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European Private Equity Fund Performance

Evaluating cross-sectional variation of returns from the perspective of limited partners

by

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Abstract In this study, we evaluate the performance of 395 private equity funds by European private equity firms between 1989 and 2018, using real cash flow data gathered from Preqin. The evaluation involves using absolute- and relative performance measures. We adopt the public market equivalent framework to measure relative performance, which compares the returns of a private equity fund with a reference benchmark. We also test if fund-characteristics, such as size, sequence, country and fund-type, have a significant impact on performance. The main empirical findings are: 1) European private equity firms outperformed the S&P 500 by 5.6% 2) Buyout funds significantly outperformed Venture capital funds 3) Greece is the only country in the sample that systematically underperformed 4) First-time funds tend to experience lower returns than follow-up funds 5) European Private equity firms experienced persistence in returns, where previous fund performance significantly impacted subsequent funds' performance for a specific partnership.

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Contents

List of Figures

List of Tables

1 Introduction

The private equity market experienced tremendous growth during the 1980s due to the emergence of a new enterprise setting that significantly reduced information asymmetries and incentives problems associated with investing in private equity (PE). The emergence of limited partnerships, (LP), enabled investors to improve the agency set by the introduction of intermediaries to monitor and manage the target firms using formal and informal control rights. These intermediaries are referred to as Private Equity Firms (PEF), which specializes in structuring, finding and managing equity investments in the PE markets (Fenn et al., 1997).

The PEF raises capital through their own PE funds, where investors commit to providing capital for the investments and agree to pay management fees to the PEF. A PE fund is analogous to a limited partnership, where the general partners (GP) are the informed agents and the LPs serve as the uninformed principals. The GPs are representatives or managers of the PEF, which takes a role as active monitors and advisors for the portfolio companies. The LPs usually consist of institutional investors, such as corporate and public pension funds and insurance companies (Kaplan and Stromberg, 2009).

Nevertheless, this setting is still suffering from information asymmetries and interest misalignment, where LPs still have to rely heavily on the reputation of the GPs and the direct positive incentives in the partnership agreement to facilitate incentive alignment (Fenn et al., 1997).

A variety of reports have highlighted the potential agency issues, arguing that GPs benefit from disclosures that can mislead the LPs during the fundraising or follow up funding cycles. As these disclosures often involve presenting inaccurate and or inflated performance metrics, where GPs have the discretion to manage interim reports in a manner that glorifies the performance of their fund (Jenkinson et al., 2013).

GPs often apply various valuation methodologies when calculating the Net Asset Value (NAV) of a fund due to the illiquid nature of many private companies, which can increase the probability of opportunistic and erroneous valuations.

The internal rate of return (IRR), is typically the primary performance metric presented and used in interim reports. The IRR signifies the discount rate at which the present value of the sum of all future cash flows is equal to zero. However, the metric's outcome is highly sensitive to timing and investment size which can lead to questions about the legitimacy and credibility of the PEF funds true performance. Managerial discretion regarding the timing and size of the investment can artificially increase the IRR, which leads to erroneous valuations (Sorensen and Jagannathan, 2015). In addition, the metric yields no information regarding the opportunity cost or the risk of the investment.

As a result, institutional investors should be cautious when forming an investment decision based solely on the interim reports IRR performance indicators. This dependence on IRR, with its inherent GP conflict of interest sparked a debate about the true performance of PEFs and if they can create value for the LPs. Consequently, the public market equivalent (PME), was created as a remedy for the issues associated with the standard performance metrics such as the IRR" (Sorensen and Jagannathan, 2015).

The performance measures in the PME framework attempt to measure the opportunity cost of a private equity investment by comparing the returns of a PE portfolio against a reference benchmark (Gredil et al., 2014). Empirical evidence suggests this framework is superior in predicting PEF true performance (Jenkinson et al., 2013).

Furthermore, the introduction of the PME framework creates an additional method to evaluate historical PEF performance to yield information concerning the value-contribution of PE funds to LPs. Several reports have evaluated PEF performance by comparing traditional performance metrics against the PME framework measures by using cash-flow data of PE funds. For instance, Harris et al. (2014a) evaluated PE fund performance by using a large dataset of 1800 PEFs. The report highlights several perspectives of PE fund performance, such as geographic focus, cross-sectional variation, persistence, timing and risk.

This report aims to extend to previous research regarding PE fund performance and incorporate new evaluation perspectives to explain any cross-sectional variation in returns of PE funds in Europe. The report will adopt all of the available performance measures within the PME framework and compare the metrics against the standard PEF performance measures such as IRR and total value to paid-in (TVPI). In aggregate, the study aims to contribute to existing literature concerning new factors that may explain the performance of private equity funds.

The report will study:
a. any evidence of variation or similarity in performance between the countries in Europe using the different performance frameworks.
b. perform a time analysis of the sample to examine differences in returns for each vintage year
c. provide an overview of descriptive statistics concerning the distribution of profits between PE funds
d. examine factors such as size, sequence and fund-type impact on performance

The outline of the thesis will be as follows:
a. Chapter 2 will contain previous literature regarding private equity fund performance, where relevant empirical evidence is presented and outlined. Additionally, it will also provide an introduction to the private equity market and present information regarding the different parties involved in this agency setting.
b. Chapter 3 consists of a presentation of the data collection and preparation

methods.
c. Chapter 4 discuss the methodology used in this study.
d. Chapter 5 outlines the results and empirical evidence of this paper.
e. Chapter 6 discusses the findings presented in Chapter 5 and highlights potential improvements for future research.

2 Theory

2.1 The private equity market

The PE market consists of professionally managed equity investments in unregistered shares of private and public companies (Fenn et al., 1997). PEFs manage equity investments and act as intermediaries between investors and the issuing firms. The intuition behind the organizational form is to reduce agency issues and strengthen control rights to facilitate interest alignment between investors and management (Fenn et al., 1997). Fenn et al. (1997) outline the main participants in the organised PE market as; issuers, intermediaries and investors.

Issuers are simply firms in need of raising capital to finance and expand their operations. The issuers can be public companies, middle-market companies or small businesses. Further, PE funds are acting as intermediaries. Under the partnership agreement, the investors serve as LPs, whereas the managers of the PE firm acts as the GPs. Lastly, investors in PE markets are usually pension funds, endowments, and insurance companies which commits to providing a predetermined amount of capital to finance investments and management fees. In short, PEFs are agents that act on behalf of its investors, where the managers of the PE firm have the means and incentives to impose both formal and informal control over the portfolio companies.

Furthermore, Fenn et al. (1997) also outlines the main motives behind the intermediation in the PE market and suggested that the organizational form can reduce some of the sorting and incentive problems that arise in PE markets. The sorting problem is associated with information asymmetries between owners of a firm and outsiders, where owners typically hold much more information concerning the condition of their business compared with outsiders. The authors suggested that owners are inclined to accent positive and sound information and are reluctant to disclose potential challenges and existing issues of the business.

In short, the incentive problem refers to the tendency of managers to act in self-interest activities versus that of outsiders. For instance, the managers can participate in activities that yield personal benefits at the expense of outsiders, such as perk consumption and over-investments. The authors further suggested that the organizational form of PEFs can solve some of the sorting and incentives problems by the GPs ability to perform intensive pre-investment, due diligence and post-investment monitoring.

2.1.1 Structure and investment scheme

PEFs raises capital through their PE funds, where the fund is a closed-end vehicle and have a finite lifetime, usually ten years (Kaplan and Stromberg, 2009). The fund typically takes the organizational form as a limited partnership, where the GPs manage the fund, and the LPs provide the necessary capital to fund the investments. The rationale behind the investments is to acquire a substantial interest in the issuer's equity in order to provide extensive oversight over the portfolio companies. The primary objective of the PE fund is to restructure the targets company's reserve capital, management and organizational infrastructure to increase the value of the firm (Cumming and Walz, 2010).

Jensen (1989) argued that the financial, governance and operational engineering of PEFs imply more careful attention to management incentives, where increased management ownership and leverage effectively functions as a governance mechanisms. The governance mechanism of leverage and management ownership can instill discipline upon the management to improve economic value.

The holding-period for investments is usually three to seven years, where the GPs function as active monitors and furnish portfolio companies with financial, operating and marketing expertise (Fenn et al., 1997). The last stage of the investment scheme is the exit, where the exit route can either be a public offering, a private sale or a stock buy back. One significant distinction in these investments schemes is the choice of investing in different types of target companies. Typically the industry is divided into two types of investing activities which are; venture capital- and buyout (Phalippou, 2007).

2.1.2 Venture capital funds

Venture capital firms specialize in investing in early and small companies with high growth potential (Kaplan and Stromberg, 2009). The target companies are typically firms that cannot raise capital in public equity- and debt markets because of the lack of historical performance and extensive risk properties (Fenn et al., 1997). The rationale behind investing in these companies is the growth potential and return premium they could generate.

PE markets experienced a surge in commitments towards venture capital partnerships in the early 1980s. Partnership commitments increased fivefold between the years of 1980 to 1984, from 600$ million to 3$ billion (Fenn et al., 1997). Today, capital commitments to venture capital funds equal approximately 257$ billion dollars in 2019 (Pitchbook, 2019).

2.1.3 Buyout funds

Buyout funds are non-venture investment schemes, meaning that buyout funds usually acquire a sizeable controlling interest in more established and mature businesses where the transactions are often primarily financed by debt (Ljungqvist et al., 2020).

Leverage buyouts became an essential phenomenon in the 1980s, where proponents predicted it would become the dominant corporate organizational form (Jenkinson et al., 2013; Kaplan and Stromberg, 2009). Nevertheless, this prediction was flawed as the leverage buyout market experienced severe default rates and bankruptcy in the 1990s (Kaplan and Stromberg, 2009).

The industry recuperated in the 2000s, experiencing a record amount of capital commitments in 2006 and 2007 (Kaplan and Stromberg, 2009). Today the assets under management in the buyout sector are approximately 1.645$ trillion (Preqin, 2020).

2.1.4 Compensation and fees

GP compensation usually follows three different reimbursement programs. The two main PEF programs involve a management fee and a share of partnerships profits; the latter referred to as "*carried interest*" (Kaplan and Stromberg, 2009; Fenn et al., 1997).

The management fee usually consists of a percentage of capital committed and a percentage of capital employed, and typically varies between one to three per cent. The carried interest usually equals 20% of the profits of the PE fund. Lastly, GPs may also charge deal and monitoring fees to the portfolio companies (Kaplan and Stromberg, 2009).

The deal and monitoring fees are not exclusive to the GPs, as the fees are usually shared between LPs and GPs via a 50-50 arrangement (Kaplan and Stromberg, 2009).

2.1.5 Agency issues

Although PE funds may solve some of the agency issues of investing in PE markets, the setting is not entirely without flaws. The incentives- and sorting problems of PE investments is limited by the GP's capacity to provide extensive oversight over the portfolio companies.

However, the setting gives rise to the same information- and incentive problems between LPs and GPs, where LPs have to rely heavily on the reputation of GPs, provisions and covenants (Fenn et al., 1997).

Prior research highlighted information asymmetries and incentive problems that still exists under the organizational form. Cumming and Walz (2010) argue that GPs tend to report inflated and distorted interim fund performance figures during times of fundraising in follow up funds to maintain an active deal-flow. PEFs typically use interim fund performance of current funds to market follow up funds to institutional investors (Jenkinson et al., 2013).

Furthermore, the illiquid nature of PE funds enables GPs to apply various valuation methodologies when calculating the net asset value, which makes valuation figures subjective and influenced by individual judgement (Jenkinson et al., 2013). Hence, institutional investors should be cautious when forming an investment decision based solely on interim fund performance for follow up funds (Jenkinson et al., 2013).

Jenkinson et al. (2013) investigated the relationship between interim fund performance and final fund returns and examined the reliability and consistency of performance disclosures during the lifetime of PE funds. The authors found no significant relationship between interim and final internal rate of return in the cross-section of the funds analyzed, indicating that interim internal rate of return has no predicting power in estimating final fund internal rate of return.

Nevertheless, the authors found a significant relationship in the current- and follow-up fund performance using alternative performance frameworks such as the PME. The authors also concluded that inflated valuations during times of fundraising exists compared to other periods in the lifetime of the fund.

Barber and Yasuda (2017) found similar results in the timing of GPs fundraising activity, especially when performance ranked is at its peak. The authors further concluded that GPs with little accumulated reputational capital had a higher proclivity to report inflated performance metrics, as GPs with established track records and strong reputations risk losing far more reputational capital by manipulating fund performance.

2.1.6 Performance frameworks

The two main performance measures most commonly used in PE markets are the internal rate of return (IRR) and the total value in paid capital (TVPI) (Metrick and Yasuda, 2010). IRR is the discount rate when the present value of all future cash flows of an investment equals zero. In other terms, the IRR is often analogous to the annual yield of the investment's underlying cashflows.

The TVPI signifies the total value created from an investment by taking the cumulative distributions and residual value of the fund divided by the committed capital from the investors. The TVPI and IRR offers a simplistic and straightforward approach to evaluate the performance of illiquid assets and are the two most used measures by practitioners in PE markets (Phalippou, 2007).

The standard performance measures are subject to several shortcomings, which can significantly affect their reliability and legitimacy. For instance, Phalippou (2007) argued that IRR is one of the worst measures to adopt when evaluating performance due to IRR's ability to exaggerate the performance and variation across funds. Phalippou (2007) argued the reinvestment assumption of the measure implies that the effective annual return is only equal to the IRR if intermediary cashflows are invested using the IRR rate. Consequently, a high (low) IRR causes a large positive (negative) spread between the effective annual return of investors and the fund's IRR. Hence, the measure may significantly overemphasise fund performance. Moreover, the assumption of reinvestment also distorts figures of variation and distribution, especially where observed performance is more dispersed than actual performance. Additionaly, Phalippou (2007) concluded that IRR can be easily inflated when managers optimize the size and timing of cash flows. Lastly, neither of the standard performance measures yields information regarding the opportunity cost and risk of the investment (Harris et al., 2015).

In conclusion, investors should treat performance information in the marketing material of PE funds with extreme caution and should seek alternative performance frameworks, such as the PME, when evaluating fund performance (Jenkinson et al., 2013)

2.2 PME

The public market equivalent framework,(PME), attempts to solve some of the pitfalls of the primary performance measures in PE markets such as IRR and TVPI. The framework provides an intuitive solution by comparing a PE investment against an equivalently-timed investment in a reference benchmark (Gredil et al., 2014). The reference benchmark represents the cost of capital and is used to discount distributions, contributions and residual net asset value of a fund at a single point in time. Today, there are several approaches to measure the excess return of a PE investment compared with a public equity investment.

2.2.1 Heuristic approaches to estimate alpha

There are three primary methods to estimating the annualized alpha of PE investments (Gredil et al., 2014). Long and Nickels (1996) introduced the first approach in 1996, which is referred to as the index comparison method (ICM). Followingly, Rouvinez (2003) and Capital dynamics developed a new approach called public market equivalent plus (PME+) in the early 2000s to solve some of the shortcomings with the original ICM model. Cambridge associates released an approach in 2013, which is called the modified public market equivalent (mPME).

All the heuristic approaches build hypothetical portfolios in the public market, from whose performance they then approximate excess return as the delta between the IRR's of the two portfolios. Thus, the approaches indirectly estimate alpha by divesting and investing the PE portfolio's cashflows in a reference benchmark, where the spread between the two portfolios is the excess return (Gredil et al., 2014).

2.2.2 ICM/PME

Long and Nickels (1996) introduced the first PME measure aimed to calculate the opportunity cost of private investments. The intuition of their ICM model is to create a hypothetical portfolio by using the cashflows of a PE fund and the returns of a reference benchmark, to determine the equivalent return received from investing the PE fund's cashflows in public equity markets.

The hypothetical portfolio will match every capital contribution to the PE fund with an equally sized investment in the public benchmark. Likewise, the portfolio will match every distribution of the PE fund with an equally sized unwinding of the portfolio. Therefore, the stream of cash flows of the portfolios will be identical. However, the hypothetical portfolio will yield a different residual value since the invested amount of capital is affected by changes in the reference benchmark. The spread in IRR between the two portfolios is the excess return.

Long and Nickels (1996) PME enables institutional investors to calculate the opportunity cost of a PE investment with a simple and straightforward approach that provides a superior guidance compared to the standard performance measures. Nevertheless, the model exhibits several shortcomings which may lead to erroneous inferences.

For instance, the hypothetical portfolio does not necessarily liquidate in the same manner as the PE portfolio (Gredil et al., 2014). Consequently, strong outperformance (underperformance) of the PE portfolio results in the reference portfolio carrying a larger short (long) position close to liquation. Thus, changes in the benchmark may have little effect on the value of the unrealized investments, but a significant impact on the residual NAV of the reference portfolio.

Furthermore, Long and Nickels (1996) argue that large distributions of the PE fund may result in a negative NAV of the reference portfolio. A short position leads to counterintuitive results as an appreciation of the benchmark leads to a lower residual NAV of the reference portfolio (Long and Nickels, 1996).

2.2.3 PME+

Rouvinez (2003) and Capital dynamics developed the PME+ measure as a remedy for some of the weaknesses in the original ICM/PME model. The PME+ model solves the ICM models negative residual value problem by introducing a scaling factor. The intuition of the scaling factor is to generate the same residual value of the reference portfolio during liquidation, by deducting the future values of scaled distributions from the reference portfolio.

Although PME+ solves the negative residual value problem of the ICM model, it still exhibits several shortcomings. Gredil et al. (2014) argue that the model is sensitive to situations of outperformance (underperformance), where downscaling (upscaling) distributions has an inflating effect on the positive (negative) IRR. Secondly, the measure may not apply well to younger PE portfolios with cases of few or no distributions.

Lastly, the reference portfolio does not represent an investable portfolio since the calculation of the scaling factor depends on the net asset value of the PE portfolio at the time of the analysis.

2.2.4 mPME

Cambridge Associates (2013) created the mPME model as an additional alternative to solve the negative NAV issue of the ICM model. Similarly, to PME+, the model attempts to construct a reference portfolio with the same liquidation scheme as the PE portfolio. Likewise, the measure involves using scaled distributions to match the PE fund's residual value during liquidation.

However, unlike PME+, mPME uses different scaling factors for cash flows at different time-periods. The scaling factors depend on the succeeding interim net asset value of the PE fund.

Nevertheless, this measure introduces several issues similar to the PME+ method. Although the scaling factor is time-varying, it still causes an inflating effect on the IRR. Further, pricing errors of interim fund balances may yield additional biases (Gredil et al., 2014). This measure will not be tested in this report.

2.2.5 Non-additive feature of compound rates

All of the heuristic measures offer an intuitive and straightforward approach to calculating the alpha of a PE investment compared with a benchmark. The heuristic approaches follow the same analogy as Cauchys functional equation.

$$f(x+y) \tag{2.1}$$

$$f(y) = f(x+y) - f(x) \tag{2.2}$$

y: α of PE fund
x: Equivalent benchmark return of reference portfolio

However, since compound rates such as IRR are non-additive, the approaches does not offer the correct rate of excess returns and should only be used as an approximation.

There are two additional methods which aim to calculate the excess return in a more direct way. These approaches attempt to resolve the issue of the non-additive nature of compound rates.

2.2.6 KS-PME

The Kaplan and Scholar PME approach,(KS-PME), generates a market multiple instead of an IRR. Thus, the approach does not aim to estimate the annualized excess return and instead focuses on the discrepancy of the acquired wealth during the entire investment period.

The investment strategy involves investing all the contributions into the PE fund by short-selling the benchmark and later reinvesting all distributions in the benchmark until time n. Hence, the calculation is similar to TVPI, but instead uses future compounded values of distributions and contributions.

A KS-PME ratio above one signifies that the LPs were able to generate an excess return over the respective benchmark, whereas a ratio under one indicates that the PE investment generated inferior returns compared to the benchmark.

In conclusion, the measure has several advantages when compared to the heuristic approaches. Those advantages include increased reliability and precision. Conversely, a disadvantage of the measure is that the ratio does not yield any information regarding the period per period rate of excess wealth.

2.2.7 Direct Alpha

Gredil et al. (2014) introduced the direct alpha method to resolve the inability of the KS-PME method to estimate annualized excess returns. This method generates a precise and robust estimate of alpha by considering both the point in time of employed capital and the performance of the benchmark.

Similarly to KS-PME, the calculation involves taking the capitalized values of the distributions and contributions of the PE fund, compounded by the returns of the benchmark. Followingly, the measure involves deducing the IRR by using the future valued distributions, contributions and NAV. The last step involves a conversion of the IRR to its natural logarithm.

Prior research suggested that the measure is superior in calculating the excess annualized return, compared to other heuristic PME approaches.

Gredil et al. (2014) study highlights the deviance between the direct alpha method against all the PME approaches. The authors use a sample of 5300 PE funds between the years of 1980 to 2007 to evaluate the relative performance, using the S&P 500 index as a benchmark. The empirical evidence suggested significant deviance in excess return using the ICM and direct alpha approaches, which was most prominent for mature funds with large values of alpha. Additionally, in 9% of all cases, the ICM was unable to yield a correct calculation of the spread due to the negative residual value issue.

Furthermore, the results also indicate that the PME + approach was superior in calculating excess return for small values, compared with the ICM approach. However, in approximately 2% of the cases the calculation of the PME+ was not possible as there was no distributions to LPs.

Lastly, the authors concluded that the difference between the annualized KS-PME and direct alpha is smaller than all of the heuristic approaches.

Moreover, the authors also examined the differences in performance distribution between the approaches for each vintage year. The findings suggested that 75.2% of the top-quartile funds assigned by the direct alpha method will also be placed in top-quartile when adopting ICM/PME. The evidence also suggested that 15.4% of the top-quartile funds of the direct alpha approach are present in the third-quartile when using the ICM method. Followingly, the authors conclude a greater consistency in performance distribution between the PME+ and the direct alpha compared the ICM approach, where 90% of all the funds are placed in the same quartile.

However, the PME+ approach still has a higher probability of assigning a lower quartile other than the same. Lastly, the authors suggested that heterogeneity in cash flow patterns significantly affects the ranking of the ICM and PME+ methods, which may lead to faulty inferences.

In conclusion, Gredil et al. (2014) argued that the direct alpha is the superior approach when evaluating the performance of PE investments compared a benchmark. All the heuristic approaches are less straightforward and more ambiguous, therefore they yield more unreliable results (Gredil et al., 2014).

2.3 Previous performance findings

Several studies have highlighted the performance of PE funds compared with public equity markets. For instance, Harris et al. (2015) evaluated PE performance in the US and Europe by using a sample of 1800 PE funds gathered from Burgiss between 1984 and 2014. The authors adopted the measures used in the PME framework and standard performance metrics to evaluate the opportunity cost, where they divided the sample into the two primary subcategories of PE which are; venture capital and buyout.

Similarly, Kaplan and Schoar (2005) investigated PE returns between 1980 and 2001 by using a cashflow dataset gathered from Venture economics. The report primarily focused on the persistency of PE funds and investigated factors which may explain heterogeneity in performance, such as size and sequence.

Phalippou and Gottschalg (2009) extended the research of Kaplan and Schoar (2005) by imposing a superior selection criterion by adding more data to their original sample.

Higson and Stucke (2012) then examined the performance of North American PE funds between the vintage years of 1980 to 2010. The authors also analyze the robustness of their findings by evaluating the significance of benchmark, fund size and sequence. The authors also highlight the importance of data gathering and potential selection biases of different data sources.

2.3.1 Standard performance measures

Harris et al. (2015) examined the difference between venture capital and buyout funds by constructing a time-series of the performance measures during the sample period. The result indicated variation in performance across the vintage years, with significant cyclical patterns. Buyout funds yielded a mean IRR of 15.7% during the vintage years and an average investment multiple of 2.02. However, adopting weighted capital averages resulted in a different outcome, with an average IRR of 12.4% during the sample period.

The performance of buyout funds peaked in the early 1990s and then experienced a rebound in the early 2000s. The authors argued that venture capital funds experienced a wider dispersion of performance during the sample period, where multiplies and IRR's were remarkably high in the mid-1990s. For instance, the average IRR was approximately 81% during 1996. Nevertheless, the authors concluded that the deterioration in venture capital funds performance after the years of 1998 was due to the dot-com boom.

Higson and Stucke (2012) also found evidence of cyclical patterns in the performance of US buyout funds. The authors concluded that there were IRR and TVPI (25% and 2,5) values at the beginning of the 1980s. Followingly, the IRRs and TVPIs deteriorated in the early 1990s due to excessive leverage and weak market conditions. The industry recuperated at the end of the 1990s, where the IRRs and TVPIs increased at the beginning of the 2000s.

Nevertheless, the authors presented significantly lower average IRR and TVPI (8.0% and 1.41) values compared with the findings of Harris et al. (2015). The choice of data source and different sample period may explain the variation in performance.

Lastly, Kaplan and Schoar (2005) reported an average IRR of 18% between 1980 and 2001. The authors also concluded that there was significant time-series variation during the sample period. The most prominent finding was the variation in performance in venture capital funds during the sample period, where the funds experienced single-digit IRRs in the years between 1980 and 1998. While since 1998 the venture capital funds have experienced double-digit IRRs.

2.3.2 PME framework

Harris et al. (2015) investigated the opportunity cost of venture capital and buyout funds by adopting the measures in the PME framework. The empirical evidence suggested that buyout funds consistently outperformed the S&P 500 when using the PME/ICM method. The weighted average PME was 1.25 during the vintage years. While the weighted average buyout PME exceeded one for 25 of the 27 years of the sample period. Neglecting the vintage years, the average fund PME was 1.18, and the median was 1.09.

Moreover, the authors adopted the direct alpha method to study the excess annualized return by using the S&P 500 as a benchmark. The results suggested an average direct alpha of 3.07% and a capital weighted-average of 3.16%.

Harris et al. (2015) findings indicated that US buyout funds significantly outperformed public markets by 20% over the funds lifetime or 3% annually. Nevertheless, the performance has deteriorated in the recent years of the sample period, where the performance of PE funds has approximately matched the performance of public markets.

The authors also adopted the PME and direct alpha approaches for the venture capital funds of the sample. Venture capital fund performance was significantly different compared with the performance of buyout funds. The results indicate a PME below one for the first years of the sample, but then significantly increased after 1986. Weighted average PMEs exceeded 1.0 between 1987 and 1998, where a PME above 4.0 was recorded in the year of 1996. Followingly, the performance diminished from 1999 to 2002, which was depicted by a PME at or below 0.91. However, the performance experienced a rebound after 2006, where the PME exceeded 1.0 between 2007 and 2010.

Venture capital funds generated an average direct alpha of 2.07%. Similar to the PME measures, the authors found considerable variation in performance between vintage years when adopting the direct alpha approach; as the direct alpha rose to a double digit number in the 1990s, and then radically decreased in the years following 1999.

Kaplan and Schoar (2005) produced inconsistent results compared with the findings of Harris et al. (2015). The authors used a sample gathered from TVE that covers the years between 1980 and 2001. Their findings suggested an equally-weighted average PME for buyout and venture capital funds of 0.96 and 0.97, respectively. Nevertheless, when adopting the value-weighted approach, the combined average PME increases from 0.96 to 1.05. The authors noted significant differences between venture capital and buyout funds, where the venture capital funds yielded an average PME of 1.21, compared to average PME of 0.93 for buyout funds. Hence, results indicate similar yields of investing in PE compared with investing in the S&P 500, where venture capital funds outperformed the market and buyout funds underperformed.

Phalippou and Gottschalg (2009) also found evidence of underperformance. The authors estimated annualized underperformance of approximately 3% between 1980 and 2003. The authors used the same sample and data sources as Kaplan and Schoar (2005)'s study. However, Phalippou and Gottschalg (2009) imposed a more redefined selection criterion which yielded a more representative sample. The selection criteria involve using funds over ten years old with no recent activity, which implies liquidation of all of the funds used in the sample. Additionally, the authors extended the sample to include data from VentureXpert. The authors research yielded an average combined PME of 0.88 for both buyout and venture capital funds during the sample period. Phalippou and Gottschalg (2009) argued that persistence, mispricing and side benefits are the factors which may explain the attractiveness of PE, despite its underperformance.

Lastly, Higson and Stucke (2012) found evidence of strong outperformance for North American buyout funds during 1980 to 2008. Their findings suggested an annualized excess return of roughly 500 basis points compared to investing in the S&P 500. The authors argued that the dataset used in the study of Kaplan and Schoar (2005) and Phalippou and Gottschalg (2009) exhibited systematic downward bias in performance, as some of the funds in the TVE dataset excluded cashflow data. Moreover, Higson and Stucke (2012) also argued that the "no further cash flow" selection criterion used in those studies allowed the authors to oversample incomplete funds, which is the primary reason behind the downward bias. Therefore, the reports excluded mature funds with little cashflow activity, such as dividend payments.

Higson and Stucke (2012) intended to extend previous research to solve the ambiguity regarding the performance of PE funds. The methodology of the report involves using an improved selection criterion and a superior database (Cambridge Associates) to yield more reliable inferences. The authors research produced an equally-weighted average PME of 1.21 during the vintage years of 1980 to 2010. Thus, the findings indicate a strong outperformance compared to investing in the relative benchmark. The authors also note a substantial increase in relative performance when excluding the years from 2006 to 2008, where the annualized average excess return increases to 809 basis points per annum.

2.3.3 Sensitivity to benchmark

The results of different PME approaches can significantly change depending on the choice of benchmark. The standard approach is to use the S&P 500 index to calculate the discount rates for the capitalization of cash flows. Nevertheless, the S&P 500 is not a comparable benchmark in terms of liquidity, size and leverage, where some studies incorporate different indices that more appropriately reflects the characteristics of the PE industry (Higson and Stucke, 2012).

Harris et al. (2015) test the sensitivity of the PME methods to the choice of benchmark. The authors conclude that PE funds outperformed public equity markets during the sample period, regardless of the choice of benchmark. Although the choice of size and value benchmarks reduces outperformance of buyout funds marginally, it does not fully diminish it.

Higson and Stucke (2012) attempted to test the sensitivity of the benchmark when adopting the PME measure. The authors compared the outcomes when changing the benchmark from the S&P 500 to the S&P 600 small-cap. The S&P 600 small-cap index consists of companies with equity values between $200m and $1000m, which more appropriately match past buyout transaction sizes. The authors find that the change in benchmark reduces the outperformance by roughly 300 basis points. Moreover, the results translate into a weighted average IRR spread of 184 basis points.

Finally, Phalippou and Gottschalg (2009) investigated the difference in relative performance when using a wide variety of indices with different geographic focuses. The results indicated a marginal change in performance when changing the benchmark to the NASDAQ or European market index.

Therefore, the authors concluded that the finding of underperformance is robust and valid, and is unaffected by the choice of benchmark.

2.3.4 Sensitivity to systematic risk

The illiquid nature of PE funds can cause a variety systematic risk estimating challenges. For instance, the standard CAPM model requires time-series data concerning the market value of the assets. Consequently, the PME calculation does not implicitly include a mechanism that accounts for the systematic risk of the investment. However, if the beta of the investments equals one, the model explicitly accounts for the systematic risk as the standard CAPM discount rate equals the expected market return (Sorensen and Jagannathan, 2015).

Several studies were undertaken to test the PME measures sensitivity to systematic risk. Phalippou and Gottschalg (2009) argued that the assumption of a beta equal to 1 is likely to overstate relative performance since most PE funds operate with higher leverage or invest in immature companies. Thus, there are incentives to adjust index returns to yield discount rates that more appropriately reflect the true risk characteristics of the PE investment (Sorensen and Jagannathan, 2015). Nevertheless, Sorensen and Jagannathan (2015) suggested that the PME approach is valid regardless of the underlying risk of the PE investment, and is robust as long as the benchmark is reasonable.

Harris et al. (2015) attempted to test the PME sensitivity to beta or systematic risk by simulating discount rates which correspond to beta values of 1.5 and 2. The methodology involved levering the benchmark to facilitate different levels of systematic risk. Buyout funds experienced an average PME of 1.18, 1.2 and 1.3 assuming betas of 1.0, 1.5 and 2.0 respectively. Venture capital funds were able to generate an average PME of 1.23, 1.21, and 1.27 assuming betas of 1.0, 1,5 and 2.0. Hence, the authors concluded that systematic risk does not explain the abnormal return for buyout- and venture capital funds and that the results are robust when applying different assumptions regarding benchmark and beta.

Robinson and Sensoy (2013) also investigate PMEs sensitivity to different levels of systematic risk. The authors adopted the same methodology as Harrison, Jenkinson and Kaplan (2015), by levering the S&P 500 in the PME calculation to facilitate different levels of systematic risk. The authors presented evidence of a convex relationship between the PME and Beta. The findings suggested a robust diminishing effect of performance when increasing the beta from 0 to 1. Nevertheless, the marginal effect decreased significantly with betas higher than 1. The authors note that an increase in beta from 1 to 1.5 resulted in a small decrease in PME from 1.18 to 1.12. Hence, the convex relationship causes performance inferences to be insensitive to different assumptions of systematic risk when increasing the beta above 1.

Lastly, Phalippou and Gottschalg (2009) examined PMEs sensitivity to systematic risk by using an "industry/size-matched" cost-of-capital to discount the cash flows of PE funds. The authors concluded a substantial decrease in relative performance, where buyouts- and venture capital funds yielded a risk-adjusted PME of 0.75 and 0.77, respectively. The values corresponded to an annualized excess return of -6%. Therefore, adjusting the beta of the funds resulted in a decrease in relative performance.

2.3.5 Distribution

Harris et al. (2015) examined the distribution of performance in every vintage year of the sample. The authors found a large dispersion in relative performance when comparing top quartile buyout funds against bottom quartile buyout funds. The results indicate an average PME for top- and bottom quartile funds of 1.76 and 0.66, respectively. The values suggested that top quartile buyout funds experienced an average PME 2,5 times larger than the bottom quartile buyout funds. Although bottom quartile funds are underperforming relative to the benchmark, third quartile funds had returns that roughly matches the S&P 500. The authors also concluded a wider performance distribution for venture capital funds compared with buyout funds. The top (bottom) quartile funds yielded an average PME of 3.29 (0.45). Thus, the top quartile funds generated over seven times larger PME in the top quartile compared to the bottom quartile.

Harris et al. (2015) also found evidence of large variation in performance between funds. The results indicated that the top (bottom) quartile buyout fund yielded an average PME of 1.8 (0.78). The authors also noted that the dispersion is more pronounced for venture capital funds, where the top (bottom) quartile average PME was 2.56 (0.49). The authors also remark the value of predictability, where evidence of persistence could guide investors to use past performance as a foundation for future investing.

Lastly, Higson and Stucke (2012) suggested that there exists considerable cross-sectional variation across fund in the sample. The authors noted that the average PME was significantly higher than the median, which suggested that outliers primarily drive the excess return.

2.3.6 Geographic focus

Brown et al. (2015) investigated the differences in PE performance between North American and the rest of the world. The findings confirmed the hypothesis of buyout funds outperforming public markets regardless of geographic origin. The authors noted that buyout funds outside North America experienced approximately the same relative performance as North American buyout funds. However, North American venture capital funds experienced superior performance compared to venture capital funds outside North-America. Venture capital funds operating outside North America generated returns on par with the S&P 500.

Harris et al. (2015) also examined differences in performance between North American and European PE funds. The empirical evidence suggested consistency in performance between the two regions for buyout funds. Hence, both geographic regions have historically outperformed public equity markets by comparable measures.

Nevertheless, the authors found a discrepancy in the performance of venture capital funds between the two regions. North American venture capital funds exhibited superior performance compared to European venture capital funds, where the European funds did not outperform public equity markets.

2.3.7 Characteristics of fund returns

Several studies have outlined how different fund characteristics may explain any cross-sectional variation between PE funds. For instance, Kaplan and Schoar (2005) explored how a variety of fund characteristics such as size, sequence and investment strategy affected relative performance. The results suggested that larger funds, and funds with higher sequence number, have higher values of PME. Moreover, the authors note a concave relation between fund size and performance when incorporating squared terms of fund size and sequence in the regression equation. Therefore, the result suggested that excessive capital commitments tend to decrease performance rather than increase it.

Kaplan and Schoar (2005) also studied the effect of size and sequence number when accounting for firm fixed effects. The findings suggested that larger subsequent funds of GPs tend to experience lower returns. Sequence number also exhibit the same negative relationship when incorporating fixed firm effects, meaning that returns in a subsequent fund of a specific GP tend to decline.

Similiarly, Phalippou and Gottschalg (2009) found that relative performance tends to increase with fund size and that performance is significantly lower for first-time funds. Although the relationship between performance and fund sequence is positive, it is not always significant. The authors argued that fund size is a superior variable to proxy skills compared to using sequence. Aditionally, Phalippou and Gottschalg (2009) did not find a concave relation between fund size and relative performance.

Higson and Stucke (2012) extend previous research by adopting a different methodology to explain any cross-sectional variation between funds. Likewise, the authors' tested the significance of factors such as fund size and sequence, but used three different measures to proxy for fund size. The tests involve using; the fund's percentile rank within its single vintage year, the logarithm of capital invested, the funds rank within three adjacent vintage years. Additionally, the test also incorporates dummy variables to capture any time-fixed effects.

Moreover, the authors found a significantly positive relationship between fund size and absolute- and relative performance. In contrast to previous research by Kaplan and Schoar (2005), the findings do not indicate a concave relationship between performance and fund size when incorporating squared terms of the variables.

2.3.8 Persistence

Kaplan and Schoar (2005) adopted a parametrical approach when testing for persistence in performance. The approach involved regressing subsequent fund performance against lagged values of performance in previous funds. The regression implies using the lagged performance of the first, second and third previous funds by a specific GP. The result indicated a strong and significantly positive relationship, where a 1% increase in performance of the current fund corresponded to an increase of 0.54% in the subsequent fund.

Furthermore, the results were also consistent when introducing additional lags into the regression equation, where the regression that included two lagged terms was still significant and positive. The authors also examined the possibility of mechanical persistence in performance, which implies overlapping investment projects between funds to cause persistence. However, the results indicated that overlapping investments do not cause persistence.

Harris et al. (2014b) also investigated the presence of persistence in PE funds. The authors used a more redefined methodology which involves analysing persistence when using both a parametrical and non-parametrical method. The non-parametrical method involves dividing the sample into performance quartiles based on fund PME for both buyouts- and venture capital funds. Followingly, the authors sorted the funds into four different categories depending on the fund's past adherence to a specific performance quartile. The results suggested modest persistence in performance for buyout funds, where funds with a previous fund in the top quartile adhere to the same quartile 27.5% of the time and is above the median in performance 55% of the time. Additionally, the funds previously positioned in the top quartile yielded an average PME 1.34, while funds previously positioned in the bottom quartile yielded a PME of 1.1. The difference in means is significant at a 1% significance level.

Moreover, the authors found a higher degree of persistence when examining venture capital funds. The results suggested that a fund with funds previously positioned in the top quartile remained in the same quartile 48% of the time and were above the median in performance 65% of the time. Contrastingly, funds previously in the bottom quartile adhered to the top quartile 21.4% of the time and were above the median in performance 14.3% of the time. The author noted that funds with better quartile performance were more likely to raise a follow-up fund.

Furthermore, the parametrical approach involved regressing subsequent funds' performance against lagged values of performance in previous funds. The results suggested that previous fund PME is a significant factor that explains current fund PME for both buyouts and venture capital funds. Nevertheless, the authors conclude mixed signs of persistence in the years post 2000, where current fund performance is not significantly related to previous fund performance.

2.4 Summary and research questions

The information asymmetries between GPs and investors has sparked a debate regarding the utility of the PE funds, and whether funds can generate abnormal returns for its investors. Some argue that the sorting- and incentive problems of PE investing can be reduced significantly by the introduction of the intermediary, and therefore becomes a superior organizational form (Jensen, 1989; Fenn et al., 1997).

Prior research has evaluated the PE market performance through several perspectives such as persistence, geographic focus, firm size and fund sequence. This study intends to evaluate PE fund performance in Europe, where previous reports have usually focused on the American PE market. Additionally, this thesis intends to introduce more factors which may explain returns, such as fund-type and country. Based on the prior research, the hypothesis will be as following;

H1: *European PE funds historical performance suggests excess returns when compared to public equity markets.*

Prior research highlighted the PE performance using a broader geographic scope, but little research exists that thoroughly investigates cross-sectional differences between countries. Therefore, the adoption of a narrower scope creates an idiosyncratic hypothesis. Both absolute- and relative performance measures will be adopted to yield a nuanced and broad perspective of the performance. The absolute performance measures involves using the IRR and TVPI. Further, the relative performance is computed by adopting the PME framework, where all the measures will be evaluated and compared. Harris et al. (2015) found that European PE funds outperformed public markets by similar measures compared to North-American PE funds. Therefore, the results are expected to be consistent when using a more updated data-set with younger vintage years.

H2: *Buyout funds generated superior relative performance compared to venture capital funds.*

Similarly, to previous research, this hypothesis will be tested by dividing the sample depending on the fund adherence to venture capital- or buyout investment activities. The intuition behind the hypothesis is to evaluate the performance between the two primary sub-classes of the industry. Previous research suggests ambiguity regarding the superiority in the relative performance between the fund types. Kaplan and Schoar (2005) found significantly better relative performance for venture capital funds compared to buyout funds. Nevertheless, Harris et al. (2015) and Higson and

Stucke (2012) found that buyout funds experienced superior relative performance compared to venture capital funds. However, Higson and Stucke (2012) argued that data used in the study of Kaplan and Schoar (2005) suffered from systematic downward bias. Therefore, we expect venture capital funds to experience inferior relative performance when compared with buyout funds

H3: *Fund size, sequence, fund-type and country origin are significant drivers of performance*

Similar to prior research, a parametrical approach will test the hypothesis by regressing current fund performance on sequence, fund size, fund-type and country origin. The motivation behind the hypothesis is to examine whether LPs should consider these factors and use them as a foundation during investment decisions. For instance, to avoid investing in first-time funds or funds with small capital commitments. Previous research suggests mixed results when regressing relative performance against sequence and size. Kaplan and Schoar (2005) found a significant concave positive relationship between relative performance and fund size and sequence. However, Phalippou and Gottschalg (2009) found an insignificant relationship between relative performance and sequence and argue that fund size is a superior variable to proxy for GP skill.

H4: *Persistence in performance between PE funds exists in Europe*

Similarly, to the study of Brown et al. (2015), a parametrical approach will answer the hypothesis. The parametrical method involves regressing subsequent fund performance against previous fund performance. The regression will test the significance of different lags to determine the robustness in persistence. The motivation behind this hypothesis is to solve the ambiguity regarding persistence in performance, and if LPs should use past performance as a guideline for future investments. Previous findings suggested strong evidence of persistence (Harris et al., 2014b; Kaplan and Schoar, 2005)

3 Data

3.1 Fund data

The data used in this report originates from Preqin, one of the most prominent data providers of the industry. It is one of the two major databases that can exclusively identify general partners by fund name, which makes the data transparent and subject to correction and validation. The database includes coverage of more than 35.000 firms and 65.000 funds worldwide, where the majority of the data concerns private equity markets (Preqin). The database relies on FOIA requests to public pension funds, which is a requirement for pension funds to report information on the funds in which they invest. Moreover, Preqin also includes voluntary disclosures from general- and limited partners, especially concerning performance data.

The dataset consists of information concerning 3284 funds during the years of 1980 to 2019. The sample contains all the cash flow information during the lifetime of each fund, where information regarding transaction type, amount and date is present. Each transaction involves either a distribution, contribution or a reporting of the current NAV. Additionally, the dataset also provides information concerning fund type, vintage year, geographic focus, industry, investment strategy, firm country, sequence, fund status and a variety of other variables.

As stated in section 2.4, the intuition of this thesis is to segment the sample to European private equity firms. Therefore, North American and private equity firms other than European, are removed and excluded from the sample. Furthermore, funds with no distributions, missing size values, and have fewer than five transactions, are also removed from the dataset. Lastly, fund-types other than Buyout, venture capital, Fund of funds and Balanced are removed and excluded from the sample. Balanced funds are funds which participate in both venture- and buyout investment activities, whereas Funds of funds are funds which invests in a variety of different private equity funds. The selection criteria results in a sample of 395 funds and 95177 transactions.

There are some potential shortcomings and biases related to Preqins data. Firstly, the data may exclude funds that do not have public pension funds as investors or funds that impose reporting restrictions. Secondly, Preqin is also dependent on voluntary disclosures and may be subject to selection- and survivorship bias.

Consequently, the selection bias may imply that successful general partners or funds have a higher probability of disclosing information compared to underperforming general partners or funds, which leads to skewed results. Further, survivorship bias may occur since the data may only represent the survivors in the industry, and neglecting the performance of underperforming firms which no longer exists.

Nevertheless, approximately 85% of the data is gathered FOIA, the selection bias is expected to be limited (Axelsson et al., 2010). Previous research also suggests consistency between different data providers, which further provides evidence of the reliability and validity of Preqin data.

For instance, Harris et al. (2014a) uses the Burgiss database to evaluate private equity performance, and argue that Pitchbook, Preqin, Burgiss and Cambridge Associates all offer unbiased and reliable private equity data. The authors suggest that the consistency in results between the data providers indicates a high degree of reliability, where all of the providers adopt different data collection methods.

The authors conclude that all of the providers yield qualitative and quantitatively similar results concerning performance and highlights the improbability of the data sources to suffer from selection bias. Therefore, the data of Preqin should be suitable and reliable to use for both business- and academic purposes.

4 Methods

4.1 The Approach

This thesis intends to adopt a deductive approach when evaluating PE performance. Therefore, hypotheses arise from previous literature and research. Furthermore, the PME framework, combined with a wide selection of fund data, will effectively answer the hypotheses stated in section 2.4.

Absolute and relative performance measures will effectively answer the hypothesis if PE fund performance in Europe has outperformed public equity markets. The intention is to first calculate the absolute performance of funds using the IRR and TVPI measures.

The thesis will analyse relative performance by performing each method within the PME framework. The results are evaluated to examine differences in ranking and consistency between the measures. Additionally, the construction of time-series of the performance measures will yield information regarding the cyclicality of the PE industry and if returns are sustainable and robust during the entire sample-period.

Furthermore, the thesis will provide information regarding the distribution of performance by dividing funds into performance quartiles for each vintage year. The method will effectively answer if only top-quartile funds have returns that are comparable to public markets.

Several regressions will answer if fund characteristics such as size, sequence, diversification, investment specialisation and strategy can explain any cross-sectional variation in performance. The regressions will impose several dummy variables to account for any time fixed effects.

This thesis also intends to investigate the presence of persistence in performance for PE funds, which will be tested by adopting a parametrical approach. The parametrical approach involves regressing subsequent funds relative performance against previous funds relative performance. The regression equation incorporates the first lag in relative performance. If the lagged performance is significant, LPs should consider using previous fund performance as a foundation for future investment decisions.

4.2 Standard performance measure

The standard performance measures used in this report are the *Internal rate of return* (IRR) and *Total value to paid-in multiple* (TVPI). The two approaches involve calculating the absolute performance of a PE investment by using the cash-flows and residual value of a fund as input variables.

4.2.1 Internal rate of return

The internal rate of return signifies the discount rate in which the present value of the sum of all future cash flows equals to zero. The formula can be deducted as follows:

$$0 = CF_0 + \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_2}{(1+IRR)^3} + ... + \frac{CF_n}{(1+IRR)^n} \tag{4.1}$$

The formula can be compressed in the following manner:

$$0 = NPV = \sum_{n=0}^{N} \frac{CF_n}{(1+IRR)^n} \tag{4.2}$$

Where:
CF_0: Initial investment
CF_1, CF_2, CF_3...CF_n: Cash-flows
n: Each period
N: Holding period
NPV: Net present value
IRR: Internal Rate of return

4.2.2 Total value to paid-in

The total value to paid-in multiple is calculated by taking the sum of all distributions combined with residual value of the PE investment divided by the sum of all the contributions. The formula is expressed as the following:

$$TVPI = \frac{\sum D + NAV_{PE}}{\sum C} \tag{4.3}$$

Where:
$\sum D$: The sum of all distributions to the PE fund
$\sum C$: The sum of all contributions to the PE fund
NAV_{PE}: Residual value of the PE portfolio

4.3 PME methods

All of the methods shares the same input variables which are:

- Sequence of contributions into the PE portfolio:

$$C = \{c_0, c_1, ..., c_n\} \tag{4.4}$$

- Sequence of distributions into the PE portfolio:

$$D = \{d_0, d_1, ..., d_n\} \tag{4.5}$$

- Residual value of PE fund at time t:

$$NAV_{PE} \tag{4.6}$$

- Time-series of reference benchmark (e.g, S&P 500):

$$M = \{m_0, m_1, ..., m_n\} \tag{4.7}$$

The returns of the benchmark effectively serve as the opportunity cost of capital. The benchmark is used to compute the discount rate to capitalize the distributions and contributions of the PE fund at a single point in time. One can choose to capitalize the cash-flows to their future value, or their present value depending on individual preferences. This report will capitalize the cash-flows to their future value. The future values of the distributions and contributions can be defined as follows:

- Future values of contributions at time n:

$$FV(C) = \left\{c_0\left(\frac{m_n}{m_0}\right), c_1\left(\frac{m_n}{m_1}\right), ..., c_n\right\} \tag{4.8}$$

- Future values of distributions at time n:

$$FV(D) = \left\{d_0\left(\frac{m_n}{m_0}\right), d_1\left(\frac{m_n}{m_1}\right), ..., d_n\right\} \tag{4.9}$$

4.3.1 ICM/PME

The ICM/PME model creates a hypothetical portfolio by using the cashflows of a PE fund and the returns of a reference benchmark to determine the equivalent return received of investing the PE fund's cashflows in public equity markets.

The hypothetical portfolio will match every capital contribution to the PE fund with an equally sized investment in the public benchmark. Likewise, the portfolio will match every distribution of the PE fund with an equally sized unwinding of the portfolio. Therefore, the stream of cash flows of the portfolios will be identical. However, the hypothetical portfolio will yield a different residual value since the invested amount of capital is affected by changes in the reference benchmark. The spread in IRR between the two portfolios is the excess return. Appendix A.1 displays a numerical example of the method. The measure is defined as follows:

Residual value of the reference portfolio at time n is:

$$NAV_{ICM} = \sum FV(C) - \sum FV(D) \tag{4.10}$$

The IRR of the reference portfolio is:

$$IRR_{ICM} = IRR(C, D, NAV_{ICM}) \tag{4.11}$$

The PME/ICM is defined as the spread in IRR between the hypothetical and PE portfolio:

$$PME = IRR_{PE} - IRR_{ICM} \tag{4.12}$$

4.3.2 PME+

The PME+ model solves the negative residual value problem of the ICM model by introducing a scaling factor. The intuition of the scaling factor is to generate the same residual value of the reference portfolio during liquidation, by deducting the future values of scaled distributions from the reference portfolio. Appendix A.2 displays a numerical example

Let γ represent the scaling factor for the distributions. The residual value is calculated as follows:

$$NAV_{PE} = \sum FV(C) - \gamma \sum FV(D) \tag{4.13}$$

$$\Leftrightarrow \gamma = \frac{\sum FV(C) - NAV_{PE}}{\sum FV(D)} \tag{4.14}$$

The IRR of the benchmark portfolio is:

$$IRR_{PME+} = IRR(C, \gamma D, NAV_{PE}) \quad (4.15)$$

PME+ is defined as the spread between the benchmark- and PE portfolio:

$$PME+ = IRR_{PE} - IRR_{PME+} \quad (4.16)$$

4.3.3 KS-PME

The KS-PME involves investing all the contributions into the PE fund by short-selling the benchmark and later reinvest all distributions in the benchmark until time n. Hence, the calculation is very similar to TVPI, but instead uses future compounded values of distributions and contributions. Appendix A.3 displays a numerical example of the measure.

$$KS\text{-}PME = \frac{\sum FV(D) + NAV_{PE}}{\sum FV(C)} \quad (4.17)$$

4.3.4 Direct Alpha

Similarly to KS-PME, the calculation of the measure involves taking the capitalized values of the distributions and contributions of the PE fund, compounded by the returns of the benchmark. Followingly, the measure involves deducing the IRR by using the future valued distributions, contributions and NAV. Appendix A.4 displays a numerical example

$$\mathrm{a} = IRR(FV(C), FV(D), NAV_{PE}) \quad (4.18)$$

The last step involves a conversion of the IRR to its natural logarithm:

$$\alpha = \frac{ln(1 + \mathrm{a})}{\Delta} \quad (4.19)$$

Δ represents the time interval for which the alpha is computed

4.4 Regressions

In this section, we specify all the regressions of the variables discussed in section 2.4. The methodology involves regressing relative performance against different fund characteristics such as size, sequence, fund type and firm country. We will also investigate if European PEFs experience persistency in relative performance.

4.4.1 Size, sequence and fund-type

We specify the following regression to test the significance of fund size, sequence and fund-type. We include squared terms of size and sequence to check for signs of non-linearity. Lastly we control for year fixed effects:

$$ln(KS\text{-}PME) = \alpha_t + \sum_{i=1}^{2} \beta_i (ln(size))^i + \sum_{i=1}^{2} \beta_i (ln(sequence))^i + \sum_{j=1}^{3} \gamma_j \delta_j, \quad (4.20)$$

where δ_1 is a *Venture capital Dummy*, δ_2 is a *Fund of Funds Dummy* and δ_3 is a *Balanced funds Dummy.*

4.4.2 Country

We specify the following regression to test the significance of fund size, sequence, fund-type and country. We include squared terms of size and sequence to check for signs of non-linearity. Lastly we control for year fixed effects:

$$ln(KS\text{-}PME) = \alpha_t + \sum_{i=1}^{2} \beta_i (ln(size))^i + \sum_{i=1}^{2} \beta_i (ln(sequence))^i + \sum_{j=1}^{3} \gamma_j \delta_j + \sum_{k=1}^{n} \theta_k \nu_k, \quad (4.21)$$

where δ_1 is a *Venture capital Dummy*, δ_2 is a *Fund of Funds Dummy*, δ_3 is a *Balanced funds Dummy*, n is the *number of countries* and θ_k is a *country origin dummy.*

4.4.3 Persistence

We specify the following regression to investigate the presence of persistence. The methodology involves including the PME of the previous fund in the regression specification. The regression will be as follows:

$$ln(KS\text{-}PME) = \alpha_t + \sum_{i=1}^{2} \beta_i (ln(size))^i + \sum_{i=1}^{2} \beta_i (ln(sequence))^i + \sum_{j=1}^{3} \gamma_j \delta_j + ln(KS\text{-}PME_{t-1}), \quad (4.22)$$

where δ_1 is a *Venture capital Dummy*, δ_2 is a *Fund of Funds Dummy*, δ_3 is a *Balanced funds Dummy* and $ln(KS\text{-}PME)_{t-1}$ is the *relative performance of previous fund.*

5 Empirical Analysis

In this section, we start by presenting a descriptive statistical analysis of the data. Followingly, we present the main performance findings, using both absolute and relative performance measures. The relative performance measures are then analysed to check for the robustness and consistency. Thirdly, we present the aggregate results and connect them to the formulated hypotheses. Lastly, we provide a discussion regarding the limitations and potential issues.

5.1 Descriptive statistics

The total number of funds in the dataset equals 395, which represents 18 different European countries and four different fund types. The four fund-types used in the study are; venture capital, buyout, fund of funds and balanced.

Moreover, the funds represent an average committed capital by LPs of $56m, which is comparably small to previous studies. For instance, Harris et al. (2015) used a sample with a considerably larger average committed capital. The most prominent finding is that buyout- and balanced funds tend to attract more capital compared to the other fund-types used in the dataset. The fund-type with the lowest average committed capital was venture capital, with an average committed capital of roughly $30m. The deviance in committed capital between fund types is comparably low compared to previous studies, where buyout funds tend to attract larger commitments in both relative and absolute terms.

Table 5.1 displays the distribution of fund sequences represented as fractions of the total amount of observations in each subcategory. The results suggest a high exposure towards higher fund sequences, where roughly half of the sample adhered to a sequence higher than 3. Nevertheless, some fund-types are more equally distributed in terms of sequence adherence. For instance, the venture capital subsample has roughly 50% of the observations depicted by a sequence number lower than or equal to 2.

Table 5.1: Distribution of fund sequences

This table displays the fraction of different fund sequences in the sample data-set. The sample includes funds issued in the years between 1989 and 2018. First time funds represents funds with a sequence number of 1, meaning that the fund is the first fund of a specific GP. Similiarly, second- and third time funds are funds with a sequence number of 2 and 3, respectively. The "Higher" sequence category includes funds with a sequence number larger than four. The last row displays the number of fund observations in each sub-sample.

	Total	Buyout	Venture	Balanced	Fund of funds
First time	0.23	0.20	0.27	0.14	0.28
Second time	0.15	0.14	0.25	0.14	0.12
Third time	0.15	0.18	0.16	0.05	0.09
Higher	0.47	0.48	0.32	0.67	0.51
Sample	395	214	63	21	97

Furthermore, high exposure towards high sequence funds creates several implications regarding the absolute and relative average performance of funds. For instance, Higson and Stucke (2012) and Kaplan and Schoar (2005) found a significant positive relationship between relative performance and fund sequence number, meaning that funds with higher sequence tend to experience higher returns. Additionally, Harris et al. (2014b) also found that funds placed in higher performance quartiles are more likely to raise follow-up funds. Thus, the distribution of fund sequences may be an indication of survivorship- and backfill bias, where the data of bottom quartile first-time funds may absent.

The last row of Table 5.1 displays the total amount of observation in each subcategory. The distribution suggests a large number of observations of buyout funds relative to other fund-types, where approximately half of the sample adhered to the buyout category. The second-largest fund type in terms of observations was "Fund of funds", which had a total of 97 observations. The class with the lowest amount of observation was the Balanced category, having a total of 21 observations. Nevertheless, the lifespan of the balanced category can explain the low number of observations, where other fund-types such as buyout and venture capital have prolonged much longer. Further, since balanced funds participate in both venture- and buyout investment activities, it is still relevant to include them in the sample.

Table 5.2 displays the distribution of funds based on geographic investment focus. The method involves dividing the sample based on fund-type, vintage decade, and geographic investment focus to examine the differences between the fund-types. The distribution may also answer if GPs have investment activities outside the geographic region of the firm origin. The three different geographic focus areas are; US (11%), Europe (82%) and RoW (7%).

The table suggests that most GPs tend to contain their investment activities within the same geographic region as the firm origin. Most funds in the dataset only have investment activities within Europe.

Nevertheless, since all PEFs in the sample originate from European countries, this is expected. Some fund-types also have a higher proclivity than others to broaden the geographic scope of their investments. For instance, 50% of the funds in the "funds of funds" category have investment activities outside Europe. Other fund-types such as venture capital have more concentrated investment activities. 90% of all venture capital funds in the sample contain their investment activities within Europe. The risk associated with venture capital investments may explain this distribution, since LPs may be unwilling to invest in immature businesses abroad. The increased geographic distance between the GPs and portfolio company would also imply a reduced capability to impose control rights and monitoring.

Table 5.2 also suggests a limited amount of observation for each fund-type in the early vintages. The total amount of observations of the entire sample in the 1980s equals 1, which makes it difficult to evaluate differences in distribution between the fund-types. Nevertheless, the number of funds increases significantly after the

Table 5.2: Distribution of Geographic focus

This table displays the distribution of geographic investment focus of the funds in the dataset. The three different geographic areas of investment focus are; US, Europe and RoW. The sample is divided by different fund-types of the sample, where the number of funds and fund size is displayed for each vintage year.

Buyout

	US		Europe		Row	
Vintage	#	Size	#	Size	#	Size
80s	0	-	1	538	0	-
90s	1	3000	23	989	0	-
00s	5	1967	87	2539	2	3048
10s	3	1515	90	1627	2	2803
Sample	9	1931	201	1943	4	2925

Balanced

	US		Europe		Row	
Vintage	#	Size	#	Size	#	Size
80s	0	-	0	-	0	-
90s	1	516	3	865	0	-
00s	1	1100	4	260	1	2900
10s	0	-	10	2800	1	1640
Sample	2	808	17	1861	2	2270

Fund of Funds

	US		Europe		Row	
Vintage	#	Size	#	Size	#	Size
80s	0	-	0	-	0	-
90s	0	-	1	112	0	-
00s	14	464	29	443	7	361
10s	18	123	18	455	10	250
Sample	32	272	48	441	17	296

Venture

	US		Europe		Row	
Vintage	#	Size	#	Size	#	Size
80s	0	-	0	-	0	-
90s	0	-	4	130	1	103
00s	0	-	23	206	2	238
10s	0	-	30	182	3	911
Sample	0	-	57	188	6	552

2000s, which creates a possibility to investigate differences between fund-types more accurately.

Moreover, table 5.2 also reveals the average fund size of each fund-type during each vintage decade. The results suggest that buyout funds tend to experience larger funds compared to other fund-types, where buyout funds had an average size of $1,9B. The most notable finding is that funds with a geographic focus of "RoW" tend to experience larger funds for the balanced, venture and buyout fund-types. However, the unwillingness of LPs to invest abroad in smaller businesses may also explain the differences in average fund size between the regions.

Lastly, the table also suggests that venture capital funds have the smallest average size compared to the other fund-types, where the average venture capital fund size was $223m. The difference in fund size between the buyout and venture capital funds may reflect the different investment activities between the two classes, where buyout funds tend to invest in more mature and established businesses.

Figure 5.1 displays the distribution of firm origin for all of the PE funds in the dataset. The figure suggests that UK PEFs manage 200 PE funds, which approximately corresponds to half funds in the entire sample. Consequently, the exposure towards UK managed funds is considerably larger than other European countries in the sample. The second-largest country of managed funds was Switzerland, which had roughly a fourth the number of funds relative to the UK. The overrepresentation of British funds may, therefore, affect the inferences regarding the overall

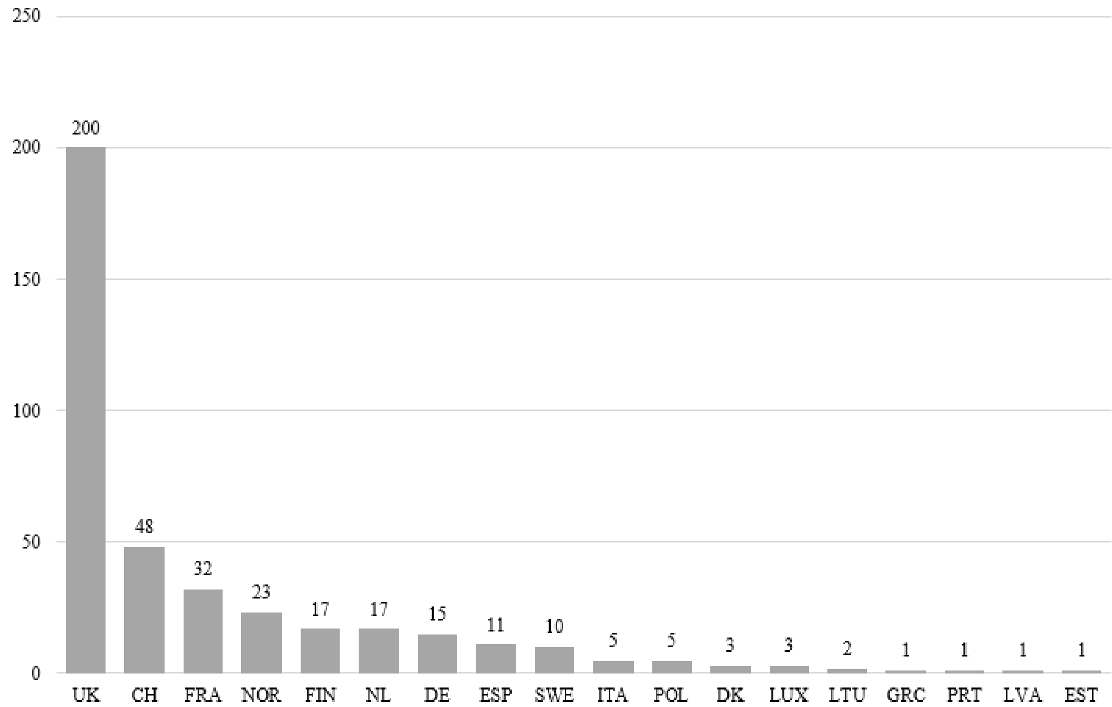

Figure 5.1: Number of observations per country

performance in the European region. Seemingly, there is also a large number of countries which manage less than ten funds, which is not a sufficient number of observations in order to conclude cross-variation in performance between countries. Therefore, this report will only include countries which manage more than ten funds when analyzing differences in performance between countries.

5.2 Absolute performance

Table 5.3 presents the main performance findings of the different fund types using standard performance measures. The table displays the IRRs and TVPIs during the sample period, where both the median and average numbers are presented. The table also includes a realisation variable, which signifies the fraction of the funds' distributions relative to its the sum of its distribution and residual NAV. Hence, a fully liquidated fund will have a realisation rate of 100%.

Differences between the median and average performance figures will yield information regarding the distribution of returns. If the median is significantly lower than the average, there may be large positive outliers in the dataset. If the median is significantly larger than the average, there may be large negative outliers in performance. The choice between using median or average values to evaluate performance can be of large significance for LPs during investment decisions.

Harris et al. (2014a) suggest that PE markets with high levels of exclusivity should adopt the median when evaluating performance, since top-quartile funds may only be available for a certain clientele of LPs. Nevertheless, if investors can choose freely between funds, the average figure is the most representative and appropriate measure.

The result in table 5.3 indicates that the "balanced" fund-type had the highest average IRR during the whole sample period compared to the other fund-types. Balanced funds generated an average- and median IRR of 15.3% and 13.3% respectively, between 1989 and 2018. However, the low amount of observations in the "balanced" category may have several implications regarding the robustness of the finding, where the other fund-types contains a lot more observations. Thus, we do not fully conclude the outperformance of the "balanced" category.

Moreover, the buyout funds yielded an average and median IRR of 14.4% and 13.4% respectively. Hence, the buyout category yielded the second-highest average IRR, and the highest median IRR compared to the other fund-types in the sample. Venture capital funds experienced the lowest IRR concerning both average and median figures, yielding 10.4% and 8.9% respectively.

In all of the different categories, we observe a positive skew which implies that the mean is larger than the median value. However, the dispersion between the two varies significantly depending on fund-type. Balanced funds experienced the largest positive skew during the sample period, suggesting that positive outliers may affect the average performance. However, the balanced category has the least amount of observation which may, therefore, affect the observed distribution. Venture capital funds also experienced a large dispersion between the average and mean performance, where the mean was roughly 1.5% lower than the average. The fund-type with the lowest dispersion was "Fund of funds", with a variation of 0.4%.

The TVPI multiple displays a different performance ranking between the fund-types. The "Fund of funds" category experienced the largest average and median TVPI, yielding a value of 1.56 and 1.52, respectively. The second-best performing fund-type was the "buyout" category, yielding an average (median) TVPI of 1.54 (1.50). The worst performing fund type was venture capital funds, yielding an average (median) TVPI of 1.37 (1.30). Seemingly, there is also less dispersion between average and median values when studying the TVPI multiple. The fund-type with the highest dispersion was the balanced funds, which suggests that the fund-type experienced the largest positive skew. Nevertheless, the number of observations in the balanced category may affect the observed distribution.

Table 5.3: IRR and TVPI over time

This table displays the absolute performances measures for the different fund-types by vintage year. The sample includes funds issued between 1989 and 2018. Additionally, the table also includes the average realisation rate for all of the funds by vintage year. The realisation rate is defined as the sum of all the distribution made to date, divided by the residual NAV and all the distribution made to date. Missing values are denoted by "-".

	Buyout						Venture						Fund of Funds						Balanced					
			IRR (%)		TVPI				IRR (%)		TVPI				IRR (%)		TVPI				IRR (%)		TVPI	
Vintage	# obs	Realized %	Average	Median	Average	Median	# obs	Realized %	Average	Median	Average	Median	# obs	Realized %	Average	Median	Average	Median	# obs	Realized %	Average	Median	Average	Median
1989	1	100%	18,0%	18,0%	1,77	1,77	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
1990	1	100%	7,1%	7,1%	1,32	1,32	2	100%	19,8%	19,8%	2,53	2,53	0	-	-	-	-	-	0	-	-	-	-	-
1991	0	-	-	-	-	-	1	100%	31,3%	31,3%	2,96	2,96	0	-	-	-	-	-	0	-	-	-	-	-
1992	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
1993	1	100%	22,5%	22,5%	2,75	2,75	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
1994	2	100%	48,4%	48,4%	2,46	2,46	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
1995	2	100%	22,8%	22,8%	1,26	1,26	0	-	-	-	-	-	0	-	-	-	-	-	1	100%	20,6%	20,6%	2,22	2,22
1996	3	98%	21,0%	22,0%	2,13	2,20	1	100%	13,4%	13,4%	1,47	1,47	0	-	-	-	-	-	0	-	-	-	-	-
1997	5	100%	6,5%	6,1%	1,38	1,28	0	-	-	-	-	-	0	-	-	-	-	-	2	100%	22,3%	22,3%	1,73	1,73
1998	7	99%	14,0%	14,3%	1,89	1,91	0	-	-	-	-	-	1	100%	3,4%	3,4%	1,17	1,17	0	-	-	-	-	-
1999	3	100%	5,5%	0,0%	1,31	0,90	1	100%	0,0%	0,0%	0,69	0,69	0	-	-	-	-	-	1	100%	7,6%	7,6%	1,35	1,35
2000	4	100%	25,8%	25,9%	2,61	2,61	3	100%	-0,1%	0,0%	0,82	0,88	1	99%	10,2%	10,2%	1,60	1,60	3	100%	17,7%	13,9%	1,74	1,74
2001	4	98%	22,9%	27,7%	1,68	1,89	4	84%	6,1%	0,0%	0,96	0,77	1	100%	7,3%	7,3%	1,43	1,43	0	-	-	-	-	-
2002	5	100%	26,8%	32,6%	1,98	1,94	2	99%	3,2%	3,2%	1,17	1,17	0	-	-	-	-	-	2	100%	9,6%	9,6%	1,57	1,57
2003	2	98%	10,5%	10,5%	1,48	1,48	1	92%	3,8%	3,8%	1,29	1,29	0	-	-	-	-	-	0	-	-	-	-	-
2004	2	99%	17,8%	17,8%	1,59	1,59	0	-	-	-	-	-	3	85%	9,6%	8,5%	1,89	1,72	0	-	-	-	-	-
2005	14	91%	10,2%	8,6%	1,45	1,39	4	77%	3,6%	0,3%	1,31	0,96	3	88%	6,7%	6,9%	1,64	1,74	0	-	-	-	-	-
2006	21	89%	8,3%	9,5%	1,61	1,58	1	97%	20,7%	20,7%	2,89	2,89	12	79%	8,3%	7,8%	1,73	1,70	0	-	-	-	-	-
2007	16	85%	3,9%	4,4%	1,18	1,21	6	73%	7,7%	3,8%	1,49	1,20	12	66%	6,8%	9,0%	1,52	1,56	1	60%	2,9%	2,9%	1,13	1,13
2008	15	81%	10,3%	11,2%	1,60	1,61	2	39%	-5,3%	-5,3%	0,80	0,80	14	65%	10,5%	10,8%	1,64	1,56	0	-	-	-	-	-
2009	11	69%	12,9%	14,3%	1,52	1,50	2	35%	7,1%	7,1%	1,37	1,37	4	44%	14,7%	15,3%	2,09	1,82	0	-	-	-	-	-
2010	7	69%	13,4%	13,5%	1,60	1,59	3	37%	13,4%	14,5%	1,83	1,88	4	46%	11,2%	12,3%	1,60	1,76	0	-	-	-	-	-
2011	14	60%	16,7%	16,1%	1,68	1,60	5	28%	10,9%	15,9%	1,44	1,52	12	30%	11,9%	11,3%	1,51	1,53	2	85%	32,8%	32,8%	2,46	2,46
2012	13	53%	19,7%	20,5%	1,70	1,73	4	17%	9,3%	9,6%	1,30	1,33	10	25%	14,6%	14,3%	1,59	1,45	1	24%	7,1%	7,1%	1,22	1,22
2013	8	48%	20,6%	19,8%	1,73	1,70	5	21%	4,7%	9,5%	1,17	1,26	9	22%	14,1%	12,3%	1,39	1,30	1	5%	3,0%	3,0%	1,06	1,06
2014	17	25%	17,8%	17,4%	1,43	1,39	7	16%	14,5%	14,8%	1,38	1,40	1	2%	6,9%	6,9%	1,13	1,13	2	30%	14,7%	14,7%	1,37	1,37
2015	16	14%	18,7%	19,6%	1,39	1,35	4	13%	2,8%	0,2%	1,06	0,99	7	12%	17,4%	14,6%	1,28	1,24	2	2%	15,5%	15,5%	1,20	1,20
2016	14	15%	11,8%	15,1%	1,15	1,16	2	23%	17,1%	17,1%	1,24	1,24	3	7%	12,7%	13,1%	1,17	1,17	2	7%	6,6%	6,6%	1,07	1,07
2017	6	12%	16,1%	3,6%	1,11	1,02	2	17%	51,7%	51,7%	1,55	1,55	0	-	-	-	-	-	1	4%	24,5%	24,5%	1,11	1,11
2018	0	-	-	-	-	-	1	27%	43,9%	43,9%	1,26	1,26	0	-	-	-	-	-	0	-	-	-	-	-
80s	1	100%	18,0%	18,0%	1,77	1,77	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
90s	24	100%	15,9%	15,7%	1,75	1,80	5	100%	16,9%	13,6%	2,04	2,28	1	100%	3,4%	3,4%	1,17	1,17	4	100%	18,2%	14,1%	1,76	1,78
00s	94	87%	11,3%	10,1%	1,56	1,53	25	77%	4,8%	1,7%	1,25	1,09	50	71%	9,0%	9,0%	1,68	1,61	6	93%	12,6%	11,3%	1,58	1,59
10s	95	35%	17,0%	16,7%	1,47	1,44	33	21%	13,6%	10,3%	1,35	1,33	46	24%	13,6%	12,7%	1,45	1,42	11	26%	15,8%	13,3%	1,42	1,22
Sample	214	65%	14,4%	13,4%	1,54	1,50	63	49%	10,4%	8,9%	1,37	1,30	97	49%	11,2%	10,8%	1,56	1,52	21	59%	15,3%	13,3%	1,53	1,35

The inconsistent ranking between the two measures may be explained by the IRRs sensitivity to the timing and size of cashflows. Consequently, managerial discretion can significantly affect the IRR (Phalippou, 2008). However, we do observe similar ranking patterns when observing the two measures. We observe in every ranking aspect that buyout funds offer absolute superior performance compared to venture capital. This finding also suggests consistency compared to previous research, where Harris et al. (2015) also found that venture capital funds experienced inferior absolute performance compared to buyout funds.

The table also suggests cyclicity in absolute performance during the sample period when examining the performance in each vintage decade. When observing the buyout subsample, we see a strong average and median absolute performance in the 1990s, where the average (median) IRR was 15.9% (15.7%). Followingly, the 2000s are depicted by lower IRRs, yielding an average (median) IRR of 11.3% (10.1%). The pattern seems to reverse in the 2010s, where the average (median) IRR of buyout funds was a remarkable 17.0% (16.7%). Likewise, the TVPIs are also high in the 1990s, experiencing an average and median TVPI of 1.75 and 1.80, respectively. However, the average and median TVPI deceases in the two following decades. This contradicting pattern may be explained by the proclivity to distribute capital more quickly to LPs during the 2000s, which would increase the IRR at the expense of a higher TVPI.

Furthermore, venture capital funds seem to experience higher volatility in returns during the sample period. Similarly to buyout funds, venture capital funds observed high IRRs during vintages of the 1990s, yielding an average (median) IRR of 16.9% (13.6%). Followingly, venture capital funds experienced a large decline in performance during the 2000s, where the average (median) IRR was 4.8% (1.7%). The dot.com bubble in 2001 and the financial crisis of 2008 may explain this large decline. The industry recuperated in the 2010s, where the average (median) IRR increased to 13.6% (10.3%).

Venture capital funds experienced consistent movements when comparing the changes in IRRs and the TVPIs during the sample period. Venture capital funds yielded an average (median) TVPI of 2.04 (2.28) during the 1990s. However, the low amount of observation in the vintages of the 1990s prevents the possibility to compare vintages before 2000 accurately. Followingly, the TVPIs deteriorated in the 2000s, yielding an average (median) TVPI of 1.25 (1.09). The average and median TVPI increase in the 2010s, yielding an average (median) TVPI of 1.35 (1.33).

The "Fund of funds" and "Balanced" categories have little information regarding absolute performance in the vintages before 2000 due to low amount of observations. Nevertheless, the number of observations increases continuously during the sample period, which indicates a growing interest in the two fund-types. For these two fund-types, we will focus on the more recent vintages of 2000 to 2018 when analysing movements in performance. Firstly, fund of funds experienced an average (median) IRR of 9.0% (9.0%) during the 2000s. Followingly, the IRRs increased during the

2010s to an average and median IRR of 13.6% and 12.7%, respectively. Likewise, balanced funds also experienced a positive trend in IRRs during the previous two decades. Balanced funds yielded an average (median) IRR of 12.6% (11.3%) during the 2000s. The absolute performed increased in the 2010s, where balanced funds yielded an average (median) IRR of 15.8% (13.3%).

Furthermore, the realisation rate of the different fund-types will also yield information regarding the accuracy of the reported performance. The results indicate that funds founded in the vintages after 2000 have only distributed approximately 54% of the total value to its LPs. Since 46% of the value is still unrealised, it may affect the accuracy of the calculated absolute performance. As suggested by Jenkinson et al. (2013), GPs can apply various valuations methodologies when reporting the NAV of their fund, which makes the residual value subject to managerial discretion. Thus, an overestimated (underestimated) residual value will result in smaller (larger) returns during liquidation.

In conclusion, the IRR and TVPI offer a straightforward and easy method to compute the absolute performance of funds. However, these measures do not yield any information regarding the opportunity cost of capital when investing in PE. In aggregate, we observe cases of contradicting information regarding absolute performance, where LPs should be cautious to solely rely on one of the standard performance measures. One should instead use the measures as complements when performing a performance analysis.

5.3 PME

In this section, we will investigate the opportunity cost of investing in the different PE funds by adopting all the PME methods stated in section 4.3. The benchmark used to compute the opportunity cost was the S&P 500 index. The S&P 500 is a value-weighted index of the 500 most widely held companies on the US stock exchange. It includes a wide variety of multi-national companies and carries daily data of index prices back to 1926. Previous studies have used the S&P 500 as the primary benchmark when adopting the PME methods. For instance, Harris et al. (2015) and Kaplan and Schoar (2005) used the S&P 500 as a benchmark to represent the opportunity cost of PE investing. This study will also adopt the S&P 500 as the primary benchmark when computing all of the PME measures.

We also analyse all the different PME measures to check for consistency and robustness. The purpose of the analysis is to examine which measure which offers the most representative figure concerning the relative performance of a PE investment. The analysis involves highlighting the shortcomings and advantages of each measure. Followingly, we perform a correlational analysis to check for consistency in performance and ranking. We also divide the funds into performance quartiles to yield a more nuanced overview regarding the distribution in performance. Lastly, we also test the sensitivity to benchmark and different levels of systematic risk, where all of the PME approaches implicitly assumes that the systematic risk of the funds equals the benchmark.

Table 5.4: Relative performance using PME approaches

This table displays the relative performance of all funds in the sample when adopting all of the different PME approaches. The measures used are ICM, PME+, KS-PME and Direct alpha. We report all the measures for all of the different fund-types during the whole sample period. The first five columns show relative returns using an equally-weighted approach, whereas the following five columns display a value-weighted approach. In the equally weighted approach, all the funds exhibit the same weight, and in the value-weighted approach, larger funds are assigned a larger weight. The first row of each PME approach displays the average relative return. The second row shows the median value and the third row displays the standard deviation of the returns. The S&P 500 is used as the benchmark in all of the different PME approaches. The sample covers funds issued between 1989 and 2018.

	Equal weighted					Value weighted				
	Total	Buyout	Venture	Balanced	Fund of funds	Total	Buyout	Venture	Balanced	Fund of funds
Δ ICM	3,1%	4,0%	1,3%	5,5%	1,9%	3,6%	3,8%	3,9%	2,8%	2,0%
	2,1%	2,6%	-0,7%	4,0%	1,9%	3,5%	4,4%	-1,4%	3,3%	1,9%
	10,9%	11,2%	14,7%	10,6%	6,4%	8,3%	8,1%	16,1%	9,2%	5,4%
Δ PME+	4,6%	6,0%	2,1%	9,1%	2,1%	5,3%	5,8%	4,3%	3,6%	2,2%
	2,8%	4,3%	-0,6%	5,6%	2,0%	4,5%	5,2%	-0,7%	4,0%	1,5%
	12,7%	13,4%	15,4%	14,4%	6,8%	10,3%	10,2%	16,2%	10,6%	6,0%
KS-PME	1,13	1,18	0,99	1,24	1,07	1,16	1,17	1,04	1,11	1,06
	1,10	1,12	0,95	1,19	1,06	1,13	1,14	0,95	1,11	1,04
	0,39	0,43	0,41	0,37	0,23	0,35	0,37	0,39	0,24	0,17
Direct alpha	5,6%	7,1%	4,1%	9,0%	2,6%	6,4%	6,8%	5,7%	5,8%	2,7%
	3,2%	5,3%	0,0%	5,9%	2,1%	5,1%	5,4%	0,0%	3,3%	1,9%
	9,7%	10,2%	11,9%	10,4%	5,1%	8,3%	8,3%	12,8%	7,3%	4,5%

Table 5.4 displays the relative performance of when adopting all of the different PME measures. The different PME measures used in this report are; ICM, PME+,

KS-PME and Direct alpha. The table displays the average relative return in the first row, the median relative return in the second row and the standard deviation of returns in the last row. The first five columns follow an equally-weighted approach, while the following five columns follow a value-weighted approach. The equally-weighted approach assigns the same weight to all funds when computing the average relative performance. The value-weighted approach weights each fund based on its value, where larger funds are assigned a higher weight. By comparing the two approaches, we can establish whether fund value has a decisive impact on the average relative performance.

The result suggests that some equally weighted averages (medians) are larger than the value-weighted averages (medians). For instance, buyout funds tend to experience lower values of relative performance when observing the value-weighted approach compared to the equally weighted. Thus, the result may indicate a concave relationship between fund-size and performance, where increased fund-size may only increase performance to a certain level. This finding is also consistent with previous research, where Kaplan and Schoar (2005) found a concave relationship between fund-size and relative performance. Nevertheless, some fund-types such as venture capital funds experience higher relative performance when observing the value-weighted approach compared to the equally weighted. The finding may suggest a lower degree of concavity for venture capital funds. The relationship between fund-size and relative performance will be evaluated in subsection 5.4.1.

Most of the fund-types show consistent results of outperformance when comparing all of the different PME approaches. For instance, buyout funds were able to outperform the market using both median and average values of all the different PME measures. Contrastingly, venture capital funds display signs of outperformance when observing average values, but underperformed when using median values. Nevertheless, when observing the KS-PME method, venture capital funds underperformed using both median and average values. Balanced funds experienced the highest outperformance when observing both median and average values for all the different PME approaches. The outperformance may suggest that a balanced investment activity that invests in companies of different sizes may be beneficial in terms of relative performance. However, the outperformance of balanced funds will be statistically tested in subsection 5.4.1. Further, funds of funds also outperformed the benchmark when using all of the different PME approaches, where "fund of funds" also experienced the smallest dispersion between the median and average values.

Venture capital funds experienced the highest volatility in relative performance compared to the other fund-types. However, the higher risk of venture capital investment activities may explain the higher volatility, since investments in immature companies have a higher degree of uncertainty. The fund-type with the lowest volatility was "Fund of Funds", which experienced considerably lower volatility compared to the other fund-types. The lower variation in relative performance may be explained by the diversification benefits associated with "Fund of Funds", where the investment activities involve investing in a variety of different PE funds.

The equally-weighted ICM method yielded a total average (median) relative performance of 3.12% (2.13%). The result suggests that all the funds in the sample outperformed the S&P 500 by 3.12% yearly. Further, Buyout funds yielded an average (median) ICM of 4.02% (2.6%), which corresponds to the second-highest level of outperformance compared to the other fund-types. The best performing fund-type according to the equally-weighted ICM method was the Balanced fund-type, yielding an average (median) ICM of 5.5%(4.0%). Fund of funds also managed to outperform the S&P 500, yielding an average and median ICM of 1.9%. The worst performing funds among the different fund-types was venture capital funds, yielding an average (median) ICM of 1.3%(-0.7%). Hence, the median venture capital fund underperformed by -0.7% yearly relative to the S&P 500. The dispersion between the average and median value suggests a sizeable positive skew for venture capital funds. The large positive skew may have several implications for investors in venture capital markets, where top-performing funds have a decisive impact on the average outperformance.

The value-weighted ICM generated considerably different results. Buyout funds generated a weighted- average (weighted-median) ICM of 3.8% (4.4%), indicating negative skew. Venture capital funds experienced the highest value-weighted average of 3.9%. However, the dispersion between the median and average value is larger compared to the equally weighted approach, suggesting a larger positive skew. Fund of funds yielded a weighted- average (weighted-median) ICM of 2.0% (1.9%). Lastly, Buyout funds experienced noticeably lower values of outperformance when adopting the value-weighted approach, yielding a weighted-average (weighted-median) of 2.8% (3.3%). Nevertheless, a prominent remark of the ICM method is that 19% of the benchmark portfolios generated a negative NAV, which may, therefore, affect the inferences.

The PME+ method displays consistent results compared to the ICM approach, where the ranking in outperformance between fund-type was similar. All of the fund-types experienced a higher average (median) relative performance in comparison to the ICM method, using both the value-weighted and equally-weighted approach. However, the volatility of the PME+ measure is also higher for the different fund-types, which implies a higher degree of uncertainty.

The KS-PME measure also displays a consistent pattern in relative performance in comparison to ICM and PME+. A prominent finding is that venture capital funds underperformed relative to the S&P 500, yielding an average (median) KS-PME of 0.99 (0.95). However, the KS-PME slightly increases when adopting the value-weighted approach, where venture capital funds outperformed the benchmark.

Lastly, the direct alpha method yielded a total average (median) excess return of 5.6% (3.2%), when adopting the equally-weighted approach. The fund-type with the highest direct alpha was the balanced funds, yielding an average (median) alpha of

9.0% (5.9%). Buyout funds yielded an average (median) alpha of 7.1% (5.3%), which corresponds to the second-best performing fund-type of the sample. The results also indicate that venture capital funds outperformed the market, yielding an average (median) alpha of 4.1% (0.0%). Funds of funds experienced the lowest average alpha in comparison to the different fund-types, yielding an average (median) excess return of 2.6% (2.1%).

The ranking between fund-types significantly changes when observing the value-weighted approach for the direct alpha method. For instance, the direct alpha decreases significantly for the balanced funds, which may indicate a concave relationship between fund-size and relative performance. Venture capital funds also achieved considerably higher direct alpha when observing the value-weighted results, which may suggest that larger venture capital funds tend to yield higher relative returns.

5.3.1 Correlation between PME methods

Most of the PME measures produced different outcomes concerning both the relative performance and the ranking pattern between fund-types. To further examine the robustness and consistency of each measure, we perform a correlational analysis to study the relationship between them. Table 5.5 displays the correlation of all the different PME measures together with the standard performance measures. We observe a strong correlation between the IRR, direct alpha, PME+ and ICM, with a correlation coefficient larger than 0.8. The result is also consistent with previous findings, where Kaplan and Schoar (2005) reported a correlation of 0.89 between IRR and ICM.

Table 5.5: Correlation between performance measures

This table displays correlation between all of the different absolute and relative performance measures. The correlation is measures between IRR, TVPI, Δ ICM, Δ PME+, KS-PME and Direct alpha. The sample covers funds issued between 1989 and 2018

	IRR	TVPI	Δ ICM	Δ PME+	Direct alpha	KS-PME
IRR	1,00					
TVPI	0,63	1,00				
Δ ICM	0,81	0,44	1,00			
Δ PME+	0,89	0,55	0,91	1,00		
Direct alpha	0,85	0,48	0,86	0,93	1,00	
KS-PME	0,72	0,83	0,67	0,77	0,69	1,00

Surprisingly, the highest observed correlation was between is PME+ and direct alpha, yielding a correlation coefficient 0.93. Gredil et al. (2014) suggest that the differences between the direct alpha and the heuristic approaches tend to small when estimating excess returns (above) below 10% (-10%), but becomes meaningful in cases above (below) 10% (-10%). Nevertheless, since both the ICM and PME+ are significantly affected by heterogeneity in cash-flow patterns, we expected a lower correlation. Thus, the result may be an indication of smaller excess returns.

The result also suggests a high correlation between TVPI and KS-PME, yielding a correlation coefficient of 0.83. However, since the two measures exhibit similar formulas, this is expected.

Gredil et al. (2014) argue that the non-additive feature of compound rates makes the PME+ and ICM heuristic. Therefore, it may be more appropriate to study the correlation in ranking rather than absolute numbers.

Table 5.6 displays the correlation in ranking between the measures. The methodology involves ranking the 395 funds in the sample from a number between 1 and 395 using each respective measure. Thus, we can determine how each measure ranks the funds performance-wise. The results also suggest a high correlation between the IRR, the PME+ and the direct alpha, yielding a correlation coefficient larger than 0.8. Nevertheless, we do observe a smaller correlation in ranking for the ICM measure between the IRR, yielding a correlation coefficient of 0.79. A prominent finding is that the direct alpha approach seems to exhibit almost the same correlation as before, yielding a correlation coefficient of 0.84.

Table 5.6: Correlation between ranked performance measures

This table displays the correlation between the TVPI, IRR, Δ ICM, Δ PME+, Direct alpha and KS-PME for all of the 395 funds of the sample. The correlation is based on the ranking of between funds of each respective measure, where the fund with the highest return is ranked as number one, and the fund with the lowest return is ranked with the number 395. The sample consists of vintages between 1989 and 2018.

	IRR	TVPI	Δ ICM	Δ PME+	Direct alpha	KS-PME
IRR	1,00					
TVPI	0,72	1,00				
Δ ICM	0,79	0,58	1,00			
Δ PME+	0,86	0,64	0,95	1,00		
Direct alpha	0,84	0,60	0,90	0,94	1,00	
KS-PME	0,84	0,76	0,90	0,95	0,89	1,00

In conclusion, there are considerable differences in how each of the measures ranks the relative performance between funds. Nevertheless, the direct alpha approach seems to offer the most robust and stable correlation to its counterpart, concerning both ranked and absolute fund-performance. Unlike the heuristic approaches, it also provides a direct way of computing the annualized excess return. Although the PME+ approach offers a high correlation to its counterpart, it still exhibited the highest volatility among all the other measures. Further, the ICM method fails to compute the excess return 19% of the time due to a negative NAV, which leads to inaccurate and skewed results. The KS-PME yields no information regarding the per-period rate of excess return. Overall, we find the direct alpha method to be the most accurate and straightforward measure in estimating the excess return and will thereby be used as the primary measure in all upcoming sections.

5.3.2 Relative performance over time

Similarly to previous research, we also examine how the different fund-types performs relative to the benchmark over time. Table 5.7 displays the average and median direct alpha (equally-weighted) by vintage year. The table also includes a column showing the price of the benchmark over time to yield information regarding the market condition in each year. Additionally, since the early and the late vintages of the sample data contain little or no observations, we decide to restrict the sample and only include funds founded between 1993 and 2016 in the analysis.

The result suggests that buyout funds outperformed the S&P 500 by 7.1% yearly during the whole sample period, which is also statistically significant above zero. We observe the most robust performance in the 1990s, where buyout funds yielded an average (median) direct alpha of 10.5% (12.5%). Followingly, the relative performance decreases dramatically in the 2000s, yielding an average (median) direct alpha of 4.7% (2.2%).

Table 5.7: Relative performance over time

This table displays the average and median direct alpha for all of the different fund-types by vintage year. The S&P 500 is used as the benchmark in the direct alpha computation. The table also displays the index level of the SP 500 by vintage year. The sample is also limited to the years between 1993 and 2016 due to scarcity of observations in the early/late vintages. Missing values are denoted by "-".

		Buyout		Venture		Balanced		Fund of Funds	
Vintage	S&P 500	Average	Median	Average	Median	Average	Median	Average	Median
1993	435	5,2%	5,2%	-	-	-	-	-	-
1994	465	21,4%	21,4%	-	-	-	-	-	-
1995	459	10,3%	10,3%	-	-	6,3%	6,3%	-	-
1996	621	11,6%	13,6%	5,9%	5,9%	-	-	-	-
1997	748	6,2%	4,7%	-	-	13,6%	13,6%	-	-
1998	977	13,9%	14,6%	-	-	-	-	1,9%	1,9%
1999	1228	6,9%	2,5%	0,0%	0,0%	5,9%	5,9%	-	-
2000	1455	20,2%	20,3%	-2,6%	-0,5%	13,8%	11,3%	6,3%	6,3%
2001	1348	15,2%	17,4%	3,2%	0,0%	-	-	2,7%	2,7%
2002	1165	15,6%	20,2%	1,4%	1,4%	3,7%	3,7%	-	-
2003	909	5,8%	5,8%	0,0%	0,0%	-	-	-	-
2004	1122	12,9%	12,9%	-	-	-	-	3,8%	3,0%
2005	1202	2,9%	2,3%	0,8%	0,0%	-	-	0,6%	0,0%
2006	1269	3,5%	4,0%	10,9%	10,9%	-	-	1,7%	1,5%
2007	1417	0,8%	0,0%	3,8%	0,0%	0,0%	0,0%	-1,4%	0,0%
2008	1447	1,7%	0,3%	-14,2%	-14,2%	-	-	0,8%	0,9%
2009	927	3,3%	1,9%	0,0%	0,0%	-	-	4,3%	5,1%
2010	1133	2,4%	1,8%	3,3%	4,2%	-	-	2,7%	1,0%
2011	1272	5,7%	5,2%	2,9%	3,1%	14,9%	14,9%	1,8%	2,6%
2012	1277	9,9%	8,6%	0,2%	0,8%	0,3%	0,3%	4,8%	4,4%
2013	1459	10,5%	10,6%	0,9%	0,1%	0,0%	0,0%	6,0%	7,2%
2014	1831	9,3%	9,6%	7,7%	8,9%	7,6%	7,6%	0,0%	0,0%
2015	2021	10,1%	11,2%	-2,3%	-0,3%	4,1%	4,1%	7,3%	7,7%
2016	2013	5,2%	6,8%	8,0%	8,0%	4,9%	4,9%	5,0%	5,8%
90s	-	10,5%	12,5%	5,7%	5,9%	9,8%	6,1%	1,9%	1,9%
00s	-	4,7%	2,2%	0,7%	0,0%	8,1%	6,5%	1,1%	0,9%
10s		8,5%	7,8%	6,5%	1,8%	9,2%	5,3%	4,3%	4,3%
Sample	-	7,1%	5,3%	4,1%	0,0%	9,0%	5,9%	2,6%	2,1%

Nevertheless, when comparing relative performance against the absolute performance of buyout funds, the deterioration in performance seems to be more severe in the case of the average direct alpha. Thus, increased deviance between absolute and relative performance may send misleading information to investors regarding the true performance of the fund, where investors should be cautious to solely rely on absolute performance values. Further, the relative performance increases in the 2010s, generating an average (median) direct alpha of 8.5% (7.8%).

In aggregate, buyout funds have outperformed the benchmark in every vintage year of the sample. We also note that the outperformance is closely related to the movements of the S&P 500, where the outperformance tends to be higher during vintages of high index levels of the benchmark. The result may seem surprising since decreases index value should correspond to higher relative performance according to the direct alpha formula. However, the relationship between the direct alpha and index level may suggest that the absolute performance of buyout funds tends to decrease jointly with the benchmark.

The outperformance of buyout funds is also significantly higher compared to most previous studies. For instance, Harris et al. observed an average yearly excess return of 3.07% for North-American buyout funds. Higson (2012) et al. also finds a large outperformance, where buyout funds yielded an excess annual return of approximately 5.0%. Nevertheless, the higher level of average relative performance may be explained by the sample period, where previous research has not included vintages post-2010 in their sample.

Venture capital funds outperformed the benchmark by 4.1% yearly during the sample period, which was also statistically significant above zero. The result is also consistent with previous studies, where Harris et al. (2015) observed an average direct alpha of 2.07% from 1986 to 2010.

During the 1990s, venture capital funds generated an average (median) direct alpha of 5.7% (5.9%). Nevertheless, there is limited information regarding the relative performance in the pre-2000 vintages due to a scarcity of observations, which may, therefore, affect the result.

Similarly to buyout funds, venture capital funds experienced a substantial decrease in performance during the vintages of the 2000s, yielding an average (median) direct alpha of 0.7% (0.0%). Seemingly, there is also large deviance in relative performance between buyout- and venture capital funds between 2000 and 2002. The deviance may suggest that the dot.com bubble in 2001 had a detrimental effect on the performance of venture capital funds, while buyout funds seem to be unaffected by the economic downturn.

Followingly, venture capital funds generated increased excess returns in the 2010s, yielding an average (median) direct alpha of 6.5% (1.8%). In aggregate, venture capital funds outperformed the market in 12 of the 18 vintages in the sample.

Furthermore, Balanced funds experienced an average (median) direct alpha of

9.0% (5.9%) during the whole sample period, which was also statistically different from zero. Unlike the other fund-types, balanced funds seem to be unaffected by the large economic turndowns in the 2000s, yielding almost the same average excess returns as the vintages of the 1990s. However, the low number of observations in these vintages may affect the reliability of the results.

Lastly, fund of funds outperformed the S&P 500 by 2,6% yearly (equally-weighted average) during all vintage years, which was also statistically different from zero. Similarly to the balanced funds, funds of funds experienced less volatile movements in performance between each vintage decade. The results indicate an average (median) direct alpha of 1.1% (0.9%) during the vintages of the 2000s. Followingly, the relative performance increases in the 2010s, yielding an average and median direct alpha of 4.3%.

As previously highlighted, most of the funds-types in the more recent vintages have funds which are not fully liquidated yet. Thus, the relative performance for these funds is still subject to the future realization of profits, which currently may be inaccurately valued by GPs. Consequently, the unrealized alphas should only serve as a forecast of the true direct alpha.

5.3.3 Quantile performance

A common practice when evaluating PE fund performance is to divide the sample into performance quartiles to yield information regarding the distribution in performance. The distribution may answer the importance of picking a top-quartile fund for LPs, and if lower quartile funds still can generate returns that are comparable to the market. Aditionally, Kaplan and Schoar (2005) find high levels of persistency in performance, where the best performing GPs tend to outperform their peers continuously. Thus, if continuity in performance exists for follow-up funds, it may be wise to examine which fund-type that offers the highest returns in the top-quartile. Similarly to the previous sections, we divide the sample based on fund-type.

Table 5.8 displays the average direct alpha for each performance quartile by each vintage decade. Column one represents the bottom-quartile funds, whereas column four represent the top-quartile funds. The results suggest that venture capital funds experienced the largest variation in performance among all of the different fund-types. Top-quartile venture capital funds experienced an average direct alpha of 18.9%, whereas bottom quartile venture capital funds generated an average direct alpha of -7.1%. We also observe significant changes in the distribution between each vintage decade. For instance, the performance of top-quartile funds in the 2000s corresponds to roughly half of the performance in the 2010s. The dot.com bubble in 2001 may explain this deviance since the average absolute performance decreased substantially in the vintages between 2001 to 2003. In aggregate, we observe 2nd and 3rd quartile funds having returns equal to or higher than the benchmark, which contradicts the claim of only top-quartile funds having returns comparable to the

Table 5.8: Quartile performance

This table displays the distribution in relative performance for each of the different fund-types. The sub-samples are divided into four different performance quartiles by each vintage decade. The worst performing funds are placed in the first quartile, and the best performing funds are placed in the fourth quartile. The S&P 500 is used as benchmark in the direct alpha computation. The sample is also limited to the vintages from 1990 to 2018.

Buyout				
Vintage	1st	2nd	3rd	4th
90s	-0,9%	6,2%	14,9%	21,8%
00s	-4,3%	1,2%	4,4%	15,7%
10s	-3,4%	5,2%	10,9%	21,4%
Sample	-2,8%	2,7%	8,4%	19,9%

Venture				
Vintage	1st	2nd	3rd	4th
90s	0,0%	3,0%	6,8%	14,8%
00s	-8,0%	0,0%	0,0%	10,7%
10s	-6,2%	1,0%	4,1%	26,2%
Sample	-7,1%	0,0%	3,0%	18,9%

Balanced				
Vintage	1st	2nd	3rd	4th
90s	0,0%	5,9%	6,3%	27,1%
00s	1,7%	4,0%	9,1%	16,1%
10s	0,1%	3,1%	7,6%	24,7%
Sample	0,1%	4,0%	7,6%	24,8%

Fund of funds				
Vintage	1st	2nd	3rd	4th
90s	1,9%	1,9%	1,9%	1,9%
00s	-3,5%	0,5%	1,8%	4,9%
10s	-2,7%	2,5%	6,1%	11,5%
Sample	-3,4%	0,9%	3,3%	9,2%

market. In contrast, Harris et al. (2015) found that only 4th and 3rd quartile funds have returns comparable to the benchmark. The deviance may indicate that the importance of fund-picking skills of LPs has decreased in the recent vintages.

Moreover, top- (bottom) quartile buyout funds generated an average direct alpha of 24.8% (-2.85%). Thus, the gap between top and bottom quartile funds is less pronounced for buyout funds compared to venture capital funds. The finding is also consistent with previous research, where Harris et al. (2015) observed wider dispersion in performance for venture capital funds compared to buyout funds.

The gap between the top and bottom quartiles seems to stable between through time, where the 2nd and 3rd quartiles experienced larger movements in relative performance. Seemingly, we observe a larger positive skewness in periods depicted by bad market conditions, where the gap between first and second quartile increases substantially in the vintages of the 2000s. The finding suggests that fund-picking skills of LPs may be of larger importance during economic turmoil.

In aggregate, the results indicate that second and third quartile funds outperformed the benchmark, which is also consistent with previous research. For instance, Harris et al. also find that 2nd and 3rd quartile buyout funds had a superior relative return to the benchmark.

Furthermore, fund of funds experienced the most narrow gap between top and bottom quartiles during the sample period. Top- (bottom) quartile fund of funds yielded an average direct alpha of 9.2% (-3.4%). The gap between top and bottom quartiles seems to be more narrow in the vintages of the 2000s compared to the 2010s.

The change in distribution may reflect a combination of increased risk-taking and superior market conditions.

Lastly, top- (bottom) quartile balanced funds generated an average direct alpha of 24.8% (0.1%). Hence, balanced funds were the only fund-type which experienced a positive alpha in each of the respective quartiles. However, balanced funds had the least amount of observations which may, therefore, affect the observed distribution. Further, we observe some changes in distribution through the sample period. Although the bottom and third quartiles experienced no or little change between the vintage decades, the second and the first quartiles change significantly. Interestingly, the vintages of the 2000s depict a deterioration in the relative performance of all of the quartiles except the second, which may be an indication of less skewed distributions during bearish market conditions.

In conclusion, we observe strong relative performance for all of the fund-types in the sample, where the fund-picking skills of LPs seem to be of less significance compared to previous claims. All of the fund-types has returns comparable to the market in the second and third quartiles, where balanced funds experienced a positive alpha in all of the quartiles. Nevertheless, fund picking skills seem to be more important for some fund-types, where the quartile results of venture capital funds indicate more dispersed outcomes compared to the other fund-types.

As highlighted in previous sections, most of the funds founded in the more recent vintages have a low realisation rate. Thus, the performance of these funds is still affected by subjective beliefs regarding the value of unrealised investments. Additionally, oversubscription and exclusivity may also affect the ability of LPs to freely invest, where top-quartile funds may be oversubscribed and only available to a certain clientele of investors.

5.3.4 Differences between countries

In this section, we attempt to examine differences in relative performance when dividing the sample by country origin of the PEF. The analysis may indicate if certain countries tend to outperform others and if the country origin is a relevant factor to consider when forming an investment decision. As previously highlighted, we restrict the sample and only include countries which have more than ten funds. Further, the relative performance will be evaluated by adopting the direct alpha approach, where the S&P 500 will be used as the benchmark.

Figure 5.2 displays the relative performance of all the different European countries of the sample. We observe that the Netherlands tend to experience the highest relative performance compared to all the other countries in the sample, yielding an average direct alpha of 13.6% during the sample period. Interestingly, we observe a large gap in relative performance between the first- and second-best performing country. France experienced considerably lower excess return compared to the Netherlands, yielding an average direct alpha of 7.35%.

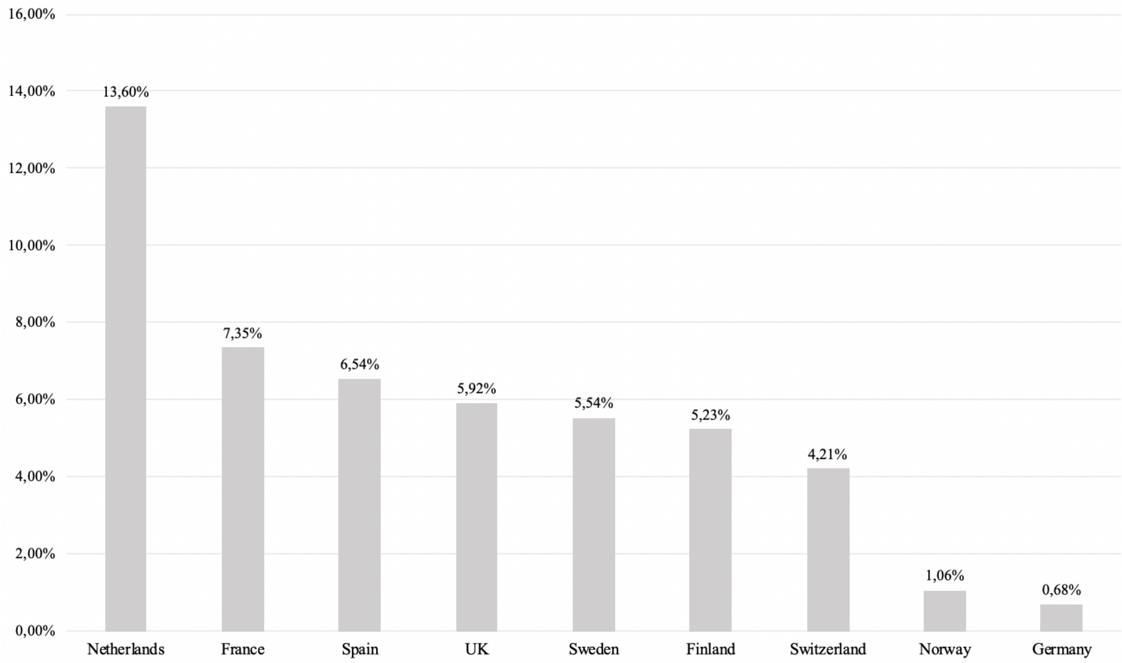

Figure 5.2: Differences between countries

Furthermore, Spain, UK, Finland, Sweden and Switzerland all experienced similar relative returns, ranging between 6.54% and 4.21% in relative performance. The worst performing country was Germany, generating a direct alpha 0.68%. In aggregate, all countries managed to outperform the benchmark.

The differences in skills and proficiency of GPs may explain the differences in relative performance between countries. Nevertheless, there is a probability that the results are entirely arbitrary, where a consistent outperformance by some countries over others may not exist. The significance of country origin will be tested in subsection 5.4.2 , to confirm if LPs should consider this factor when picking funds.

5.3.5 Sensitivity to benchmark

In all of the previous sections, we have assumed the S&P 500 to be the most suitable benchmark in every PME approach. However, since all of the PEFs in the sample originate from Europe, it might be wise to choose a benchmark that more appropriately reflects the opportunity cost of a European investor. Further, the benchmark should also be comparable in terms of liquidity, size and leverage to a PE investment, where the S&P 500 sometimes fails to match these characteristics accurately.

In this section, we investigate the robustness of the direct alpha method to different assumptions regarding the benchmark. Moreover, we will only include buyout and venture capital fund in the analysis, since the two fund-types have very distinct differences regarding risk. Further, we hold the MSCI Europe index as the alternative benchmark to represent the opportunity cost of a European investor.

MSCI Europe is an equity index that incorporates the performance of 15 European developed public equity markets, where the index covers approximately 85% of the market capitalization across these markets.

Table 5.9: Benchmark

This table displays the average direct alpha for the fund-types; venture capital and buyout when adopting the S&P 500 and MSCI Europe as benchmarks, split by vintage year. The table also includes the index price of each respective benchmark on the first observable date each year. Missing values are denoted by "-".

	Benchmarks		Direct alpha	
Vintage	S&P 500	MSCI	S&P 500	MSCI
1992	419	532	-	-
1993	435	491	5,2%	7,8%
1994	465	621	21,4%	25,9%
1995	459	612	9,0%	10,4%
1996	621	740	10,2%	12,4%
1997	748	856	8,3%	8,9%
1998	977	1069	12,4%	11,8%
1999	1228	1424	5,3%	3,6%
2000	1455	1461	11,0%	8,7%
2001	1348	1378	8,5%	6,2%
2002	1165	1099	9,8%	7,2%
2003	909	900	3,9%	5,5%
2004	1122	1200	7,4%	10,3%
2005	1202	1346	2,2%	5,9%
2006	1269	1547	3,1%	9,3%
2007	1417	1917	0,5%	5,2%
2008	1447	2071	0,3%	7,2%
2009	927	1136	3,1%	9,8%
2010	1133	1468	2,7%	10,3%
2011	1272	1445	4,4%	12,0%
2012	1277	1245	6,4%	14,3%
2013	1459	1472	6,2%	14,3%
2014	1831	1733	8,4%	16,1%
2015	2021	1532	7,3%	13,9%
2016	2013	1459	5,4%	11,9%
90s	-	-	9,5%	10,2%
00s	-	-	3,2%	7,4%
10s	-	-	7,2%	14,8%
Sample			5,6%	11,1%

Table 5.9 displays the direct alpha method when using the two different benchmarks. The first two columns show the index level of the benchmark by vintage year. The following four columns display the direct alpha for venture capital- and buyout funds, using the two respective indices as a benchmark. The results indicate that both venture capital and buyout funds experienced significant increases in relative performance when changing the benchmark. Buyout funds yielded an average direct alpha of 7.1% when using the S&P 500 as a benchmark, and a direct alpha of 12.2% when using the MSCI Europe index as a benchmark. Likewise, venture capital funds generated a direct alpha of 4.1% when using the S&P 500 as a benchmark, and a direct alpha of 9.0% when using the MSCI as a benchmark.

We observe consistent movements in relative performance when comparing the benchmarks during the vintages of the 1990s. However, the following decades indicates a discrepancy in relative performance between the two benchmarks, where the direct alpha is considerably higher when adopting the MSCI Europe index as a benchmark. The finding indicates that the MSCI Europe index experienced inferior absolute performance relative to the S&P 500 in the vintages of 2000s and 2010s. The euro-crisis in 2011 may have caused a significant decline in the performance of the MSCI Europe index, whereas the S&P 500 may have been less affected.

In conclusion, there are large differences in relative performance when assuming a different benchmark to reflect the opportunity cost. The finding further suggests that LPs should be cautious when deciding which proxy to use to represent an equivalent public market investment. Nevertheless, the results signal that the outperformance of the fund-types is robust and significant to changes in benchmark assumptions.

5.3.6 Sensitivity to systematic risk

Estimating the systematic risk of a PE investment is problematic since there is no daily information regarding the market value of the fund. The illiquidity implies that the standard capital asset pricing model (CAPM) is unapplicable, which makes it hard to determine if a PE fund has generated abnormal returns. As previously highlighted, the PME methods do not include a mechanism which accounts for different levels of systematic risk of cash flows. Nevertheless, if the beta equals one, the standard CAPM discount rate equals the expected market return. Thus, if we discount the cash-flows of a PE fund using realized market returns instead of expected, we implicitly assume the cash-flows to have a beta of one.

Consequently, Kaplan and Schoar (2005) argue that the PME approaches is only valid when the beta of the PE fund equals one. Further, assuming a beta of one is likely to overstate relative performance since PE funds usually operate with high levels of leverage or invest in immature companies. Therefore, there is an incentive to simulate a discount rate that more appropriately reflects the true risk-characteristics of a PE investment.

Table 5.10 displays the direct alpha for venture capital- and buyout funds when assuming different levels of systematic risk. The method involves leveraging the index to simulate different discount rates that reflect different levels of systematic risk. Similarly to previous sections, we adopt the S&P 500 as the primary benchmark when performing the direct alpha computation. We simulate betas of 1, 1.5 and 2 for the buyout funs, and betas of 1, 2.5 and 4 for the venture capital funds. The different simulation of betas between the fund-types is a reflection of the different risk-properties, where venture capital funds are considered to be the riskier investment.

Buyout funds yielded a direct alpha of 7.1%, 5.5% and 4.9% with betas of 1, 1.5 and 2, respectively. The results indicate a concave relationship between the beta and direct alpha, where the derivative seems to decrease monotonically between the

Table 5.10: Systematic risk

This table displays the average direct alpha (equally-weighted) when assuming different levels of systematic risk for the fund-types; venture capital and buyout, split by vintage year. For the buyout subsample, we simulate betas of 1.0, 1.5 and 2.0, and for venture capital subsample, we simulate betas of 1.0, 2.5 and 4.0. The S&P 500 is used as a benchmark in the direct alpha calculation. The sample is also limited to the years between 1992 and 2016 due to the scarcity of observations in the early/late vintages. Missing values are denoted by "-".

	Buyout			Venture		
Vintage	Beta 1.0	Beta 1.5	Beta 2.0	Beta 1.0	Beta 2.5	Beta 4.0
1992	-	-	-	-	-	-
1993	5,2%	-0,2%	-4,2%	-	-	-
1994	21,4%	14,4%	8,8%	-	-	-
1995	10,3%	7,9%	6,9%	-	-	-
1996	11,6%	9,9%	9,5%	5,9%	4,5%	13,0%
1997	6,2%	7,6%	10,1%	-	-	-
1998	13,9%	16,0%	19,2%	-	-	-
1999	6,9%	8,9%	11,6%	0,0%	0,0%	8,7%
2000	20,2%	19,9%	20,5%	-2,6%	-1,2%	5,1%
2001	15,2%	13,5%	12,4%	3,2%	3,6%	10,6%
2002	15,6%	12,8%	11,1%	1,4%	4,0%	14,0%
2003	5,8%	5,5%	6,6%	0,0%	0,0%	9,2%
2004	12,9%	12,9%	14,1%	-	-	-
2005	2,9%	2,3%	5,2%	0,8%	-0,2%	1,9%
2006	3,5%	3,1%	3,6%	10,9%	3,4%	0,0%
2007	0,8%	0,8%	0,5%	3,8%	2,8%	6,3%
2008	1,7%	-0,6%	-0,8%	-14,2%	0,0%	0,0%
2009	3,3%	0,4%	-0,4%	0,0%	0,0%	0,0%
2010	2,4%	-1,8%	-4,5%	3,3%	-3,2%	-2,1%
2011	5,7%	1,8%	-1,2%	2,9%	-4,1%	-6,2%
2012	9,9%	6,6%	3,6%	0,2%	-1,6%	-2,3%
2013	10,5%	7,6%	5,2%	0,9%	-1,1%	-1,8%
2014	9,3%	6,5%	4,2%	7,7%	2,3%	-0,3%
2015	10,1%	7,6%	5,3%	-2,3%	-8,4%	-12,0%
2016	5,2%	4,5%	4,0%	8,0%	5,3%	6,0%
90s	10,5%	10,5%	11,5%	5,7%	1,0%	3,8%
00s	4,7%	3,6%	3,9%	0,7%	1,5%	5,6%
10s	8,5%	6,1%	4,2%	6,5%	2,8%	2,5%
Sample	7,1%	5,5%	4,9%	4,1%	2,2%	3,9%

interval of 1 to 2. Thus, changing the beta from 1.5 to 2 resulted in a smaller change in direct alpha, than changing it from 1 to 1.5. Nevertheless, some vintages display a different relationship. For instance, the vintages of 2000s indicate that a beta of 2 resulted produced a higher direct alpha than a beta of 1.5. The financial crisis in 2008 may explain the increased direct alpha, where the index declined substantially during that period.

Moreover, venture capital funds generated a direct alpha of 4.1%, 2.2% and 3.9% with betas of 1, 2.5 and 4, respectively. Similarly to buyout funds, changing the betas have a detrimental effect on performance between the first interval. Interestingly, the direct alpha starts to increase in the interval between 2.5 and 4, which may indicate the existence of an inflection point. However, in some vintages, we observe a positive relationship between beta and direct alpha for all of the specified intervals. For instance, the vintages of the 2000s depicts a convex relationship between direct alpha and beta. The relationship implies that the interval between 2.5 and 4 resulted in a larger positive change than than 1.0 to 2.5.

In conclusion, the results suggest that the direct alpha method is robust to different assumptions regarding systematic risk. Although the direct alpha decreases during certain intervals of beta, it never reduces the outperformance to zero. Thus, different assumptions regarding systematic risk cannot explain the outperformance. The findings are also consistent with previous research, where Robinson and Sensoy (2013) also finds a concave relationship between PME and beta when simulating different values of systematic risk.

5.4 Regression analysis

In this section, we evaluate the significance of different fund characteristics to relative performance. The methodology involves regressing relative performance against different fund characteristics such as size, sequence, fund type and firm country. The intuition is to investigate whether these factors are valuable for LPs to consider when forming an investment decision. Lastly, we will also investigate if European PEFs experience persistency in relative performance, which implies that certain GPs tend to outperform others consistently.

5.4.1 Size, sequence and fund-type

We begin by testing the relationship between relative performance, fund-size, sequence and fund-type. Previous research suggests that there is still some ambiguity concerning how these factors affect relative performance. Kaplan and Schoar (2005) find a positive concave relationship between relative performance and fund-size. The finding implies that larger funds tend to experience larger returns to a certain point, suggesting that increased fund-size becomes detrimental to performance at a certain level. The authors also note a significant positive relationship between relative performance and sequence number, where higher sequence correspond to higher relative returns. Contrastingly, Phalippou and Gottschalg (2009) find an insignificant relationship between relative performance and sequence number, where the authors argue that sequence is an inferior measure compared to fund-size to proxy for the skill of GPs. Higson and Stucke (2012) also find a systematic relationship between relative performance and fund-size, showing that larger funds generated a higher outperformance. Nevertheless, Higson and Stucke (2012) do not find a significant concave relationship.

We begin by specifying the first regressional equation to test the relationship between relative performance, sequence and fund-size (Equation 4.20). Similarly to previous research, we incorporate dummy variables to control for year fixed-effects. We also log-transform the variables, since most of the PME measures display signs of skewness in the distribution. Lastly, we include squared terms of both the size and sequence variable to check for concavity.

Appendix B.1 displays the regressional output. Consistently to previous research, the results indicate a positive coefficient for the size variable and a negative coefficient for the squared size variable. Interestingly, the results are not significant at a 5 or 10% significance level. Hence, there is no significant relationship between fund-size and relative performance, which may be an indication that fund-size is a bad proxy for GP skill.

Nevertheless, we do observe a significant positive concave relationship between fund-sequence and relative performance, where both the standard and squared sequence variable was significant at a 1% significance level. The finding implies that first-time funds tend to experience lower performance compared to follow-up funds. Unlike Higson and Stucke (2012), we also observe a significant negative coefficient of the squared sequence variable, which confirms a concave relationship.

A prominent remark is also that the VC dummy indicates a consistent significant underperformance compared to buyout funds, yielding a point estimate of -0.211 and a standard error of 0.062.

In conclusion, the results suggest that increased firm-size does not correspond to higher relative performance concerning European PEFs. LPs should instead consider the sequence number of the fund when forming an investment decision. These results are consistent with Harris et al. (2014b), where the authors also find an insignificant relationship between size and PME.

5.4.2 Country

As previously discussed, we attempt to test if GPs of some countries systematically outperform others. The intuition is to examine whether the country origin of the PEF has a decisive effect on relative performance and if LPs should avoid investing in certain countries. To test this, we specify a regression that includes dummy variables of all the different countries in the study. The regressional equation is found in subsection 4.4.2.

Appendix B.2 displays the regressional output. All of the country dummy variables produced insignificant coefficients except one country. Interestingly, we observe a significant adverse effect when the PEF originates from Greece, where the dummy variable yielded a point estimate of -1.351 and standard error of 0.423. Further, the sequence variables and the VC dummy remain significant.

5.4.3 Persistence

We examine the presence of persistence in performance by adopting a parametrical approach. The intuition is to determine whether previous fund performance of a specific GP has a significant effect on subsequent fund performance. The methodology involves extending equation 4.20 by including a lagged term of relative performance as one of the explanatory variables. Previous research indicates mixed evidence of persistence during different time-periods. Harris et al. (2014b) conclude significant persistence in before 2000, where a 10% increase in previous fund PME was associated with a 2,9% increase in current fund PME. Similarly, Kaplan and Schoar (2005) also find evidence of persistance and argues that partnerships vary systematically in their average performance.

To evaluate the presence of persistence in performance, we specified the regression equation in subsection 4.4.3.

Appendix B.3 show the regressional output. The results suggest strong evidence of persistence across the sample period. Previous funds PME significantly affected the current funds PME, where a 10% increase in previous fund PME corresponded to a 2.2% increase in current fund PME. Worth noting is that all the other control variables loose significance when incorporating the lagged PME, which suggests that previous fund performance is the unique explanatory variable that has a significant effect on current funds performance. The results are also consistent with previous studies, where Phalippou and Gottschalg (2009) notes that variables representing fund characteristics such as size and sequence lose their significance when including previous fund performance into the regressional equation. Similairly, Harris et al. (2014b) find an insignificant relationship relative performance and fund-size when including previous performance in the regressional specification.

In conclusion, the findings have several implications for LPs seeking to invest in PE funds owned by European PEFs. Investors should pick funds of a GP that has a track record of generating high relative returns since partnerships vary systematically in their average performance. Nevertheless, investors should be cautious about using previous fund performance as a foundation for investing before the fund is fully liquidated. As highlighted in previous sections, previous fund performance during times of fund-raising is a noisy measure of the true performance and should, therefore, be evaluated with careful analysis.

5.5 Summary and results

To conclude, we find evidence of strong outperformance when investing in funds of European PEFs between 1989 and 2018. In aggregate, all the PE funds of the sample outperformed the S&P 500 by 5.6% yearly when using the direct alpha approach.

We observe different rankings between fund-types when adopting the absolute performance measures. The IRRs indicate that the best performing fund-type of the sample was the balanced funds, whereas the TVPI multiple suggests that the top-performing fund-type was "fund of funds". However, we conclude that IRRs sensitivity to the timing of cash-flows may explain this deviance.

Balanced funds seem to offer the highest absolute- and relative performance during the sample period, yielding average IRR and direct alpha of 15.3% and 9% respectively. However, we are unable to conclude outperformance of this fund-type over others, which may be explained by the low amount of observations of this fund-type. Further, fund of funds experienced the lowest volatility in both relative and absolute returns in comparison to the other fund-types. The lower volatility may be a reflection of the diversification benefits yielded by investing in a variety of different PE funds.

Furthermore, we evaluate all of the different PME measures to check for consistency and robustness of the outperformance. The results indicate considerable differences concerning the ranking of relative performance between the measures. We argue that the direct alpha approach offers the most consistent and robust method of computing the excess return of a PE investment. Unlike the heuristic approaches, it offers a direct and straightforward way of estimating excess annual return. Further, it avoids some of the shortcomings of the heuristic approaches, such as the negative NAV problem.

Consistent with previous research, we also find signs of cyclicity in absolute- and relative performance. All of the fund-types experienced a high relative- and absolute performance in the 1990s. Followingly, we note a deterioration in the performance of the funds during the 2000s. The decline may be a result of the two large economic turndowns during the decade. Nevertheless, both absolute and relative performance experienced considerable increases during the vintages of the 2010s, suggesting that the industry is recuperating.

Moreover, the result also indicates that all of the fund-types experienced a positive skew in the performance distribution, meaning that large positive outliers may have a decisive impact on the average performance. We carefully analyse the distribution by dividing each subsample into four different performance quartiles. The results suggest that the fund-picking skill of LPs seems to be of less significance compared to previous claims, where all of the fund-types experienced returns comparable to the market in the second and third performance quartile. Thus, we neglect the standard presupposition of only top-quartile funds having returns comparable to the market. However, fund-picking seems to be of larger importance for some fund-types, where venture capital funds display more dispersed outcomes compared to the other fund-types.

We also test the sensitivity of the direct alpha approach to different benchmarks. The results indicate that changing the benchmark can significantly affect the outperformance. The finding implies that LPs should be cautious when deciding which proxy to use to represent an equivalent public market investment. Nevertheless, the finding serves as an additional validation of the robustness of the outperformance, where changing the benchmark resulted in a higher average direct alpha.

Furthermore, we test the sensitivity of the direct alpha approach to different levels of systematic risk. We conclude that the direct alpha method is robust to different assumption regarding systematic risk. Although the direct alpha decreases for certain intervals of beta, it never reduces the outperformance to zero. We also note several inflection points in the relationship between beta and direct alpha, where the function changes during certain intervals from being convex to concave, or vice versa.

Similarly to previous research, we find that buyout funds outperformed venture capital funds using both relative and absolute performance measures. Buyout funds outperformed the S&P 500 in every vintage year of the sample, yielding an average yearly excess return of 7.1%. The outperformance is also robust and consistent across all the different PME approaches. We also found the outperformance of buyout funds over venture capital to be statistically significant in the regressional output. Worth noting is that all the other dummy variables representing the different fund-types were insignificant.

We also evaluate relative performance by dividing the sample by country origin of the PEF. The intuition is to examine whether certain countries tend to outperform others systematically and if the country origin of the PEF is a crucial factor to consider for LPs. We observe that the Netherlands generated the highest relative performance during the sample period, yielding an average direct alpha of 13.6%. The second and third best-performing countries were France and Spain, yielding an average direct alpha of 7.35% and 6.54% respectively. However, when testing the significance of the outperformance, we find that Greece is the only country that systematically underperforms compared to the other countries. The finding may function as a guideline for investors to avoid investing in Greek PEFs.

Followingly, we test the significance of fund characteristics to relative performance. These characteristics include fund-size, sequence number and fund-type. Previous research suggests that there is still some ambiguity regarding how these factors affect relative performance. We observe inconsistent results compared to previous research, where the findings suggest a non-significant relationship between size and relative performance. Thus, LPs should not use the size of the fund to proxy for GP skill. Nevertheless, we find a positive concave relationship between relative performance and sequence, suggesting that first-time funds tend to experience lower returns compared to follow-up funds.

Lastly, we examine if persistency in performance exists across the funds in the sample. The results show that previous fund PME significantly affected current fund PME, where a 10% increase in previous fund PME corresponded to a 2.2% increase in current fund PME. The finding has several implications for LPs seeking to invest in funds owned by European PEFs. Investors should pick funds of GPs with a track record of delivering high relative returns.

5.6 Discussion and limitations

We want to end the empirical analysis with a small discussion regarding the limitations of this study. As stated in previous chapters, prior research has mostly focused on evaluating PE returns using a much broader geographic scale. This study intended to use a much narrower scope and only include funds of European PEFs. However, this selection criteria has had several effects on the specified inferences. The descriptive statistics produces several findings which may question the reliability of the study. For instance, most of the firms in the sample originate from the UK, where the overrepresentation of British firms may have a decisive impact on the overall performance. Moreover, some fund-types also experienced a considerably lower number of observations compared to others. The sample contained a limited amount of information regarding the balanced funds' category, yielding a total of 21 observations. Thus, the scarcity of observations restricts the possibility to evaluate performance thoroughly.

Furthermore, we also conclude a limited amount of information in the early vintages of the 1990s, where most of the fund-types did not have any funds present. The finding serves as an indication of a less established European PE market in the early vintages, where research in which includes North-American PEFs contains significantly more observations. Nevertheless, it could be the case that the sorting problems associated with PE markets are much more pronounced in Europe compared to North-America. Consequently, this would cause an enlarged degree of information asymmetries and would restrict information disclosures.

Additionally, the descriptive statistics also indicates an overexposure towards higher sequence funds, which has several implications concerning the specified inferences. Higson and Stucke (2012) and Kaplan and Schoar (2005) finds a positive relationship between relative performance and sequence number. Similarly, the results of this study also suggest a positive relationship between sequence and relative performance. The distribution of fund-sequences may be an indication of survivorship- and backfill bias, where the data of bottom quartile first-time funds may be absent. Thus, the sample may not be representative and produces an upward bias as a consequence of the sequence distribution.

Lastly, we also conclude a low average realisation rate of 54% for the funds in the vintages post the 2000s, which implies that 46% of the value is still unrealized. Jenkinson et al. (2013) argue that GPs can apply various valuation methodologies when calculating the NAV of the fund, which increases the probability of opportunistic and erroneous valuations. Additionally, since GPs use interim-fund performance to market follow-up funds, it incentivises GPs to report an inflated residual value to boost the IRR Cumming and Walz (2010). Consequently, a low realisation rate may have a severe effect concerning the accuracy of the calculated absolute- and relative performance of this report, where the non-liquidated funds are still subject to the future realisation of profits. Nevertheless, we believe this effect to be limited, as GPs with established track records and strong reputation may risk losing reputational capital by manipulating performance figures.

6 Conclusion

In this study, we evaluate the relative- and absolute performance of funds by European PEFs. The sample is gathered from Preqin, one of the most prominent data-providers in the industry, containing 395 funds between 1989 and 2018. The standard performance metrics used in PE markets, such as IRR and TVPI, fail to capture information regarding the opportunity cost of a PE investment. Additionally, the measures can also be affected by managerial discretion, where GPs can choose the timing and size of cash flows to increase absolute performance. As a remedy, we adopt the public market equivalent framework, which attempts to compare the returns of a PE portfolio between a reference benchmark.

Within the PME framework, there are several approaches which all have different methodologies in estimating the excess return between a benchmark. We test the consistency between the approaches by performing a correlational- and ranking analysis, where we conclude the direct alpha method to be the most accurate and straightforward approach to estimate relative returns.

In aggregate, we find that the PE funds of the sample outperformed the S&P 500 by 5.6% yearly when using an equally-weighted direct alpha approach. Consistent with previous research, we find that buyout funds outperformed venture capital funds in every ranking aspect, which is also statistically significant when observing the regressional output. We also find signs of cyclicity in performance when observing the different vintage decades of the sample. All of the fund-types experienced high relative and absolute returns in the 1990s. Followingly, we note a deterioration in performance in the 2000s. Both the absolute and relative performance then seems to increase in the vintages in the 2010s, suggesting that the industry is recuperating.

Evidently, the outperformance justifies the large commitments and allocations observed in the PE industry in recent decades. Consistent with previous research, we find that the outperformance is robust and coherent across all relative performance measures, and it is also insensitive to different assumptions regarding systematic risk and benchmark. The prediction of Jensen (1989), may have been accurate, where the organisational form can provide value to all participants involved in PE markets. Nevertheless, it is critical to acknowledge the additional costs and uncertainties of PE investments compared to public market investments. For instance, the illiquidity costs and commitment risk may offset some of the benefits of the asset class. It may also explain the return premium associated with PE investments, where investors might require a higher premium to bear the additional risk.

In comparison to previous research, we note that LP fund picking skills seem to be less important in Europe than the US. Research which focused on North American PEF performance indicates a larger variation in performance compared to the result of this study, which was also particularly prominent for venture capital funds. This finding may indicate that GPs in Europe are more risk-averse compared to GPs in

North America. We also find that fund size seems to be less related to performance compared to previous claims. Most of the North American studies indicated a significant relationship between fund size and relative performance, whereas this study did not.

Moreover, we realise the value the PME framework provides, where it offers deep insights concerning the true performance of PE investments in European PEFs. We observed several occasions where the absolute performance measures did not provide sufficient information regarding the true performance. Thus, to avoid misleading and inaccurate performance signals, it is critical to always combine relative and absolute performance measures to grasp the true performance of a PE fund.

For future research, there are two different areas worth investigating. Firstly, it would be interesting to examine whether a higher management fee charged by GPs corresponds to a higher relative- and absolute return. The research question may highlight if the compensation to GPs accurately reflects the performance. Secondly, it would be interesting to examine how interest alignment mechanisms, such as provisions and clauses, affect the performance in PE funds.

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A (Appendix A title)

Table A.1: ICM/PME Numerical example

This table displays a numerical example of the ICM approach. In this approach, the PE funds IRR is compared to the IRR of the hypothetical public market equivalent portfolio to calculate the residual spread. The IRR of the hypothetical portfolio is defined as the IRR using net-cashflows of the PE fund and the residual value of the fictive portfolio.

	PE fund				ICM	
Period	Contributions	Distributions	Net Cashflows	Index	Index performance	NAV ICM
p1	100	0	-100	100	0,0%	100
p2	0	0	0	110	10,0%	110
p3	100	50	-50	115	4,5%	165
p4	0	70	70	120	4,3%	102
Valuation (p5)			120	130	8,3%	111

Fund IRR:	8,2%
IRR ICM/PME:	6,5%
Δ:	1,7%

Table A.2: PME+ Numerical example

This table displays a numerical example of the PME+ approach. In this approach, the PE funds IRR is compared to the IRR of the hypothetical public market equivalent portfolio to calculate the residual spread. The IRR of the hypothetical portfolio is defined as the IRR using net cashflows (where the distributions are multiplied by the scaling factor) of the PE fund and the residual value of the PE fund.

	PE fund				PME +		
Period	Contributions	Distributions	Net Cashflows	Index	Theoretical contributions	Scaled(D)	Cash-flows
p1	100	0	-100	100	100	0	-100
p2	0	0	0	110	0	0	0
p3	100	50	-50	115	100	46	-54
p4	0	70	70	120	0	65	65
Valuation/NAV (p5)			120	130			120

Scaling factor:	0,93
Fund IRR:	8,2%
IRR PME+:	6,5%
Δ:	1,7%

Table A.3: KS-PME Numerical example

This table displays a numerical example of the KS-PME approach. In this approach, the output multiple is calculated by taking the sum of the future values of distributions and residual NAV, divided by the sum of the future values of the contributions. The distributions and contributions are compounded to future values by using the index price.

		PE fund					
Period	Contributions	Distributions	Net Cashflows	Index	FV(C)	FV(D)	KS-PME
p1	100	0	-100	100	130	0	0,0
p2	0	0	0	110	0	0	0,0
p3	100	50	-50	115	113	57	0,2
p4	0	70	70	120	0	76	0,5
Valuation/NAV (p5)			120	130		120	1,04

KS-PME:	1,04
TVPI:	1,20

Table A.4: Direct alpha Numerical example

This table displays a numerical example of the Direct alpha approach. In this approach, the excess return is calculated by taking the IRR using the future values of the contributions and distributions, and residual NAV. The last step involves taking the natural logarithm of the calculated IRR.

		PE fund				Direct alpha	
Period	Contributions	Distributions	Net Cashflows	Index	FV(C)	FV(D)	Net Cash-flow
p1	100	0	-100	100	130	0	-130
p2	0	0	0	110	0	0	0
p3	100	50	-50	115	113	57	-57
p4	0	70	70	120	0	76	76
Valuation/NAV (p5)			120	130			120

Direct alpha:	1,62%
Fund IRR:	8,23%

B (Appendix B title)

Table B.1: Regression size, sequence and fund-type

This table displays the regressional output when regressing KS-PME on fund-size, sequence and fund-type. We also include squared variables of size and sequence to check for concavity. Further, the variables are transformed into their natural logarithmic form. We also control for year fixed effects. The first row for each variable represents the parameter coefficient, and the second row displays the standard error. The dataset includes 386 observations.

VARIABLES	(1) ln(KS-PME)
Dummy Balanced	0.038
	(0.088)
Dummy Fund of Funds	0.047
	(0.054)
Dummy Venture capital	-0.211***
	(0.062)
ln(Size)	0.034
	(0.102)
$\ln(\text{Size})^2$	-0.002
	(0.008)
ln(Sequence)	0.320***
	(0.091)
$\ln(\text{Sequence})^2$	-0.122***
	(0.043)
Constant	0.138
	(0.496)
Observations	386
R-squared	0.254

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.2: Regression size, sequence, fund-type and country

This table displays the regressional output when regressing KS-PME on fund-size, sequence, fund-type and country. We also include squared variables of size and sequence to check for concavity. Further, the variables are transformed into their natural logarithmic form. We also control for year fixed effects. The first row for each variable represents the parameter coefficient, and the second row displays the standard error. The dataset includes 371 observations.

VARIABLES	(1) $\ln(KS_{PME})$
Dummy Fund of funds	0.018
	(0.062)
Dummy Balanced	0.037
	(0.091)
Dummy Venture capital	-0.174***
	(0.063)
ln(Size)	0.065
	(0.111)
$\ln(\text{Size})^2$	-0.005
	(0.009)
ln(Sequence)	0.271***
	(0.098)
$\ln(\text{Sequence})^2$	-0.084*
	(0.045)
Estonia	0.099
	(0.435)
Finland	-0.288
	(0.238)
France	-0.007
	(0.223)
Germany	-0.199
	(0.234)
Greece	-1.351***
	(0.423)
Italy	-0.035
	(0.274)
Latvia	0.162
	(0.425)
Lithuania	0.071
	(0.356)
Luxemburg	-0.140
	(0.296)
Netherlands	0.301
	(0.230)
Norway	0.003
	(0.226)
Poland	-0.351
	(0.275)
Portugal	0.057
	(0.427)
Spain	0.215
	(0.241)
Sweden	-0.006
	(0.241)
Switzerland	-0.007
	(0.220)
UK	-0.061
	(0.215)
Constant	0.096
	(0.555)
Observations	371
R-squared	0.349

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.3: Regression Persistence

This table displays the regressional output when regressing KS-PME on fund-size, sequence, fund-type and the relative performance of previous fund. We also include squared variables of size and sequence to check for concavity. Further, the variables are transformed into their natural logarithmic form. We also control for year fixed effects. The first row for each variable represents the parameter coefficient, and the second row displays the standard error. The dataset includes 143 observations.

VARIABLES	(1) ln(KS-PME)
Dummy Funds of funds	-0.010
	(0.070)
Dummy Balanced	0.049
	(0.097)
Dummy Venture capital	-0.008
	(0.088)
$\ln(size)^2$	0.100
	(0.134)
$\ln(size)^2$	-0.007
	(0.010)
ln(Sequence)	-0.006
	(0.135)
$\ln(Sequence)^2$	0.014
	(0.054)
KS-PME t-1	0.220***
	(0.072)
Constant	-0.229
	(0.518)
Observations	143
R-squared	0.421

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$