAR_36m = matrix(ncol=6,nrow=nrow, dimnames = list(c(1:nrow),c("Eur CAR","Variance
Eur","Country CAR","Variance Country","Industry CAR","Variance Industry")))

for (i in 1:nrow){CAR_36m[i,1] = sum(EurCAR[i,1:ncol])}
for (i in 1:nrow){CAR_36m[i,3] = sum(CoCAR[i,1:ncol])}
for (i in 1:nrow){CAR_36m[i,5] = sum(IndCAR[i,1:ncol])}

I= matrix(0,ncol=ncol,nrow = ncol)
for (i in 1:ncol) {I[i,i]=1}
gamma = vector(mode="numeric",length=ncol)
gamma[]=1

for (i in 1:nrow){
```

```
  vector = as.vector(EurCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(EuIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_36m[i,2] = t(gamma)%*%V_i%*%gamma
  vector = as.vector(CoCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(CoIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_36m[i,4] = t(gamma)%*%V_i%*%gamma
  vector = as.vector(IndCAR[i,1:ncol])
  vector[is.na(vector)] = 0
  varCAR = (1/((ncol-2)))*(t(vector)%*%vector)
  si = as.vector(varCAR)
  XX = as.vector(IndIndex[i,1:ncol])
  V_i = as.matrix(I*si + ((XX%*%(solve(t(XX)%*%XX))%*%t(XX))*si))
  CAR_36m[i,6] = t(gamma)%*%V_i%*%gamma
}

CARSummary[1,z] = sum(CAR_36m[,1])/nrow
CARSummary[4,z] = sum(CAR_36m[,3])/nrow
CARSummary[7,z] = sum(CAR_36m[,5])/nrow

CARSummary[2,z] = sum(CAR_36m[,2])*(1/(nrow)^2)
CARSummary[5,z] = sum(CAR_36m[,4])*(1/(nrow)^2)
CARSummary[8,z] = sum(CAR_36m[,6])*(1/(nrow)^2)

hey = acf(EurCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[3,z] = sum(hey$acf)/ncol
hey = acf(CoCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[6,z] = sum(hey$acf)/ncol
hey = acf(IndCAR[,1:ncol],type = "covariance",plot=FALSE)
CARSummary[9,z] = sum(hey$acf)/ncol

print(CARSummary)
```

Appendix 9 – R code for non-parametric tests and distribution – event time studies

```
rm(list=ls())

require(Matrix)
require(openxlsx)
require(nlme)
options(scipen = 4)

All.Data = read.xlsx("/Users/nicklaslj/Dropbox/1a Master Thesis/R/Long Term/R code
CAR_BHAR.xlsx",sheet=1,startRow=3,colNames=TRUE,skipEmptyRows = TRUE)
CAR.Raw = as.matrix((All.Data[,1:3]))
CAR.Eur = as.matrix((All.Data[,4:6]))
CAR.Co = as.matrix((All.Data[,7:9]))
CAR.Ind = as.matrix((All.Data[,10:12]))

BHR.Raw = as.matrix((All.Data[,13:15]))
BHR.Eur = as.matrix((All.Data[,16:18]))
BHR.Co = as.matrix((All.Data[,19:21]))
BHR.Ind = as.matrix((All.Data[,22:24]))

#Histograms

#CAR
#Europe
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/CAREuropeWholeSample.tiff", res=600, compression = "lzw", height=6,
width=6, units="in", pointsize = 10)
bins = c(seq(from = -4, to = 4, by = 0.2))
WholeSampleDen = density(CAR.Eur[,1])
plot(WholeSampleDen)
hist(main = 'Histogram and Density Plot of CAR Europe Returns', CAR.Eur[,1],col='grey',
bins,
    prob=TRUE,xlab = 'CAR')
lines(WholeSampleDen,col='red')
curve(dnorm(x, mean=mean(CAR.Eur[,1]), sd=sd(CAR.Eur[,1])), add=TRUE)
dev.off()

#Country
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/CARCountryWholeSample.tiff", res=600, compression = "lzw", height=6,
width=6, units="in", pointsize = 10)
bins2 = c(seq(from = -6, to = 3, by = 0.2))
```

```
WholeSampleDen = density(CAR.Co[,1])
plot(WholeSampleDen)
hist(main = 'Histogram and Density Plot of CAR Country Returns', CAR.Co[,1],col='grey',
bins2,
    prob=TRUE,xlab = 'CAR')
lines(WholeSampleDen,col='red')
curve(dnorm(x, mean=mean(CAR.Co[,1]), sd=sd(CAR.Co[,1])), add=TRUE)
dev.off()

#Industry
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/CARIndustryWholeSample.tiff", res=600, compression = "lzw", height=6,
width=6, units="in", pointsize = 10)
WholeSampleDen = density(CAR.Ind[,1])
plot(WholeSampleDen)
hist(main = 'Histogram and Density Plot of CAR Industry Returns', CAR.Ind[,1],col='grey',
bins,
    prob=TRUE,xlab = 'CAR')
lines(WholeSampleDen,col='red')
curve(dnorm(x, mean=mean(CAR.Ind[,1]), sd=sd(CAR.Ind[,1])), add=TRUE)
dev.off()



#BHR
#Europe
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/BHREuropeWholeSAmple.tiff", res=600, compression = "lzw", height=6,
width=6, units="in", pointsize = 10)
bins1 = c(seq(from = -1, to = 4, by = 0.1))
WholeSampleDen = density(BHR.Eur[,1])
plot(WholeSampleDen)
hist(main = 'Histogram and Density Plot of BHR Europe Returns', BHR.Eur[,1],col='grey',
bins1,
    prob=TRUE,xlab = 'BHR')
lines(WholeSampleDen,col='red')
curve(dnorm(x, mean=mean(BHR.Eur[,1]), sd=sd(BHR.Eur[,1])), add=TRUE)
dev.off()

#Country
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/BHRCountryWholeSAmple.tiff", res=600, compression = "lzw", height=6,
width=6, units="in", pointsize = 10)
WholeSampleDen = density(BHR.Co[,1])
plot(WholeSampleDen)
```

```
hist(main = 'Histogram and Density Plot of BHR Country Returns', BHR.Co[,1],col='grey',
bins1,
    prob=TRUE,xlab = 'BHR')
lines(WholeSampleDen,col='red')
curve(dnorm(x, mean=mean(BHR.Co[,1]), sd=sd(BHR.Co[,1])), add=TRUE)
dev.off()

#Industry
tiff(filename = "/Users/Christian/Dropbox/1A Master Thesis/Final
Calculations/BHRIndustryWholeSAmple.tiff", res=600, compression = "lzw", height=6,
width=6, units="in", pointsize = 10)
WholeSampleDen = density(BHR.Ind[,1])
plot(WholeSampleDen)
hist(main = 'Histogram and Density Plot of BHR Industry Returns', BHR.Ind[,1],col='grey',
bins1,
    prob=TRUE,xlab = 'BHR')
lines(WholeSampleDen,col='red')
curve(dnorm(x, mean=mean(BHR.Ind[,1]), sd=sd(BHR.Ind[,1])), add=TRUE)
dev.off()

#Wilcoxon single sample tests
#BHR Wilcoxon Tests
WilcoxonBHR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(BHR.Eur[,i])
  WilcoxonBHR[1,i-1] = a$statistic
  WilcoxonBHR[2,i-1] = a$p.value
  b = wilcox.test(BHR.Co[,i])
  WilcoxonBHR[1,i+1] = b$statistic
  WilcoxonBHR[2,i+1] = b$p.value
  c = wilcox.test(BHR.Ind[,i])
  WilcoxonBHR[1,i+3] =  c$statistic
  WilcoxonBHR[2,i+3] = c$p.value
}
print(WilcoxonBHR)


#CAR Wilcoxon Tests
WilcoxonCAR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
```

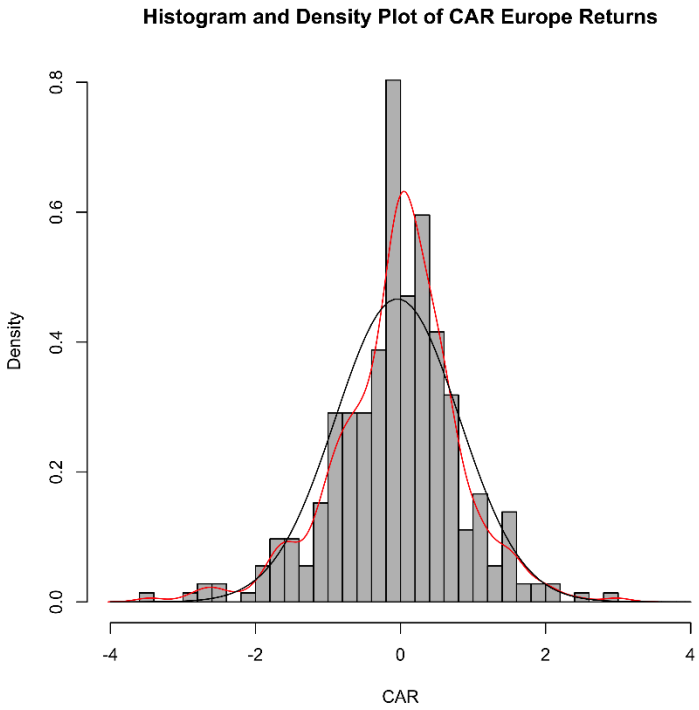
```
  a = wilcox.test(CAR.Eur[,i])
  WilcoxonCAR[1,i-1] = a$statistic
  WilcoxonCAR[2,i-1] = a$p.value
  b = wilcox.test(CAR.Co[,i])
  WilcoxonCAR[1,i+1] = b$statistic
  WilcoxonCAR[2,i+1] = b$p.value
  c = wilcox.test(CAR.Ind[,i])
  WilcoxonCAR[1,i+3] =  c$statistic
  WilcoxonCAR[2,i+3] = c$p.value
}
print(WilcoxonCAR)


All.Data = read.xlsx("/Users/nicklaslj/Dropbox/1a Master Thesis/R/Long Term/R code
CAR_BHAR.xlsx",sheet=2,startRow=3,colNames=TRUE,skipEmptyRows = TRUE)
CAR.Raw = as.matrix((All.Data[,1:3]))
CAR.Eur = as.matrix((All.Data[,4:6]))
CAR.Co = as.matrix((All.Data[,7:9]))
CAR.Ind = as.matrix((All.Data[,10:12]))

BHR.Raw = as.matrix((All.Data[,13:15]))
BHR.Eur = as.matrix((All.Data[,16:18]))
BHR.Co = as.matrix((All.Data[,19:21]))
BHR.Ind = as.matrix((All.Data[,22:24]))

#Wilcoxon single sample tests
#BHR Wilcoxon Tests
WilcoxonBHR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                  c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(BHR.Eur[,i])
  WilcoxonBHR[1,i-1] = a$statistic
  WilcoxonBHR[2,i-1] = a$p.value
  b = wilcox.test(BHR.Co[,i])
  WilcoxonBHR[1,i+1] = b$statistic
  WilcoxonBHR[2,i+1] = b$p.value
  c = wilcox.test(BHR.Ind[,i])
  WilcoxonBHR[1,i+3] =  c$statistic
  WilcoxonBHR[2,i+3] = c$p.value
}
print(WilcoxonBHR)
```

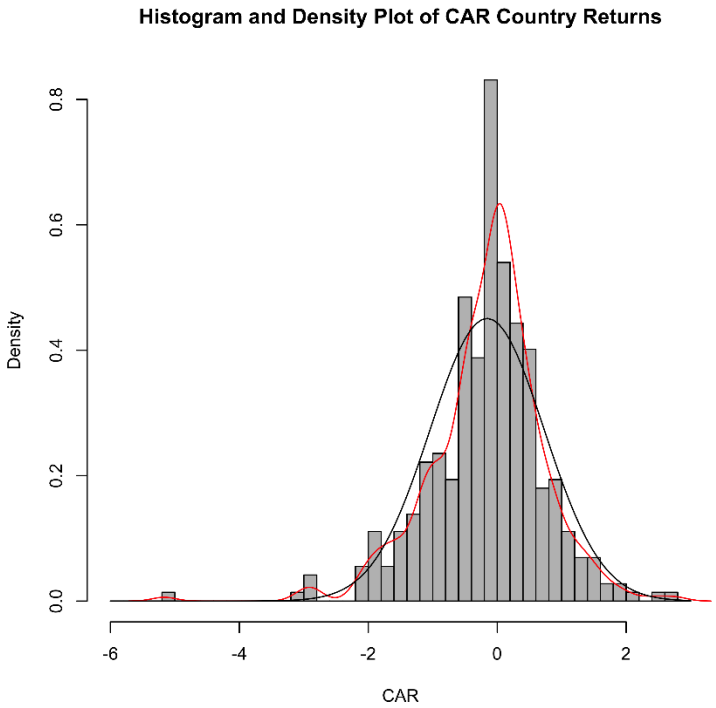
```
#CAR Wilcoxon Tests
WilcoxonCAR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(CAR.Eur[,i])
  WilcoxonCAR[1,i-1] = a$statistic
  WilcoxonCAR[2,i-1] = a$p.value
  b = wilcox.test(CAR.Co[,i])
  WilcoxonCAR[1,i+1] = b$statistic
  WilcoxonCAR[2,i+1] = b$p.value
  c = wilcox.test(CAR.Ind[,i])
  WilcoxonCAR[1,i+3] =  c$statistic
  WilcoxonCAR[2,i+3] = c$p.value
}
print(WilcoxonCAR)


All.Data = read.xlsx("/Users/nicklaslj/Dropbox/1a Master Thesis/R/Long Term/R code
CAR_BHAR.xlsx",sheet=3,startRow=3,colNames=TRUE,skipEmptyRows = TRUE)
CAR.Raw = as.matrix((All.Data[,1:3]))
CAR.Eur = as.matrix((All.Data[,4:6]))
CAR.Co = as.matrix((All.Data[,7:9]))
CAR.Ind = as.matrix((All.Data[,10:12]))

BHR.Raw = as.matrix((All.Data[,13:15]))
BHR.Eur = as.matrix((All.Data[,16:18]))
BHR.Co = as.matrix((All.Data[,19:21]))
BHR.Ind = as.matrix((All.Data[,22:24]))

#Wilcoxon single sample tests
#BHR Wilcoxon Tests
WilcoxonBHR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(BHR.Eur[,i])
  WilcoxonBHR[1,i-1] = a$statistic
  WilcoxonBHR[2,i-1] = a$p.value
  b = wilcox.test(BHR.Co[,i])
  WilcoxonBHR[1,i+1] = b$statistic
  WilcoxonBHR[2,i+1] = b$p.value
```

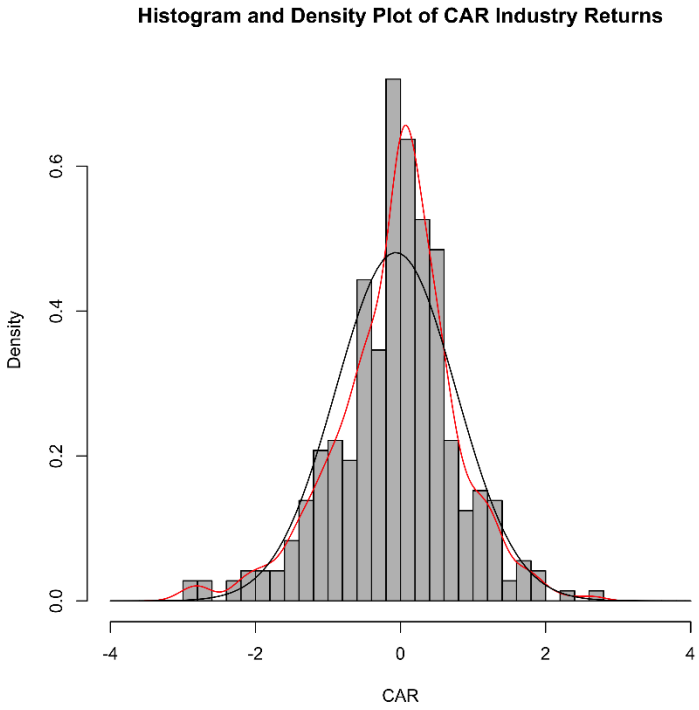
```
  c = wilcox.test(BHR.Ind[,i])
  WilcoxonBHR[1,i+3] =  c$statistic
}
  WilcoxonBHR[2,i+3] = c$p.value
print(WilcoxonBHR)


#CAR Wilcoxon Tests
WilcoxonCAR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(CAR.Eur[,i])
  WilcoxonCAR[1,i-1] = a$statistic
  WilcoxonCAR[2,i-1] = a$p.value
  b = wilcox.test(CAR.Co[,i])
  WilcoxonCAR[1,i+1] = b$statistic
  WilcoxonCAR[2,i+1] = b$p.value
  c = wilcox.test(CAR.Ind[,i])
  WilcoxonCAR[1,i+3] =  c$statistic
  WilcoxonCAR[2,i+3] = c$p.value
}
print(WilcoxonCAR)

All.Data = read.xlsx("/Users/nicklaslj/Dropbox/1a Master Thesis/R/Long Term/R code
CAR_BHAR.xlsx",sheet=4,startRow=3,colNames=TRUE,skipEmptyRows = TRUE)
CAR.Raw = as.matrix((All.Data[,1:3]))
CAR.Eur = as.matrix((All.Data[,4:6]))
CAR.Co = as.matrix((All.Data[,7:9]))
CAR.Ind = as.matrix((All.Data[,10:12]))

BHR.Raw = as.matrix((All.Data[,13:15]))
BHR.Eur = as.matrix((All.Data[,16:18]))
BHR.Co = as.matrix((All.Data[,19:21]))
BHR.Ind = as.matrix((All.Data[,22:24]))

#Wilcoxon single sample tests
#BHR Wilcoxon Tests
WilcoxonBHR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(BHR.Eur[,i])
```

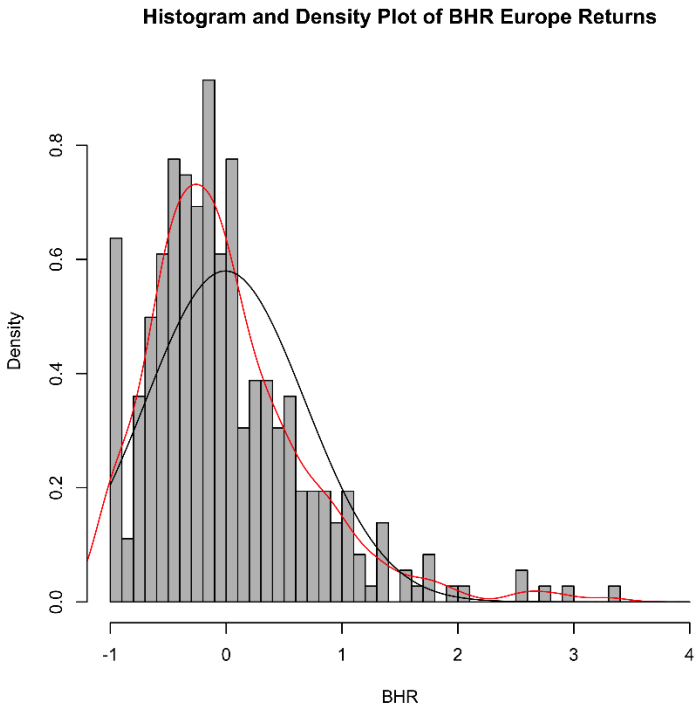
```
  WilcoxonBHR[1,i-1] = a$statistic
  WilcoxonBHR[2,i-1] = a$p.value
  b = wilcox.test(BHR.Co[,i])
  WilcoxonBHR[1,i+1] = b$statistic
  WilcoxonBHR[2,i+1] = b$p.value
  c = wilcox.test(BHR.Ind[,i])
  WilcoxonBHR[1,i+3] =  c$statistic
  WilcoxonBHR[2,i+3] = c$p.value
}
print(WilcoxonBHR)


#CAR Wilcoxon Tests
WilcoxonCAR = matrix(ncol=6,nrow=2,dimnames=list(c("V","p-value"),
                                    c("Europe Non-PE","Europe PE","Country Non PE","Country
PE","Industry Non PE","Industry PE")))
for (i in 2:3) {
  a = wilcox.test(CAR.Eur[,i])
  WilcoxonCAR[1,i-1] = a$statistic
  WilcoxonCAR[2,i-1] = a$p.value
  b = wilcox.test(CAR.Co[,i])
  WilcoxonCAR[1,i+1] = b$statistic
  WilcoxonCAR[2,i+1] = b$p.value
  c = wilcox.test(CAR.Ind[,i])
  WilcoxonCAR[1,i+3] =  c$statistic
  WilcoxonCAR[2,i+3] = c$p.value
}
print(WilcoxonCAR)
```

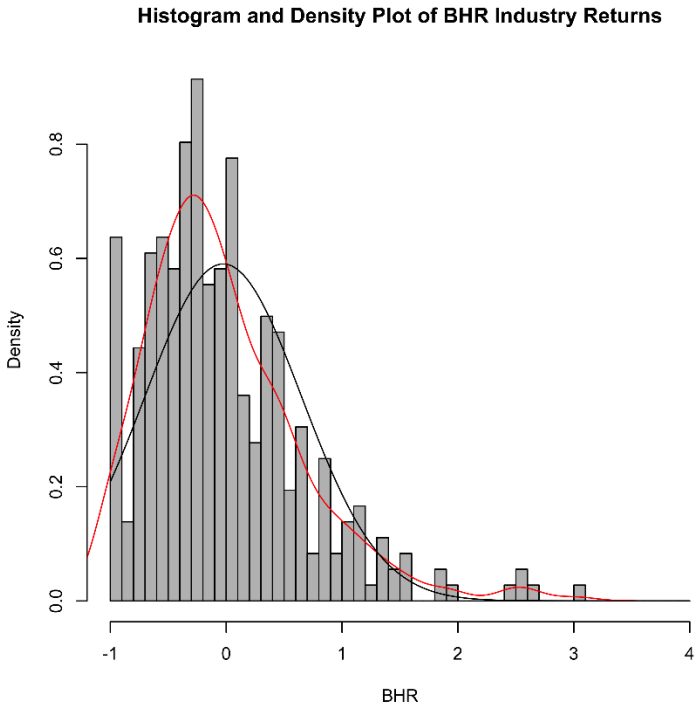
Appendix 10 - Distribution of long-run BHAR and CAR returns

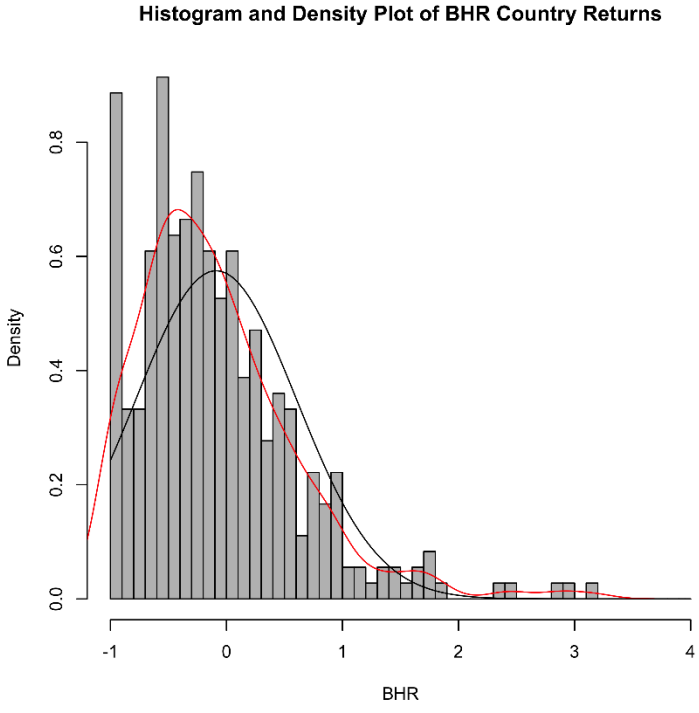





Histogram and Density Plot of CAR Industry Returns
Density
0.0
0.2
0.4
0.6
-4
-2
0
2
4
CAR


Histogram and Density Plot of BHR Europe Returns
Density
0.0
0.2
0.4
0.6
0.8
-1
0
1
2
3
4
BHR


Histogram and Density Plot of BHR Industry Returns
Density
0.0
0.2
0.4
0.6
0.8
-1
0
1
2
3
4
BHR


Histogram and Density Plot of BHR Country Returns
Density
0.0
0.2
0.4
0.6
0.8
-1
0
1
2
3
4
BHR

Appendix 11 – Calendar time CAPM regressions of abnormal returns

SUMMARY OUTPUT

VW full sample

Regression Statistics	
Multiple R	0.68771
R Square	0.47295
Adjusted R Square	0.46728
Standard Error	0.04250
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*'ignificance F*
Regression	1	0.15072	0.15072	83.45	1.38E-14
Residual	93	0.16796	0.00181		
Total	94	0.31868			

	Coefficient	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.00542	0.00436	1.2429	0.2170	-0.00324	0.01409	-0.00324	0.01409
mkt-rf	0.76694	0.08395	9.1352	1.4E-14	0.60023	0.93366	0.60023	0.93366

SUMMARY OUTPUT

EW full sample

Regression Statistics	
Multiple R	0.6781
R Square	0.4599
Adjusted R Square	0.4541
Standard Error	0.0361
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*'ignificance F*
Regression	1	0.10296	0.10296	79.18118	4.376E-14
Residual	93	0.12093	0.00130		
Total	94	0.22390			

	Coefficient	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.00087	0.00370	0.23484	0.81485	-0.00648	0.00822	-0.00648	0.00822
mkt-rf	0.63391	0.07124	8.89838	4.4E-14	0.49244	0.77538	0.49244	0.77538

SUMMARY OUTPUT

VW non-PE backed

Regression Statistics	
Multiple R	0.65177
R Square	0.42480
Adjusted R Square	0.41861
Standard Error	0.04471
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	1	0.13729	0.13729	68.68282	8.473E-13
Residual	93	0.18589	0.00200		
Total	94	0.32318			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.00278	0.00459	0.60520	0.54652	-0.00634	0.01189	-0.00634	0.01189
mkt-rf	0.73197	0.08832	8.28751	8.47E-13	0.55658	0.90737	0.55658	0.90737

SUMMARY OUTPUT

EW non-PE backed

Regression Statistics	
Multiple R	0.69341
R Square	0.48082
Adjusted R Square	0.47523
Standard Error	0.03463
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	1	0.10327	0.10327	86.12719	6.811E-15
Residual	93	0.11151	0.00120		
Total	94	0.21478			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-0.00434	0.00355	-1.22080	0.22525	-0.01140	0.00272	-0.01140	0.00272
mkt-rf	0.63485	0.06841	9.28047	6.81E-15	0.49901	0.77069	0.49901	0.77069

SUMMARY OUTPUT

VW PE backed

Regression Statistics	
Multiple R	0.08681
R Square	0.00754
Adjusted R Square	-0.00337
Standard Error	0.05910
Observations	93

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00241	0.00241	0.69091	0.40803
Residual	91	0.31782	0.00349		
Total	92	0.32024			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.05134	0.00613	8.37655	6.33E-13	0.03916	0.06351	0.03916	0.06351
mkt-rf	0.09857	0.11859	0.83121	0.40803	-0.13699	0.33414	-0.13699	0.33414

SUMMARY OUTPUT

EW PE backed

Regression Statistics	
Multiple R	0.41716
R Square	0.17402
Adjusted R Square	0.16494
Standard Error	0.07314
Observations	93

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.10256	0.10256	19.17196	3.18543E-05
Residual	91	0.48678	0.00535		
Total	92	0.58933			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.02186	0.00758	2.88249	0.00492	0.00680	0.03693	0.00680	0.03693
mkt-rf	0.64262	0.14676	4.37858	3.19E-05	0.35109	0.93415	0.35109	0.93415

Appendix 12 – Calendar time Fama-French regressions of abnormal returns

SUMMARY OUTPUT

VW full sample

Regression Statistics	
Multiple R	0.74817
R Square	0.55976
Adjusted R Square	0.54524
Standard Error	0.03926
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	3	0.17838	0.05946	38.56781	0.00000
Residual	91	0.14030	0.00154		
Total	94	0.31868			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.00509	0.00408	1.24566	0.21609	-0.00303	0.01320	-0.00303	0.01320
mkt-rf	0.80997	0.09234	8.77129	0.00000	0.62654	0.99340	0.62654	0.99340
SMB	0.84731	0.21280	3.98170	0.00014	0.42461	1.27001	0.42461	1.27001
HML	0.23202	0.17961	1.29182	0.19969	-0.12475	0.58879	-0.12475	0.58879

SUMMARY OUTPUT

EW full sample

Regression Statistics	
Multiple R	0.83738
R Square	0.70121
Adjusted R Square	0.69136
Standard Error	0.02711
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	3	0.15700	0.05233	71.18710	0.00000
Residual	91	0.06690	0.00074		
Total	94	0.22390			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.00019	0.00282	0.06580	0.94768	-0.00542	0.00579	-0.00542	0.00579
mkt-rf	0.71021	0.06377	11.13752	0.00000	0.58354	0.83687	0.58354	0.83687
SMB	1.20640	0.14695	8.20974	0.00000	0.91451	1.49829	0.91451	1.49829
HML	0.26710	0.12403	2.15360	0.03391	0.02074	0.51346	0.02074	0.51346

SUMMARY OUTPUT

VW non-PE backed

Regression Statistics	
Multiple R	0.70276
R Square	0.49388
Adjusted R Square	0.47719
Standard Error	0.04240
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.15961	0.05320	29.59941	0.00000
Residual	91	0.16357	0.00180		
Total	94	0.32318			

	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.00232	0.00441	0.52521	0.60072	-0.00644	0.01108	-0.00644	0.01108
mkt-rf	0.78267	0.09971	7.84951	0.00000	0.58461	0.98073	0.58461	0.98073
SMB	0.77749	0.22977	3.38371	0.00106	0.32107	1.23390	0.32107	1.23390
HML	0.16574	0.19393	0.85461	0.39501	-0.21949	0.55096	-0.21949	0.55096

SUMMARY OUTPUT

EW non-PE backed

Regression Statistics	
Multiple R	0.83548
R Square	0.69803
Adjusted R Square	0.68807
Standard Error	0.02670
Observations	95

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.14992	0.04997	70.11799	0.00000
Residual	91	0.06486	0.00071		
Total	94	0.21478			

	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-0.00525	0.00278	-1.89067	0.06185	-0.01077	0.00027	-0.01077	0.00027
mkt-rf	0.72625	0.06279	11.56699	0.00000	0.60153	0.85097	0.60153	0.85097
SMB	1.14381	0.14469	7.90538	0.00000	0.85641	1.43122	0.85641	1.43122
HML	0.17303	0.12212	1.41689	0.15993	-0.06955	0.41560	-0.06955	0.41560

SUMMARY OUTPUT

VW PE backed

Regression Statistics	
Multiple R	0.14738
R Square	0.02172
Adjusted R Square	-0.01125
Standard Error	0.05933
Observations	93

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.00696	0.00232	0.65869	0.57963
Residual	89	0.31328	0.00352		
Total	92	0.32024			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.05157	0.00622	8.29551	0.00000	0.03922	0.06393	0.03922	0.06393
mkt-rf	0.08553	0.14235	0.60087	0.54946	-0.19731	0.36838	-0.19731	0.36838
SMB	-0.34559	0.32381	-1.06726	0.28874	-0.98899	0.29781	-0.98899	0.29781
HML	-0.09876	0.27572	-0.35819	0.72105	-0.64661	0.44909	-0.64661	0.44909

SUMMARY OUTPUT

EW PE backed

Regression Statistics	
Multiple R	0.58687
R Square	0.34442
Adjusted R Square	0.32232
Standard Error	0.06589
Observations	93

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.20298	0.06766	15.58598	0.00000
Residual	89	0.38635	0.00434		
Total	92	0.58933			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0.02166	0.00690	3.13728	0.00231	0.00794	0.03538	0.00794	0.03538
mkt-rf	0.62417	0.15808	3.94841	0.00016	0.31007	0.93828	0.31007	0.93828
SMB	1.48204	0.35960	4.12140	0.00008	0.76753	2.19654	0.76753	2.19654
HML	0.72237	0.30619	2.35919	0.02050	0.11397	1.33076	0.11397	1.33076