Stockholm School of Economics
Department of Finance

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Bachelor's Thesis

# The Curse of Private Equity

## Exploring the Size-Performance Relationship of Private Equity Firms

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**Abstract**

Research on private equity (PE) fund performance is extensive but incoherent. Numerous US studies conclude that fund size increases have a negative impact on net-of-fees returns. This relationship can be seen as a curse of PE, reflecting the difficulty of employing the committed capital effectively when funds grow. However, other studies claim that the relationship is not significant while a few studies even find that size increases have a positive impact on returns. Consequently, there is a need for additional research focusing on what factors affect the size impact on PE performance. Are some PE firms able to evade the curse?

We test if a negative size-performance relationship exists in PE. In contrast to previous studies, we capture the interplay between fund characteristics and size by including variables such as regional focus, industry focus and fund type (venture capital or buyout) along with an interaction variable with size for each characteristic. Our results confirm a negative size-performance relationship in PE on an aggregate level, but we find exceptions. In contrast to US funds and venture capital funds that are more sensitive to size increases, European funds, buyout funds and funds specialized in infrastructure are more tolerant of size increases.

Further we expect certain PE firms to be more skilled in managing size disadvantages, independent of region, industry focus or fund type. Consequently, we test if such firm specific skill factor can be observed when measuring the impact of net-of-fees returns as fund size increases. We conclude there is a significant skill-factor affecting firms' abilities to manage size increases.

**Keywords:** Private Equity, IRR, Fund Size, Diseconomies of Scale, Skill

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## Contents

# 1 Introduction

## 1.1 Recent development in the private equity industry

The mega-buyout years between 2003 and 2007, driven by loose credit markets and increased investor risk appetite, are known to be the "golden age of private equity". Over these years fundraising in private equity (PE) increased eight-fold to more than USD 240bn globally. As the PE bubble burst during the financial crisis, the impact on the industry was substantial. In general, the industry size decreased, PE firms with large legacy problems had difficulties raising new funds and many funds liquidated. Consequently, the golden age of PE was over (Rizzi, 2009).

However, it now appears that the memories of the PE industry's cyclical nature have faded. With a global economic environment similar to the one before the financial crisis, combined with favorable credit markets, risk appetite has increased again. Fundraising has reached record levels. In 2017, Apollo Investment Fund IX raised USD 24.6bn, surpassing the previous all-time high of Blackstone's USD 21.7bn from 2007 (*Preqin Data A.*, 2018).

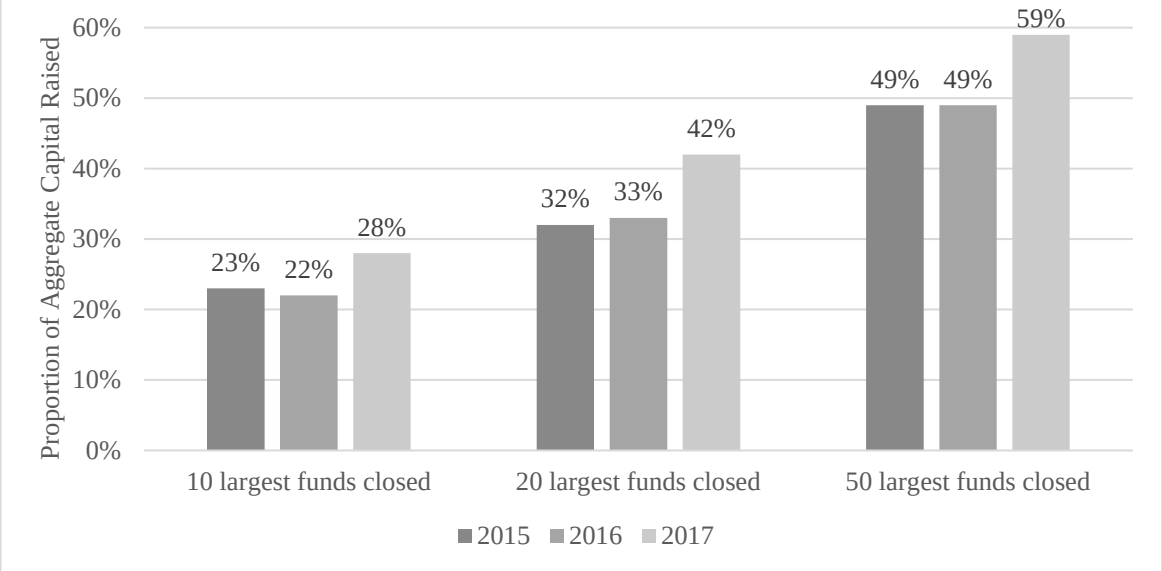


**Figure 1. Proportion of aggregate capital raised by largest funds closed, 2015-2017**

*If a PE firm has been able to generate high returns in their previous fund, it can usually raise capital for a larger subsequent fund. 2017, the 50 largest funds in PE received 59% of the capital* (*Preqin Data A.*, 2018).

At the same time as fund sizes have grown in the PE industry, overall returns have decreased (*Preqin Data A.*, 2018). The decreasing returns observed in connection to increasing fund sizes can be seen as "a curse of private equity".

Some studies have found a negative fund size-performance relationship in the PE industry as a whole (Kaplan and Schoar, 2005; Aigner, Albrecht, Beyschlag, Friederich, Kalepky and Zagst, 2008). However, there are other studies contradicting this result (Phalippou and Zollo, 2005; Harris, Jenkinson and Kaplan, 2014). Furthermore, there is no clear breakdown of which factors make some firms more negatively affected by the same size increase than others. This is a relevant research area as limited partners (LPs) dedicate more of their capital to certain mega-funds. Therefore, we study if some PE firms can tolerate larger size increases with less damaging effect on LP net returns, and which parameters drive tolerance to size increases.

## 1.2 Research focus and delimitations

Consequently, the aim of this paper is to answer the following research questions:

- On an aggregate level, is there a fund size disadvantage, meaning larger funds cause decreasing net-of-fees returns to LPs?
- Can certain fund characteristics predict how different funds respond to size increases regarding net-of-fees returns?
- Are some PE firms more skilled in managing size increases, translating into a smaller negative net-of-fees return impact as funds grow?

To narrow the scope of this study we make the following delimitations:

- We limit our sample to PE firms investing in Europe or the US.
- Only funds active between the years 1972-2018 with a fund size greater than EUR 5m have been included.
- We have only included firms with a minimum of four funds to be able to perform a hierarchical regression with large enough clusters.
- In contrast to Kaplan and Schoar (2005), Aigner et al. (2008) and Korteweg and Sorensen (2017) who only include quasi-liquidated funds, we have chosen to use both liquidated and ongoing funds for the regressions. One bias of including non-liquidated funds is overvaluation by GPs. However, they suffer a reputational cost from overvaluing their assets, and our data provider, Preqin, regularly conducts valuation updates (Lopez-de-Silanes et al., 2013). By including ongoing funds, we can base our regressions on a broader and more recent set of data.
- We exclude funds investing in real estate, hybrid or debt instruments, co-investment funds and fund of funds as these differ from buyout (BO) and venture capital (VC) funds

considering financing structure, investment targets and rely more on financial engineering than operational improvement (Alcock, Baum, Colley, Steiner, 2013; Gresch and von Wyss, 2011; Yager and Connor, 2006). Also, previous research has shown that past performance is a significant indicator for future performance for VC and BO, which is not the case for real estate (Chung, Sensoy, Stern and Weisbach, 2010).

## 1.3 Definitions

i. A **buyout fund (BO)** acquires a majority equity stake in mature companies often using high leverage.

ii. **Committed capital** constitutes the money contributions to the PE fund, and it is drawn from when investments in new portfolio companies are made. In this study, **fund size** is defined as the total committed capital by GPs and LPs to a particular fund.

iii. **Dry powder** are reserves of cash or cash equivalents in a fund, waiting to be invested.

iv. **Experience vs. skill** in managing larger funds. In this thesis we separate static from dynamic competences. Experience is considered to be a dynamic competence connected to learning and is therefore built up over time. Firm skill is a static competence relating to an individual firm which constitutes of unique firm factors, for example competent GPs, firm brand and ability to attract talent.

v. **General partners (GPs)** form the PE fund and commit a minority of a PE fund's total capital. GPs make all of the decisions for the PE firm, including decisions concerning investments and management of the fund's portfolio.

vi. A fund's **gross internal rate of return (gross IRR)** is a return metric of a PE fund's yearly performance before deduction of management and performance fees charged to LPs. The gross IRR can be seen as the IRR from the GPs' perspective before fees.

vii. **Limited partners (LPs)** are investors such as pension funds, insurance companies, university endowments, wealthy families etc. who commit the majority of the capital to a PE fund. LPs are passive partners in the management of a fund, meaning risk management and investment considerations, are entirely delegated to GPs.

viii. A fund's **net internal rate of return (net IRR)** is a return of a PE fund's yearly performance after fees. The net IRR can be seen as the IRR from the LPs' perspective and is always lower than gross IRR due to the deduction of fees.

ix. A **venture capital fund (VC)** acquires minority equity stakes in early-stage companies with high growth potential.

# 2 Background

## 2.1 Characteristics of the PE industry

### *2.1.1 The business model at a glance*

The PE business model consists of equity investments in companies, usually with an investment horizon of three to eight years. There are many types of PE funds, with the most common being BO and VC funds. Each fund belongs to a series within a firm, and the firm can have several funds series active simultaneously. In this highly cyclical industry, the ease of fundraising and returns are dependent on market conditions. With the current low interest rates, investors are turning to equity in the hopes of higher returns (Gompers, Kaplan and Mukharlyamov, 2016).

The PE firm is created by GPs who usually commit 1 - 5 percent of the total capital of the fund, while the larger equity amount is committed by LPs. GPs charge a fixed percentage of committed capital as a management fee, commonly 1.5 - 2 percent, as well as a variable price tied to returns, around 20 percent of profits. The fixed management fees can be charged both on raised and invested capital (Kaplan and Strömberg, 2009).

GPs often have many years of experience from banking, consulting or other PE firms before starting their own fund. The skill of the GPs can help them understand value creation in companies, while their network can help them find attractive targets and raise large amounts of capital. Therefore, having skilled GPs can be a main built-in differentiator between PE firms, explaining why some are more successful than others (Ivashina and Lerner, 2016).

### *2.1.2 BO vs. VC*

The main difference between BO and VC funds is the maturity of the companies they invest in, with BOs focusing on mature companies and VC on growing firms. BOs add value by limiting agency problems through increased leverage and improved management, while VCs instead help companies overcome financial constraints by enabling necessary investments. Research on PE performance often includes both VC funds and BO funds but distinguish the results due to the characteristics dissimilarities. Phalippou and Zollo (2005) find that VC funds invest 11 percent of the capital in BO and BO funds invest 18 percent in VC, indicating a notable overlap.

The differences between BO and VC have also been covered by Bertoni, Ferrer and Martí (2013), who find that small VC funds often achieve higher returns as they are able to invest in smaller firms with higher typical growth rates – a strategy that is more volatile. In regards to sensitivity to size increases, Metrick and Yasuda (2010) have confirmed that BO is a more scalable business model than VC, resulting in BO funds being significantly larger than VC.

### *2.1.3 US vs. Europe*

The PE industry emerged in the US during the 80's, but it was not until the late 90's PE that boomed in Europe. Consequently, over the years 2000-2004 the western European PE market made up 49 percent of the total value of worldwide leveraged buyout transactions, compared with 44 percent in the US according to Kaplan and Strömberg (2009).

Apart from the US market being older and more mature, the US and European PE markets have proved to be different in several ways. In general, the European market is more regulated, including recent regulations like AIFMD[1]. Moreover, according to an industry report, the European market is more fragmented in sectors such as healthcare (Erez, Podpolny, Rudolph and Grigalauskas, 2017). Regarding a fund's ability to manage size increases, Lopez-de-Silanes et al. (2013) have found that non-scalability is a more prominent issue in the US and developing countries than in Europe.

### *2.1.4 Industry specialization*

Historically, most PE funds have been mixed, meaning they invest in a range of sectors. However, as the PE market matures, it has become more common to specialize in e.g. consumer, healthcare or technology. PE funds who choose to specialize outperform generalists on average (Zweig, Auerbach and Tabares, 2014).

Of all industry focuses, infrastructure funds are unique in several respects. According to Bitsch, Buchner and Kaserer (2010), infrastructure funds tend to be larger as the investments are capital intensive. Infrastructure deals are on average more than twice the size of other deals.

Making an investment in infrastructure assets such as power plants or toll roads generally requires longer time horizons for the investor. This is because the life of infrastructure assets is long, approximately 60 years on average (Rickards, 2008), where some concessions will last as long as 99 years (Beeferman, 2008). As a consequence of the physical nature of infrastructure assets, direct investments cannot easily be sold, which implies a high liquidity risk. Inderst (2009) estimates the volatility of infrastructure investments to lie between bonds and stocks, in comparison to mixed BO and VC funds that are riskier. Government interaction in the infrastructure industry is high and institutional investors, especially pension funds, are showing an increased interest in these types of investments (Inderst, 2009).

[1] Alternative Investment Fund Manager Directive (AIFMD) is a EU directive that regulates PE funds and hedge funds among other alternative investment funds.

### *2.1.5 Dry powder*

Klonowski (2018) estimates that the global value of dry powder in PE amounted to USD 1.3 trillion at the end of 2016, signalling a lack of good investment opportunities, uncertainty and eager LPs. The dry powder has grown over the past years, mostly driven by a rise in total industry commitments. Even though the fraction of dry powder to total assets under management in PE has fallen, the vast amount of dry powder signals eager LPs and contributes to higher competition for good investment opportunities. Ljungqvist and Richardson (2003) and Inderst and Mueller (2003) find that intensified competition in the PE industry prolongs the GPs search time for potential targets, hence, dry powder increases. A reason for GPs to keep cash reserves is to be able to act fast when good opportunities arise. For LPs, the time from fundraising to investment yields low return, suggesting that not only the IRR matters for returns, but also the time it takes to invest. Largely due to difficulties in obtaining data, research within dry powder is limited (Braun and Stoff, 2016).

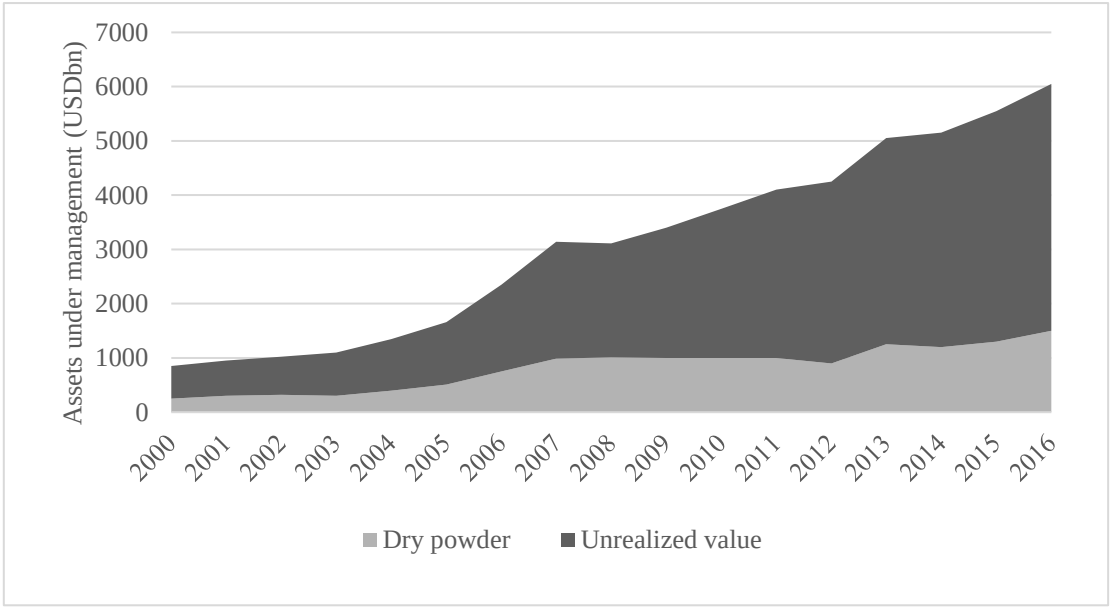


**Figure 2. Private capital assets under management, 2000-2016**

*Total global private capital assets under management has increased six-fold since 2000. Also dry powder has increased in absolute value, but the fraction of dry powder to unrealized value has fallen* (*Preqin Data B.*, 2018)

## 2.2 Performance and persistence in returns

There has been extensive research covering why some PE firms perform better than others and if it is possible to predict fund returns. Korteweg and Sorensen (2017) find that top-quartile PE firms perform 7 - 8 percent higher than the bottom quartile regarding annual net-of-fees returns.

The findings are more distinct for BO than VC firms. Kaplan and Schoar (2005) find that current fund size is positively related to the performance of the two previous funds raised by a firm. Additionally, they stipulate a concave relationship between size and performance, with the optimal size being USD 90m. This is significantly lower than the average LBO fund size of their sample (USD 416m) and also below the average VC fund size (USD 103m). The reasons behind this are lack of good deals and constraints in human capital such as skilled GPs.

Research shows a significant persistence in fund returns and a correlation between previous performance and ease of raising a subsequent fund, also called the flow-performance relationship. Aigner et al. (2008) observe the drivers for PE performance and find great support for persistence in fund returns, meaning that firms with funds that have performed well in the past are more likely to raise funds performing well in the future. Their findings show that if the preceding fund performed in the top quartile, there is a 33 - 42 percent probability that the subsequent fund will reach the top quartile as well. The tenacity is attributed to the GPs experience and skill, but there is also a risk-taking component associated with this. Funds with previous mediocre performance are more likely to either outperform or underperform other funds, hence, not achieving an average return again, suggesting that GPs take on more risk hoping to end up in the top quartile.

Chung et al. (2010) test the flow-performance relationship in PE and find that BO funds exhibit a stronger relationship than VC, which is explained by scalability and less noisy performance. The "rational learning framework", that investors learn about the ability of the GP through past performance, describes this phenomenon well. Furthermore, Chung et al. (2010) find that fundraising for later sequence funds is not as dependent on current performance.

With LPs turning to funds with consistently high performance, an extensive share of capital is going to a few funds and mega-funds are created. For instance, in 2017 Apollo raised the largest BO fund ever at USD 24.7bn and KKR raised USD 13.9bn for the biggest ever North American PE fund (*Preqin Data A.*, 2018). Considering the vast amount of capital these mega-funds accumulate, LPs seem to believe the PE firms can continuously deliver high returns, but it is uncertain whether the superior performance will be maintained with increased sizes and whether it will benefit LPs in terms of net returns.

To summarize, performance and size goes hand in hand. As LPs expect top funds to keep generating high returns, they choose to invest in these. However, increasing fund sizes are believed to cause declining returns. The next section aims to explain why this is the case.

## 2.3 Size disadvantages

In order to employ all the capital raised, larger funds will either invest in more companies, or they will invest in larger companies. Firstly, assume that the option of investing in more companies applies for PE firms. Investing in more companies means there will be less time and resources per investment manager to engage in each portfolio company, causing less operational improvement (Aigner, et al., 2008; Lopez-de-Silanes et al., 2013). Cumming, Siegel and Wright (2007) have shown that as fund sizes grow, the number of investment professionals does not increase proportionally, leading to fewer professionals in relation to the committed capital, also illustrated in appendix 1 (*Preqin Private Capital Compensation and Employment Review*, 2015). In terms of internal fund structure, Lopez-de-Silanes et al. (2013) find that disadvantages of scale are prominent in PE, meaning that larger and hierarchical organizations are less efficient due to ineffective communication.

The second strategy, investing in larger companies, also entails size disadvantages. In line with Robinson and Sensoy (2015), there is a high correlation between the size of a BO fund and the size of the portfolio companies. BO funds typically target companies with the aim of improving governance and streamlining processes (Bertoni et al, 2013). Factors speaking against high returns for large companies are high competition, slow change due to size and little room for growth in mature markets. Leifer O'Connor and Rice (2001) explain that large companies have difficulties coping with radical innovation and Taymaz (2005) claims that managing a larger portfolio company makes it harder to have insight into all divisions.

Concerning size disadvantages, the main drivers for low returns are more committed capital per PE professional and communication inefficiencies due to the size of the PE firm.

### *2.3.1 Competition*

In PE, targets are usually bought either via a “structured process”, also known as an “auction”, or via an “exclusive process”. An auction means an investment bank is responsible for selling the company, and the bank will invite several potential acquirers to bid for the company. The auction process usually involves multiple rounds, which means that in each round, the interested acquirers can increase their prices to match competing offers. Structured processes are often applied in the sale of larger companies and are competitive.

However, in the sale of smaller companies, exclusive processes are common. This means there are only one or two buyers invited to negotiate the price. Subramanian (2008) finds that PE firms put high value on the exclusivity of a process. The main advantage with an exclusive process is the decreased burden on the selling company to coordinate several interested parties

and they can instead allocate more energy to identify the most likely buyer's intentions and strategies. For the PE fund, engaging in an exclusive process implies an 86 percent chance of acquiring the target, compared to the average 3 percent of an auction process. The certainty of deal enables the PE fund to perform a proper due diligence and refine their investment value creation thesis for enabling higher returns.

Furthermore, there are by nature fewer large companies than small companies. With the recent trend of increasing fund sizes in PE, more companies have capability to acquire larger targets, increasing competition (Phalippou and Zollo, 2005). An industry report by McKinsey&Co (2018) finds that in 2017 the number of PE deals decreased but that total deal volume remained, meaning that funds invest in fewer but larger companies. The intensified competition is also reflected in rising valuation multiples, indicating higher sales prices and lower returns.

To summarize, investing in larger companies pose challenges as funds will experience stronger competition through structured processes.

## 2.4 Reasons for increasing fund sizes

### *2.4.1 Size advantages*

Investing in large companies can also provide benefits. Tying back to the two different strategies of investing in more companies or in larger companies as funds grow, these will both have a risk diversifying effect. Investing in more companies is an example of the finance classic of not putting all eggs in the same basket and investing in larger companies, who often have several divisions, a broader range of services and an international reach, provides internal diversification (Humphery-Jenner, 2012). Furthermore, large funds increase the scope of investment, enabling funds to target both large and small companies.

There are scale benefits with larger funds, namely knowledge synergies and combined purchasing benefits. Larger funds have higher negotiation power with suppliers such as banks and due diligence providers, translating into for example lower interest rates. Having a big PE firm often means they are an attractive client for the large banks, as they regularly search for financing in leveraged buyout transactions (LBOs). Therefore, the larger PE firms often have an advantage in securing cheap financing (Humphery-Jenner, 2013). The recently published industry report by McKinsey&Co (2018) shows that mega-funds outperform other funds, which suggests that mega-funds manage to capture these size advantages.

Tying back to the flow-performance relationship, a significant size advantage is associated with a reputational factor. Having a big fund means there will be more capital per fund manager, which is often connected to higher salaries. Furthermore, it can help firms establish their brand to attract the best talent (Stowell, 2017).

Lie and Lie (2002) find that the most common type of valuation in the industry, multiples valuation, is more accurate for larger companies and these are also less likely to be overvalued. While small companies might be small due to market restrictions, large companies do not face the same boundaries. These companies also possess operations that have enabled previous growth and success.

### *2.4.2 Fee structures create incentives for larger funds*

Despite the several size advantages mentioned, a majority of the previous research in the field concludes that PE fund returns are negatively affected by large sizes. This indicates that the size disadvantages outweigh the benefits. Thereby, it should be beneficial for PE firms to manage smaller funds, not raising as much capital from investors in order to keep up higher returns. It is, however, unusual that PE funds decide to limit their fund size.

One plausible reason for PE firms' increasing fund sizes is the incentive structure of having large amounts of capital invested. According to Kaplan and Schoar (2005), VC and BO funds take a 20 percent cut of profits through carried interest in addition to management fees. For successful funds, the carried interest can rise to 25-30 percent. Management fees usually start at 2 percent of committed capital and are often gradually lowered over the lifetime of the fund. When size increases, the ratio of management fees to committed capital declines but carried interest increases (Robinson and Sensoy, 2013). As PE firms allow their funds to increase more than number of fund managers, this implies the revenue per employee is higher for large funds, creating an incentive for GPs to increase fund sizes (Metrick and Yasuda, 2010).

In the case of actively managed mutual funds[2], it has been established that equity funds earn a negative after-fee alpha (Fama and French, 2010; French, 2008; Gruber, 1996). Such a negative relationship has not been identified in PE. Robinson and Sensoy (2013) find no correlation between fees and net-of-fees returns, meaning that funds that charge high fees neither achieve higher, nor lower LP returns. They conclude that the fees reflect firm skills, suggesting that high performing GPs charge higher fees.

[2] Mutual funds are diversified funds investing in stocks, bonds and other securities, open to the public enabling instant diversification for the investor. Apart from passive funds who track an index, active mutual funds hand-pick the securities.

### *2.4.3 Institutional investors demand larger funds*

Throughout this thesis, we have assumed that LPs investing in PE wish to receive high returns. However, there are other objectives such as risk-profile, time horizon, amount of capital and decision process that need to be taken into account (Lopez-de-Silanes et. al., 2013). Institutional investors struggle to balance the task of investing large amounts of capital with the time and resources needed to manage networks of GPs and portfolio companies. Furthermore, the fee structure of larger funds (lower fixed fees and higher carried interest), increase variation in GP earnings but decrease variation in LP returns (Robinson and Sensoy, 2013). Also, in line with the flow-performance relationship, large funds are often large due to successful fundraising based on previous performance (Chung et al., 2010). Funds absorbing large checks and with good track record provide an attractive opportunity for LPs. The advantage of managing larger funds is therefore an opportunity to attract institutional investors. As seen in the rise of mega-funds, the demand push is evident (*Preqin Data A.*, 2018).

## 2.5 Literature overview

**Table 1. Summary of Research Findings**

| Thesis | Author and Date | Sample | Performance drivers | Other findings |
|---|---|---|---|---|
| Private Equity Performance: Returns, Persistence, and Capital Flows | Kaplan & Schoar 2005 | Thomson Venture Economics, 1980-2001, quasi-liquidated funds larger than USD 5m, 78% VC 22% LBO | • Small size<br>• High historical performance<br>• High market performance | Funds raised when market performed well and fundraising peaked are less likely to raise follow on funds. |
| What Drives Private Equity Fund Performance? | Phalippou & Zollo 2005 | Thomson Venture Economics, US and Europe, 1980-2003 | • Experience: high sequence number and large size<br>• Short lifetime | PE market is pro-cyclical to business and market environment. |
| What Drives PE? Analyses of Success Factors for Private Equity | Aigner, Albrecht, Beyschlag, Friederich, Kalepky & Zagst 2008 | Dataset from an institutional PE fund-of-funds investor in Europe, 104 funds, 1971-2007, at least 70% liquidated | • High percentage BO funds in portfolio<br>• Years of experience<br>• GDP growth<br>• Low interest rates<br>• Small fund size | Funds raised when market performed well and capital commitments were high suffer lower return. Significant persistence in returns and confirmation of the flow-performance relationship. |
| Pay for Performance from Future Fund Flows: The Case of Private Equity | Chung, Sensoy, Stern & Weisbach 2010 | Preqin, funds larger than USD 5m raised before 2005, 37% BO 49% VC 14% Real Estate funds | • Past performance, significant for BO and VC but not real estate | GP earnings from subsequent fund based on current fund performance are higher for BO than VC. Future fundraising is less sensitive to current performance for later sequence funds. |
| Giants at the Gate: Investment Returns and Diseconomies of Scale in Private Equity | Lopez-de-Silanes, Phalippou & Gottschalg 2013 | Data from fundraising prospectus, 334 PE firms | • Concentrated bets (large amounts of money in few investments)<br>• Non-hierarchical PE organizations | Non-scalability is strongest in US and developing countries. |
| Private Equity Performance: What do we know? | Harris, Jenkinson & Kaplan 2014 | Burgiss, data from cash flow to institutional investors (LPs), 1400 US funds, 1984-2008 | • Low total capital flows to PE industry<br>• Large size for VC | BO funds outperform the public market by at least 3 percent in yearly net-of-fees returns, VC funds after '99 do not. Fund size and performance is not correlated for BO funds. |
| Cyclicality, Performance Measurement, and Cash Flow Liquidity in Private Equity | Robinson & Sensoy 2015 | Proprietary dataset from US institutional investor, 837 funds, 1984-2010 | • Small size<br>• Low interest rates | In booming years, small VC funds suffer most from large size. |
| Skill and Luck in Private Equity Performance | Korteweg & Sorensen 2017 | Preqin, 1969-2001, quasi-liquidated funds larger than USD 5m, categorized in BO, VC and others | • Past performance, stronger for small funds and funds outside US | In practice, LPs need to collect information beyond past performance to decide upon an investment. |

***Note**: As seen in the table, findings regarding fund size and returns are inconsistent. Phalippou & Zollo (2005) find that larger funds increase returns, and Kaplan & Schoar (2005) find that smaller funds increase returns.*

# 3 Hypothesis

Based on previous research, we have formulated two hypotheses. Due to the size disadvantages including increased competition, greater fund commitments per professional and difficulties adding value to an already large company we reach our first hypothesis.

*H1: There is a size disadvantage in PE, meaning larger funds will generate lower IRR to LPs.*

In testing this hypothesis, we will breakdown the factors influencing a firm's ability to manage size increases. For example, we test if certain fund types, regions and industry focuses can counteract a potential size disadvantage. Further, we expect certain PE firms to be more skilled in managing the size disadvantages, independent of region, industry focus or fund type. Because of unique firm skill factors, for example competent GPs, firm brand and ability to attract talent, we form our second hypothesis.

*H2: There is a skill factor making some firms better at managing size increases.*

# 4 Method

To test H1, we use an ordinary least square (OLS) regression. To use this model, the error term needs to be normally distributed. We tested the error term for normality to verify that the data meets model requirements, see appendix 2. Excluding control variables, the regression is seen as below. All variables for the OLS regression are presented in table 2.

$$IRR_i = \beta_0 + \beta_1 \, lnsize_i + \, \varepsilon_i$$

To test H2, we use a hierarchical linear model, HLM, also called multilevel model, random effects model and mixed effects model. This method is most commonly used in social sciences when extensive data is available and allocated in certain groups. A common use-case is when analysing variables affecting student test scores, for which HLM allows analysis to be conducted on school, district and region level without loss of data. It has also been applied in PE research by Korteweg and Sorensen (2017) among others. The model is based on the OLS-regression, assumes normal distribution of the error term and is especially useful when data is nested in clusters.

With clustered data, the OLS assumption about independent observations is violated. If data in the same clusters correlate (funds from a certain firm perform better than funds from another one), the idiosyncrasy prevents the observations from being treated as independent. HLM combines disaggregation (conducting a separate regression for each firm) and aggregation (using mean IRR for each firm to regress on firm level) by comparing both within

and between firm variances. HLM can accommodate for small group sizes as well as non-independence of observations, making it an ideal method to test our second hypothesis. It is preferable to have many groups rather than many observations per group, which works well with the Preqin data set.

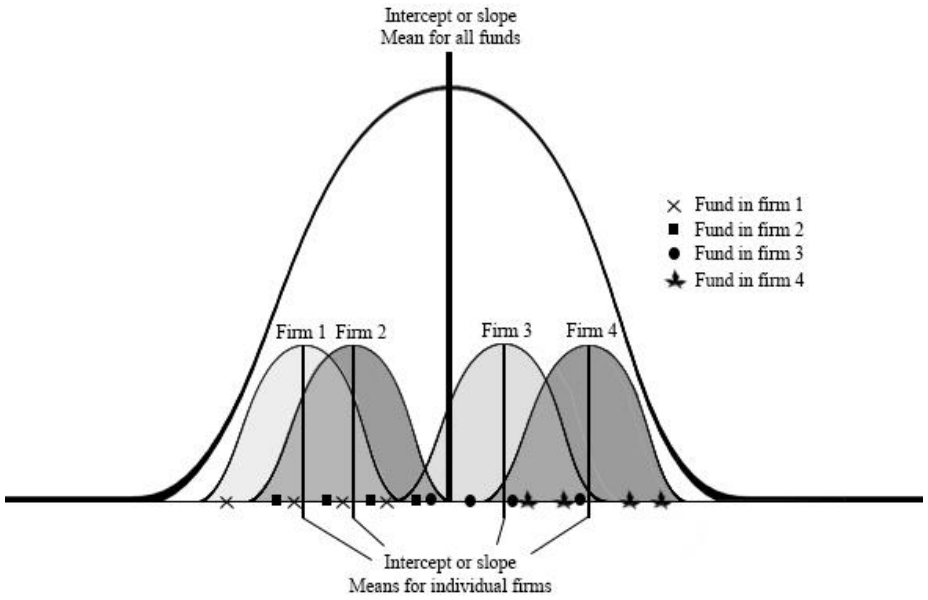


**Figure 3. Illustration of the mechanics of HLM**

*The graph illustrates the hierarchical model mechanics, where funds are clustered depending on the firm they belong to. The small bells in the graph represent 4 different firms, and the associated funds to each firm are plotted on the horizontal axis. All funds in each cluster generate a firm mean for intercept (IRR) and slope in relation to lnsize. Firm mean intercept and slope deviate from the average mean intercept and slope for all observations combined. The deviations per firm are captured by random effects parameters in the hierarchical regression.*

We will be conducting a two-level HLM regression. The first level is fund and the dependent variable is $IRR$. Independent variable and control variables are each tied to a specific fund. The second level is firm, where we have chosen to include firms with four or more funds each. Fewer than four funds entail difficulties with statistical significance due to small sample size.

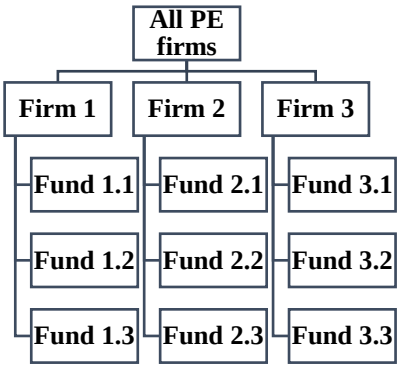


**Figure 4. Dendrogram illustrating PE fund structure**

*The figure illustrates the structure of the Hierarchical Model applicable for the PE firms and funds.*

To perform this regression a series of assumptions and conditions need to be satisfied:

*Assumptions (coefficients, $\gamma$, that need to be significant for assumption be valid)*

1. Fund size is related to IRR ($\gamma_{00}$, $\gamma_{10}$)
2. Firm skill is related to IRR, after controlling for fund size ($\gamma_{01}$)
3. Firm skill moderates the fund size-IRR relationship ($\gamma_{11}$)

*Conditions*

1. There is systematic within- and between-firm variance in IRR
2. There is significant variance in fund intercept (funds differ largely in IRR)
3. There is significant variance in fund slope (funds differ largely in sensitivity to size increases)
4. The variance in the fund intercept and slope is predicted by firm skills

HLM regression line (excluding control variables)

$$IRR_{ij} = \gamma_{00} + \gamma_{10}(lnsize_{ij}) + \gamma_{01}(Firm_j) + \gamma_{11}(Firm_j)(lnsize_i) + U_{1j}(lnsize_{ij}) + U_{0j} + r_{ij}$$

Where

- $\gamma_{00}$ = mean of intercepts across firms
- $\gamma_{10}$ = mean of slopes across firms
- $\gamma_{01}$ = regression coefficient associated with size, relative to firm-level intercept
- $\gamma_{11}$ = regression coefficient associated with size, relative to firm-level slope
- $U_{0j}$ = random effects on intercept on firm-level
- $U_{1j}$ = random effects on slope on firm-level
- $r_{ij}$ = random error for each observation

HLM works through all conditions from the top down. For condition 1, HLM tests for significance in between-firm variance in intercept, meaning that different firms have different means in IRR. Looking only at differences in intercept between firms, IRR equals the mean across all firms $\gamma_{00}$ plus the firm's respective error $U_{0j}$. The variance in IRR within firms is captured by the random error term $r_{ij}$. For condition 2 and 3, a t-test is conducted to determine whether the aggregate means in intercept and slope ($\gamma_{00}$ and $\gamma_{10}$) differ significantly from zero, which, if satisfied, supports hypothesis 1 and should correspond to the OLS results. Furthermore, HLM tests whether the variance in $U_{0j}$ and $U_{1j}$ differ significantly from zero using a $\mathcal{X}^2$ test. The variance in $U_{0j}$ and $U_{1j}$ represent how much of the variance in intercept and slope can be

attributed to a firm-specific skill factor. For condition 4, firm as a predictor for intercept at the aggregate level, (seen with the coefficient $\gamma_{01}$) is included. This directly tests if firm skill is related to IRR after controlling for fund size, as per hypothesis 2. Again, the significance of $U_{0j}$ is tested using a $\mathcal{X}^2$ test. Furthermore, firm as a predictor for slope at the aggregate level (seen with the coefficient $\gamma_{11}$) is added. A significant $\mathcal{X}^2$ test for $U_{1j}$ shows that there is a systematic variance in sensitivity to fluctuations in $lnsize$ between firms, meaning some firms are more skilled in managing changes in fund size. For further illustration of the HLM model, please see appendix 5. In the regression results, $var(\_cons)$ corresponds to variance in $U_{0j}$ and $var(lnsize)$ to variance in $U_{1j}$.

To summarize, the HLM model is used to test the size-performance relationship on two levels; firm and fund. The model predicts how variation in slope and intercept vary depending on the firm and can thereby show how much of the variance is attributable to a systematic firm skill effect (Woltman, Feldstain, MacKay and Rocchi, 2012).

## 4.1 Variable selection

**Table 2. Variables and dependants**

| *Variables and dependants* | *Comment* |
|---|---|
| IRR | Benchmark IRR net-of-fees, yearly |
| lnsize | Natural logarithm of fund size measured in mEUR |
| Vintageyear | Vintage year calculated with 1972 as base |
| Buyout | Dummy: value 1 if BO and 0 if VC |
| Region | Dummy: value 1 if the fund focuses on US investments and 0 if the fund focuses on European investments |
| Lifetime | Lifetime calculated using years between funds in the same series, or average years of funds in the same firm if no subsequent fund has been raised |
| SeqNo | Sequence Number, 1 if it is the first fund in the series etc. |
| TMT | Dummy: value 1 if the fund invests a majority in technology, media and telecom |
| Healthcare | Dummy: value 1 if the fund invests a majority in healthcare |
| InfraNR | Dummy: value 1 if the fund invests a majority in infrastructure/natural resources |
| ConsLeis | Dummy: value 1 if the fund invests a majority in consumer/leisure industries |
| xDummy | Interaction variable with lnsize and a dummy variable, indicating the industry/region/fund type specific effect on IRR of increasing size |
| FirmID | Each firm in the dataset has a firm ID. This is used to separate firms in the HML regression and omitted in the OLS regression |

The variables described in table 2 will be analysed through the OLS and HLM regressions in STATA. The dependent variable is $IRR$ and the independent variable is $lnsize$.

In accordance with PE research standards, we have chosen to use benchmark net IRR as our dependent variable. This measure stands for the return on invested capital for LPs and is adjusted against a market benchmark, which allows for comparison between funds of different vintage years and operating in different geographical markets. Research by for example Aigner et al. (2008) has included GDP growth and interest rates in the regression. Our dependent variable, however, captures the effect of economic conditions through the benchmarked IRR. IRR has obvious drawbacks (for example concerning non-normal cash flow, when additional cash is contributed during the project's lifetime to accommodate for negative cash flow), but is the most widely used performance measure in PE, used by Korteweg and Sorensen (2017), Kaplan and Schoar (2005) and Aigner et al. (2008).

To analyze the independent variable $lnsize$ in isolation, we need to account for other factors that influence the $IRR$. In table 1 we have summarized variables that previous research has shown to affect performance. Hence, these variables have been considered when selecting control variables for the regressions. The selection has also been influenced by literature on different fund types, industry focuses and regional effects on PE returns presented in the background. Accordingly, control variables added to the analysis are: $Vintageyear$, $Buyout$, $Region$, $Lifetime$, $TMT$, $Healthcare$, $InfraNR$, $ConsLeis$ and $SeqNo$.

With increasing competition in the PE market, returns have decreased over recent years. Thereby, $Vintageyear$ has been included as a control variable. $Buyout$ is commonly included in previous research since there are many differences in fund size, risk, strategy etc. between BO and VC funds (Bertoni, Ferrer and Martí, 2013). Regions with enough data for statistical significance are Europe and US and there are differences between these, such as regulations, market fragmentation and PE industry age which imply an effect on $IRR$ (Wright, Lockett, Pruthi, Manigart, Sapienza, Desbrieres, Hommel, 2004; Cumming et al., 2007).

With the reasoning behind dry powder, we have decided to include $Lifetime$, a proxy for time it takes to employ the capital, as a control variable in the regression. Firms waiting longer before investing the capital should exhibit lower performance as the non-invested capital yields low yearly returns. Moreover, due to lack of data of fund lifetime, the variable has been estimated using the difference in vintage year between funds in the same series.

Using US data, research conducted by Zweig et al. (2014) conclude that a sector focus in general has effect on the returns compared to diversified funds. Funds specializing in

technology, healthcare or consumer sectors outperform generalists. However, infrastructure funds are often characterized by significantly lower risk exposure compared to other sectors. These funds invest in for example gas pipelines, electrical and water networks, and transportation companies, that are naturally businesses generating stable cash flows. These funds generally demonstrate lower returns in accordance with the risk-return tradeoff reasoning (Rickards, 2008). To include industry focus, we have sorted the 80 categories delivered by our dataset into five main groups with Excel, see appendix 3. This is to generate enough data points for each group, but on the other hand, the results will not be as decisive.

Aigner et al. (2008) and Kaplan and Schoar (2005) also adjust for sequence number to account for experience accumulation of the fund manager. The reasoning behind suggests that later sequence funds have more experienced managers and should achieve a higher IRR than earlier sequence funds. As mentioned, we divide GP competence into two separate factors: experience and skills. Experience is accumulated over time and hence captured in the control variable *SeqNo*. A new fund series occasionally specialises in a new field, for example a BO firm could start a growth fund, meaning a different strategy is needed and that new experiences need to be learned. For this reason, we have included sequence number based on fund series, not the first fund raised by the firm. Further, intrinsic firm skills are captured in the hierarchical level by using $FirmID$ as a variable for certain firms.

Since the focus of this thesis is how increasing fund size affects returns, we have chosen to include an interaction variable for each dummy. The effect of $lnsize$ on $IRR$ is different for different fund types, industries and regions.

Previous research has used additional variables such as industry total commitments in vintage year and number of portfolio companies. Lack of data has prevented us from including these variables. Kaplan et al. (2005), Aigner et al. (2008) and Harris et al. (2014) find that performance decreases with total industry commitments in vintage year. In booming years many funds are raised but the average returns fall. We believe that this effect is partly adjusted for in our benchmarked IRR and partly captured in our control variable $Vintageyear$, but also that including a separate variable would increase the explained variance in performance. Concerning number of portfolio companies, Lopez-de-Silanes et al. (2013) finds that concentrated bets correlate with high performance. This effect could partly be captured by the coefficient for $lnsize$ as larger funds might invest in more portfolio companies. We will discuss the influence of the number of portfolio companies on performance in the analysis.

# 5 Data

Preqin has been used for data on fund performance and is one of the most comprehensive data sources for PE. It is self-reported, which could imply a certain bias as funds with poor performance might sustain from reporting. However, Harris et al. (2014) find that Preqin, when comparing to other data sources, has performance measures for the greatest number of BO and VC funds and IRR shows no bias.

In the Preqin dataset we received a total of 7913 data points. However, the data was then filtered for funds investing in other funds, real estate, co-investment funds, debt instruments or hybrids as the characteristics of these funds differ from VC or BO funds. In total, 80 different industry specifications followed the dataset, which were then grouped into five main industry categories: Consumer/Leisure, Healthcare, Infra/NR and TMT, and the funds investing in a variety of sectors where labeled Mixed/Diversified. After filtering and grouping the data, there was 1649 data points to run the regression.

**Table 3. General Descriptive Statistics**

| | VC | | | | | | Buyout | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Mean* | *Median* | *Max* | *Min* | *SD* | *N* | *Mean* | *Median* | *Max* | *Min* | *SD* | *N* |
| Size (mEUR) | 356 | 171 | 6,055 | 5 | 595 | 725 | 1,170 | 470 | 15,936 | 9 | 1,915 | 1014 |
| IRR (%) | 10.64 | 9.90 | 49.80 | -8.40 | 9.67 | 711 | 14.39 | 13.30 | 31.40 | -4.80 | 5.55 | 970 |
| Vintage (year) | 2002 | 2001 | 2017 | 1972 | 9 | 755 | 2004 | 2005 | 2017 | 1977 | 8 | 1027 |

***Note:*** *The table above shows general descriptive statistics for fund size, performance (IRR) and vintage year for VC and BO funds. The difference in number of observations is due to missing values.*

**Table 4. Means by Quartile**

| | VC | | | | | Buyout | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *All* | *Q1* | *Q2* | *Q3* | *Q4* | *All* | *Q1* | *Q2* | *Q3* | *Q4* |
| Size (mEUR) | 356 | 187 | 507 | 406 | 370 | 1,170 | 968 | 1,400 | 1,195 | 1,163 |
| IRR (%) | 10.64 | 23.57 | 11.92 | 7.48 | -0.26 | 14.39 | 22.0 | 14.78 | 12.15 | 8.55 |
| Vintage (year) | 2002 | 1997 | 2006 | 2004 | 2001 | 2004 | 2001 | 2008 | 2005 | 2003 |

***Note:*** *The table above shows means in size, IRR and vintage year depending on quartile for VC and BO funds. Quartiles are defined based on benchmark net IRR for each type of funds.*

## Table 5. Means by Decade

| | VC | | | | | Buyout | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *All* | *pre 90s* | *90s* | *00s* | *10s* | *All* | *pre 90s* | *90s* | *00s* | *10s* |
| Size (mEUR) | 356 | 60 | 152 | 402 | 685 | 1,170 | 338 | 548 | 1,365 | 1,521 |
| IRR (%) | 10.64 | 13.81 | 16.09 | 5.30 | 11.81 | 14.39 | 18.86 | 14.60 | 14.35 | 13.36 |
| N | 725 | 69 | 213 | 291 | 152 | 1014 | 44 | 242 | 442 | 286 |

***Note:*** *The table above shows means in size, IRR and vintage year depending on which decade the funds were raised for VC and BO funds. N is based on number of observations for size.*

## Table 6. Means by Region

| | VC | | | Buyout | | |
|---|---|---|---|---|---|---|
| | *All* | *Europe* | *US* | *All* | *Europe* | *US* |
| Size (mEUR) | 356 | 221 | 372 | 1,170 | 1,180 | 1,166 |
| IRR (%) | 10.64 | 9.85 | 10.74 | 14.39 | 15.88 | 13.76 |
| Vintage (year) | 2002 | 2002 | 2002 | 2004 | 2005 | 2004 |
| N | 725 | 79 | 646 | 1014 | 300 | 714 |

***Note:*** *The table above shows means in size, IRR and vintage year depending on region for VC and BO funds. Regions are based on reported regional focus and all funds outside Europe and US are excluded from the data set. N is based on number of observations for size.*

## Table 7. Means by Industry

| | VC | | | | | Buyout | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Mixed Diversified* | *TMT* | *Healthcare* | *Infra/NR* | *Consumer Leisure* | *Mixed Diversified* | *TMT* | *Healthcare* | *Infra/NR* | *Consumer Leisure* |
| Size (mEUR) | 138 | 263 | 223 | 806 | 203 | 1,418 | 1,102 | 429 | 1,020 | 966 |
| IRR (%) | 13.35 | 10.86 | 9.57 | 10.31 | 12.47 | 14.47 | 13.87 | 13.48 | 14.34 | 15.68 |
| Vintage (year) | 1999 | 2000 | 2004 | 2006 | 2000 | 2006 | 2002 | 2006 | 2002 | 2003 |
| N | 37 | 405 | 131 | 143 | 9 | 422 | 314 | 58 | 74 | 146 |

***Note:*** *The table above shows means in size, IRR and vintage year depending on industry for VC and BO funds. Industries are based on industry focus according to the fund managers. See appendix 3 for how industries are grouped together. N is based on number of observations for size.*

### 5.1 Comments on descriptive statistics

The statistical tables 3 - 7 aim to illustrate ongoing trends in the PE industry and describe the nuances in our dataset. As seen in table 3, VC funds have both a smaller average size and IRR than BO funds. The standard deviation in size for both VC and BO funds is large, indicating a noticeable spread in size between funds within each category. Looking at table 4, the best performing funds appear to be smaller and older for both VC and BO. These sample statistics exemplify the trend of increasing size and decreasing returns seen in PE over the recent years. The difference in size depending on quartile is greater for VC, with top performing funds being prominently smaller. IRR is wider distributed for VC; top quartile funds generate an average IRR of 23.6 percent and bottom quartile -0.3 percent. This follows the theory that VC funds are more volatile than BO funds.

Looking at the development over time in table 5, BO funds have almost tripled in size since the 90s and VC funds have increased four-fold over the same time period. The number of observations has also increased, signalling both a growing market and intensified competition. For BO, the IRR has seen a steady decrease over time, however in the past 30 years it has not dropped more than 1.5 percent on average. For VC, there was a significant dip in IRR in the 00s, possibly due to the IT bubble. Even though there are many characteristic differences between BO and VC funds, they do follow the similar trends over time: increasing size and decreasing returns.

Table 6 shows means by region and European VC funds appear to have both smaller size and lower IRR than VC funds in the US. For BO funds, the size difference is less prominent, but European funds seem to have a higher IRR. The US PE market is both older and more developed than the European, which explains the larger availability of data in the Preqin data set. Lastly, average size and IRR varies largely depending on industry and fund type as seen in table 7.

# 6 Results

We have performed two types of regressions based on the selected variables and dependants. The first regression is an ordinary least square (OLS) lin-log regression where we have added control variables through regression 1 - 4. We have included the standard OLS regression to illustrate how the fractions of explained variance ($R^2$) increase when control variables are added. For all OLS regressions, the independent variable $lnsize$ is significant and we achieve an $R^2$ of close to 20 percent. The second table shows the hierarchical linear model (HLM).

**Table 8. OLS Lin-Log Regression**

| Benchmark Net IRR, % | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| lnsize | -0.679*** | -0.780*** | -0.895*** | -1.778*** |
| | (0.13) | (0.13) | (0.14) | (0.51) |
| Vintage year | | -0.217*** | -0.223*** | -0.210*** |
| | | (0.02) | (0.02) | (0.02) |
| Fund Type, Buyout | | 4.877*** | 4.503*** | -5.561** |
| | | (0.42) | (0.46) | (2.03) |
| Region focus, US | | -1.198** | -1.065* | 2.052 |
| | | (0.42) | (0.42) | (1.94) |
| Lifetime | | 0.042 | 0.046 | -0.005 |
| | | (0.09) | (0.09) | (0.09) |
| Sequence Number | | -0.108 | -0.047 | 0.014 |
| | | (0.08) | (0.08) | (0.08) |
| TMT | | | -1.203** | 2.543 |
| | | | (0.45) | (2.23) |
| Healthcare | | | -2.004** | -4.071 |
| | | | (0.70) | (3.08) |
| InfraNR | | | 0.276 | -5.194* |
| | | | (0.52) | (2.80) |
| Consumer Leisure | | | 0.271 | 1.217 |
| | | | (0.52) | (2.70) |
| xBuyout | | | | 1.936*** |
| | | | | (0.35) |
| xRegion | | | | -0.532* |
| | | | | (0.30) |
| xTMT | | | | -0.619 |
| | | | | (0.34) |
| xHealthcare | | | | 0.459 |
| | | | | (0.52) |
| xInfraNR | | | | 1.102* |
| | | | | (0.45) |
| xConsLeis | | | | -0.102 |
| | | | | (0.42) |
| constant | 16.652*** | 22.284*** | 23.653*** | 26.783*** |
| | (0.82) | (1.15) | (1.24) | (3.14) |
| R-sqr | 0.015 | 0.159 | 0.168 | 0.199 |

* p<0.1, ** p<0.01, *** p<0.001

***Note:*** *The regression table above summarizes robust lin-log regressions with fund performance measured in benchmark net IRR as the dependent variable. Standard deviation is in parentheses. Regression 1 only includes the independent variable size, while control variables are added in regression 2 through 4. xDummy are interaction variables with lnsize. The size variable is significant at a 1 percent level for all cases.*

According to table 8, a negative coefficient for the $lnsize$ variable can be seen in all regressions, 1 - 4. This confirms H1, that there is a general size disadvantage in PE affecting $IRR$. The difference between regression 1 to 4 is that more control variables have been added. When including more variables, the interpretation for the coefficient of $lnsize$ changes. For regression 1, the coefficient indicates the sensitivity to changes in size for the average fund independent of fund characteristics. For regression 4, it shows the sensitivity to changes in size for a European VC fund investing in mixed industries. Our interaction variables indicate how different fund types, industry and region focuses affect a firm's ability to manage size increases. For example, based on the OLS regression 4, a European BO fund with EUR 50m in committed capital and a vintage year of 2000 would have an IRR of around 16 percent. A VC fund with the same characteristics achieves and IRR of 14 percent according to our regression model.

The reason for the change in coefficient for $Buyout$ between regression 3 and 4 in table 8 is a response to the inclusion of the interaction variable $xBuyout$. The difference in effect of size on IRR between BO and VC funds is captured by $xBuyout$, which is illustrated below in figure 5.

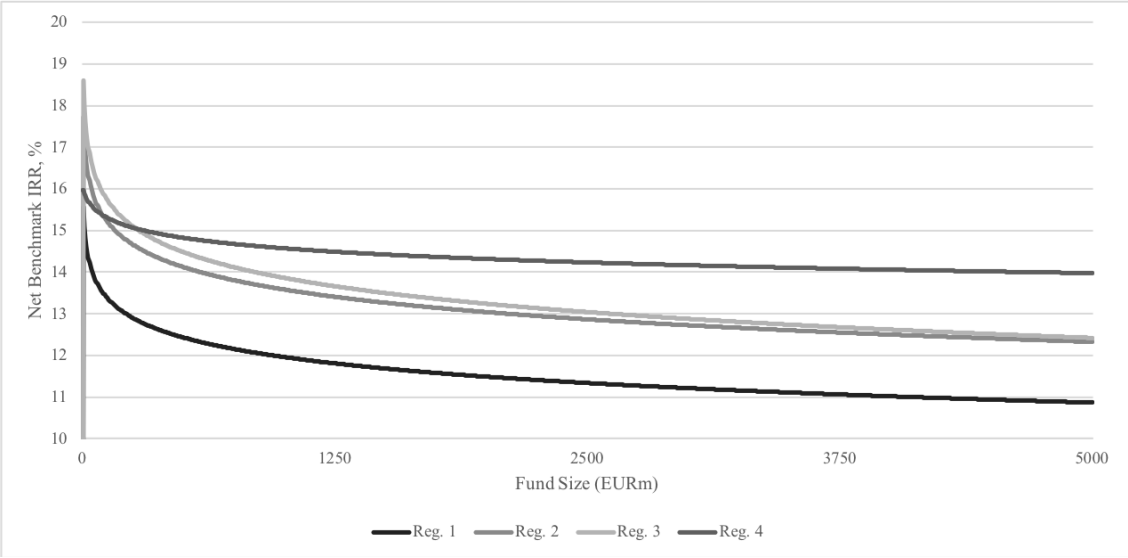


**Figure 5. Illustration of OLS regression results – change of sign for $Buyout$ coefficient**

*The graph shows how size impacts a US BO fund with vintage year in 2004 in the four OLS regressions presented in table 8. There is a change in sign for the coefficient of Buyout between regression 3 and 4. This is due to an additional variable, xBuyout being added to regression 4. The xBuyout variable captures the positive effect of the BO characteristics in relation to size, which is why Buyout receives a change in sign, as xBuyout compensates for the sign change. As can be seen in the graph above, regression 4, which includes the BO-size interaction variable, best captures that BO funds are not very sensitive to size increases, illustrated by the flatter slope.*

## Table 9. Hierarchical Linear Model

| **Benchmark Net IRR, %** | HLM1 | HLM2 |
|---|---|---|
| lnsize | -1.405*** | -2.303*** |
| | (0.19) | (0.48) |
| Vintage year | | -0.185*** |
| | | (0.03) |
| Fund Type, Buyout | | -7.607*** |
| | | (2.04) |
| xBuyout | | 2.309*** |
| | | (0.35) |
| Region focus, US | | 1.998 |
| | | (2.07) |
| xRegion | | -0.527* |
| | | (0.34) |
| Lifetime | | 0.026 |
| | | (0.10) |
| Sequence Number | | 0.028 |
| | | (0.09) |
| Industry: TMT | | 1.425 |
| | | (2.22) |
| xTMT | | -0.460 |
| | | (0.36) |
| Healthcare | | -5.255* |
| | | (3.24) |
| xHealthcare | | 0.630 |
| | | (0.57) |
| Infrastructure | | -7.504* |
| | | (3.13) |
| xInfraNR | | 1.477** |
| | | (0.50) |
| Consumer Leisure | | 1.270 |
| | | (3.42) |
| xConsLeis | | -0.119 |
| | | (0.55) |
| constant | 20.451*** | 28.901*** |
| | (1.08) | (2.84) |

* p<0.1, ** p<0.01, *** p<0.001

| **Random Effects Parameters** | | HLM 1 | HLM 2 |
|---|---|---|---|
| Firm ID: Unstructured | var(lnsize) | 2.705 | 0.930 |
| | | (1.004) | (0.439) |
| | var(_cons) | 90.538 | 43.086 |
| | | (30.918) | (17.524) |
| | cov(lnsize,_cons) | -15.090 | -6.329 |
| | | (5.489) | (2.732) |
| | var(Residual) | 54.212 | 45.329 |
| | | (2.214) | (1.750) |
| LR test vs. linear model: chibar2(01) | | 31.77 | 12.28 |
| Prob >= chibar2 | | 0.000 | 0.007 |

***Note:*** *The regression table above summarizes two regressions conducted using the hierarchical linear model. Standard deviation is in parentheses. The first regression only includes the independent variable lnsize and the random effect parameter is statistically significant (p-value is 0). The second regression includes a number of control variables and the random effect parameters are smaller but still significant. For HLM2 the net effect of size increases for BO funds (coefficient for lnsize plus coefficient for xBuyout) is close to zero.*

The linear regressions given by the HLM model provide an estimated line, also called fitted line, for the average fund. In the random effects parameters table, $FirmID\ Unstructured$, refers to the covariance between $lnsize$ and $\_cons$ and assumes that all covariances and variances may be different between firms. Using this preference is common for models measuring slope. The output of the random effects parameters is interpreted as follows:

- $Var(lnsize)$ measures the overall variance in slope between a firm's regression lines and the fitted line. Connecting to our sample, $var(lnsize)$ is the variation in how certain firms manage size increases.
- $Var(\_cons)$ measures the variance in intercept (estimated IRR using the linear part of the HLM regression). It could be mathematically interpreted as the variation in IRR between firms for fund sizes close to zero. However, as no funds have a size of zero the high number itself is not directly applicable for any of the funds in our sample.
- $Cov(lnsize, \_cons)$ produces the relationship between slopes and intercepts and the negative value suggests that firms with high intercepts have steeper slope and firms with low intercepts have a flatter slope, the observations are fanning in (see appendix 5).
- $Var(Residual)$ is the error variance that cannot be attributable to a firm-specific factor.
- An LR test is conducted to test if this hierarchical model adds explanatory power in comparison to the standard linear model. A high value motivates the inclusion of random effects parameters. *Prob>=chibar2* (which is a p-value) tests the significance of the model, the lower value, the more significant. Both models are significant at a 1 percent level.

These results indicate that when accounting for control variables, the differences in how firms manage size increases (difference in slope) is reduced. When adding covariance, a negative relation between high IRR and larger size becomes apparent. Firms with high IRR appear to have steeper slopes, meaning that their IRR decreases more with size increases, illustrating the concept of fanning in (appendix 5). This could be due to volatile VC funds with high returns and will be discussed in the analysis.

# 7 Analysis

## 7.1 Size and performance

As can be confirmed in the quantitative analysis, there is a significant support for H1 with a lin-log relationship between performance and fund size, confirming that there is a general fund size disadvantage in PE. Moreover, it is clear that some funds' IRR is more negatively impacted by large sizes. By studying the size interaction variables, we can confirm that mainly three factors contribute to a fund's capability to limit the negative impact of size increases: fund type, region and industry focus.

### *7.1.1 BO vs. VC*

Connecting to previous studies, Kaplan and Schoar (2005) use a dataset with 78 percent VC funds and find a significant size disadvantage. When considering only VC funds and when considering the aggregate effect (i.e. excluding interaction variables) we also conclude a size disadvantage. However, separating the results exclusively for BO funds, we find no such disadvantage.

As seen in table 8, the coefficient for our independent variable $lnsize$ changes when adding interaction variables. It goes from -0.895 to -1.778 in regression 3 to 4 at the same time as the interaction variable $xBuyout$ receives a coefficient of 1.936. This indicates that the BO fund characteristic counteracts the previously seen size disadvantage. The value -0.895 is an average of the VC and BO size disadvantage.

The results indicate that VC funds generally decrease their returns more with size increases compared to the same percentage increase in a BO fund. This result is logical as VC funds are more dependent on their small size in order to invest in high growth ventures which are by nature often small. We have not been able to include a variable for number of portfolio companies. However, when analyzing the industry and reading previous research papers, there is a prominent link between fund size, fund type and number of portfolio companies.

Concerning VC funds, finding larger and thereby more established ventures goes against the VC business concept. Thereby, for VC funds to scale their operations, they have to invest in more companies. This type of expansion gives little scale benefits as number of fund managers would need to increase at least proportionally. VC fund managers spend much time screening companies in order to find the ventures with most potential and are also highly involved in operations to quickly grow their investments. Compromising on number of fund managers per portfolio company could therefore negatively impact returns. The diseconomies

of scale are prominent as larger organizations require more sophisticated communication structures and risk losing information due to hierarchical levels and insufficient time to keep the team updated. As mentioned, research finds no strong flow-performance relationship for VC funds. LPs might refrain from investing in large VCs due to obvious scale disadvantages and GPs may realize the importance of involvement in operations for growing VC funds, meaning they must limit the amount of portfolio companies per employee.

BO, in contrast, is a more scalable business model due to the viable option of investing in larger companies. For BO funds, size advantages such as internal diversification, larger pool of possible targets and high demand from institutional investors appear to mitigate the disadvantages of fewer fund managers per committed capital and difficulties implementing change in large companies. The scalability is also reflected in the flow-performance relationship where BO funds exhibit stronger correlation between past performance and fundraising of subsequent funds. Partially, the difference is due to a higher persistence in returns for BO funds.

### *7.1.2 US vs. Europe*

The interaction variable $xRegion$ is significant at the 10 percent level and proves that funds in the US are not as tolerant to size increases as in Europe, coherent with Lopez-de-Silanes, Phalippou and Gottschalg's (2013) findings that non-scalability of PE business was most prominent in the US. Potentially, this could relate to the European market being more fragmented, providing opportunities for more roll-up[3] cases compared with the US. In our sample there are 28 percent European funds and 72 percent US funds. Although significant results are obtained at the 10 percent level, it would be beneficial to have a more even split between European vs. US funds.

As figure 5 indicates, accounting for the interaction variable ($xRegion$), only a slight size disadvantage for BO funds can be identified in the US, whereas in Europe the impact of size increases appears to be marginally advantageous. For VC funds however, the size disadvantage is prominent both in Europe and in the US.

[3] Consolidating the market through acquisition of many small companies in a fragmented market

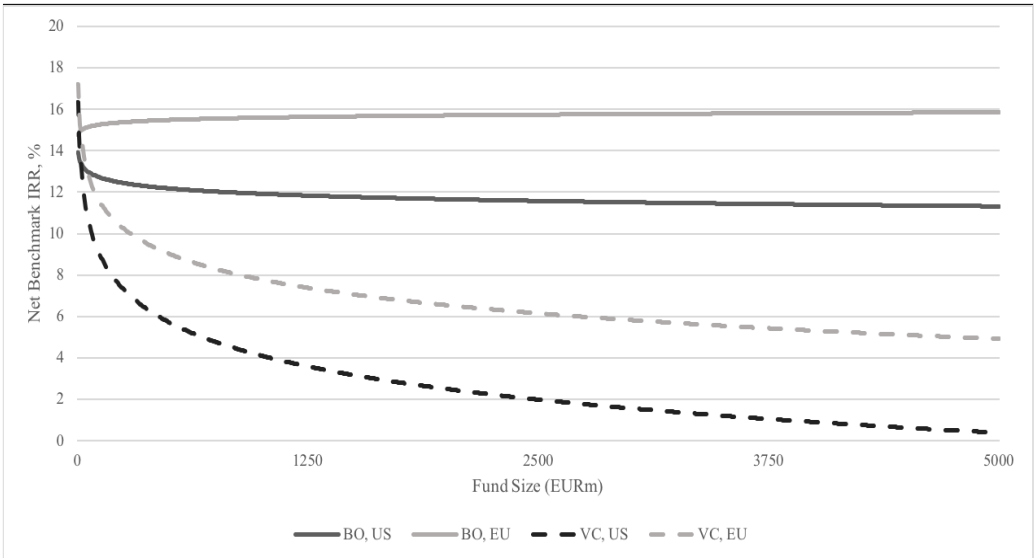


**Figure 5. Effect of size increases for different funds**

*The graph is based on the significant variables in regression 4 in table 8 and illustrates four different funds, BO in Europe and US along with VC in Europe and VC in the US. All funds have an assumed vintage year in 2004. The graph shows that VC funds in the US are the most sensitive to size increases, whereas BO funds in Europe show a slightly positive effect of size increases. However, it should be noted that VC funds and BO funds act in different size segments, with the mean size of VCs being EUR 356m and BOs being EUR 1,170m in the sample.*

### *7.1.3 Industry specialization*

Secondly, according to our results, funds specializing in certain industries are better at managing fund size increases than others. The quantitative analysis generates significant results that funds investing in infrastructure are better at managing a size increase, with a coefficient for the interaction variable $xInfraNR$ of 1.102. The reasons to why infrastructure funds benefit from larger sizes range from fundraising and investment to liquidation. Resting on physical assets with long lifetime, the volatility of infrastructure funds is lower than for other, more consumer-driven industry funds. With one of the main investors in PE being institutional investors such as pension funds, low volatility is preferred. Our $InfraNR$ dummy variable shows significance with a negative coefficient of -5.194, which is in line with the risk-return relationship in infrastructure being a less volatile asset class. Furthermore, investments in infrastructure can entail spill-over effects for society in terms of the economic value of faster transportation etc. Pension funds do not face the same cash-constraints as other LPs, meaning they can fuel large fundraisings in infrastructure sectors.

Natural resource and infrastructure companies are capital-intensive, a characteristic that often entails economies of scale. Increasing size can enable these companies to go after

government contracts and sizeable cash flows are needed to support investments in equipment, land and buildings. When target companies grow, PE funds must follow.

Concerning the liquidation, potential buyers of infrastructure and natural resources companies are often governments, government-related agencies or companies with the government as a major client. The size of these actors enables purchase of large companies from PE firms. Furthermore, the assets in infrastructure and natural resource companies are often tied to a specific geographic area (forests, roads, hydro power plants), meaning that the buyer is likely to have few options for purchase. The positive effect of this should be increased sales price, while the negative is lack of potential buyers and a liquidity risk concerning the capital-intensiveness. However, the liquidity risk is partly mitigated as countries are in need of continuous infrastructure investments. Thus, the governments have incentives to support infrastructure companies.

As seen in the case of infrastructure, PE funds are highly exposed to and dependent on the sector they choose to invest in. The nature of the target company's industry affects the buy/sell process, strategy, expertise requirement and ability to manage size increases of the PE fund. The lack of significance in terms of interaction variable with size for the other industries could be due to too broad specification or because the respective industry characteristics do not have a direct link to fund size. Infrastructure companies possess more distinct characteristics while the other industry focuses entail a significant overlap, for example tech companies selling to consumers.

Concerning the dummy variables $TMT$ and $Healthcare$ in regression 3 (table 8), they indicate that funds specializing in these sectors are less successful than a generalist fund. This contradicts previous research by Zweig, Auerbach and Tabares (2014), who conclude that specialized funds outperform generalist funds. Also, when adding further interaction variables in regression 4, there is no longer significance for the dummy variables $TMT$ and $Healthcare$. A potential reason for our contradicting results concerning $TMT$ and $Healthcare$ variables could once again be due to our industry categorisation. We have defined a fund as "sector focused" if it invests more than 50 percent in a certain sector, while Zweig et al. (2014) used a 70 percent threshold.

### *7.1.4 Lack of significance for Lifetime*

In our results, the control variable $Lifetime$ is not significant for any of the HLM or OLS Lin-log regressions. We included this variable with the aim to capture the negative effect of dry powder. Assuming that funds with longer lifetime wait longer to invest the capital, these funds should suffer lower IRR. There are two potential reasons to why this variable was not significant; either the proxy is not accurate, or keeping dry powder is in line with the business strategy for PE firms.

Firstly, fund lifetime itself includes other parameters than just the time of dry powder. For PE firms, it can be beneficial to invest over longer periods and the proxy also captures the advantages of longer funds. Examples when longer fund lifetimes are preferred include investment in companies such as Klarna who enter new, high growth markets which entail a long growth journey. The proxy's inability to exclude the benefits make the variable noisy.

The second reason would suggest that firms benefit enough from waiting for good opportunities to offset the negative impact of storing cash. PE firms are dependent on finding good targets to acquire for a fair price. The current market conditions show eager LPs in combination with high competition among PE firms. Eager investors and lack of attractive targets have caused dry powder to increase. However, the caution of GPs might not be negative for LP returns. Assuming our proxy is correct, the lack of significance for $Lifetime$ suggests that dry powder neither enhances nor dilutes returns. PE firms who wait long to commit the capital appear to catch up over the lifetime of the fund and are in a way rewarded with an attractive target company for waiting.

The absolute fees charged by GPs to LPs are either based on invested or committed capital. Both options present principal-agent problems. If fees are based on invested capital, GPs are incentivized to quickly find a target for investment and might not have the patience to wait for attractive opportunities. If fees are based on committed capital, LPs pay GPs for storing cash that is currently not generating any return and GPs have less pressure to employ the capital. These contradicting principal agent problems impose a difficulty in measuring the dry powder effect on PE performance. However, referring to the flow-performance relationship, the success of PE firms and future fundraising is dependent on current performance, so GPs are still pushed to generate high returns and should follow a sustainable strategy that is profitable for both them and LPs.

## 7.2 Individual firm skill factor

For the HLM model, the coefficients for $lnsize$ and $xBuyout$ cancel each other out. This reflects that there is no effect of size increases for BO funds. For VC funds, there is a size disadvantage in the linear part of the HLM model as the coefficient $lnsize$ is negative of -2.3 and significant, corresponding to the results obtained by the OLS regression. Concerning an individual firm skill factor, our results suggest that there is a difference in how firms manage size increases. This means that the second hypothesis, that skills attributed to certain firms can help them evade the size-disadvantage, can be confirmed.

The covariance between intercept (IRR) and slope is negative, suggesting that firms with high IRR manage size increases worse. This causes firm lines to converge, meaning that for larger sizes, the relationship between high IRR and large size is less prominent, see appendix 5. Hence, the negative covariance is most attributable to small funds, often VC.

For VC funds alone, the result of convergence of performance when size increases is rational. The high volatility of VC funds and the risk diversification effect from investing in more portfolio companies as VC funds grow indicate that larger funds should have a smaller spread in IRR. This is in line with the negative covariance obtained by our HLM regression.

The existence of a firm-level skill factor systematically influencing the size-performance relationship, means that some firms are able to more efficiently and with greater accuracy invest large amounts of capital. These firms should then be able to leverage on previous performance and attract more capital with less effort, meaning that they can spend resources on employing the capital instead. Our results suggest that GPs of top performing funds receive some brand-benefits in terms of fundraising, as LPs have some success in distinguishing these funds. The largest funds receive a great portion of all committed capital and these mega-funds are currently outperforming the market.

To summarize, we observe that some firms are more skilled in managing size increases than others and that small funds, often VC, are more sensitive to increases.

### *7.2.1 Issues with using net-of-fees IRR*

The dependent variable in this regression is benchmark net IRR, meaning that firm fees have already been adjusted for. In PE, however, top firms generally charge higher fees, meaning that if these firms have a skill effect that enables them to manage fund size increases better, the firm skill effect could potentially be even more prominent in the use of gross-IRR. If PE firms with good performance have the opportunity to charge higher fees and still receive more capital from LPs, a skill factor would be better measured using gross IRR.

### *7.2.2 Fee structures and principal-agent problem*

With the size disadvantage for VC funds, large funds experience decreasing returns, which affect LP returns. PE firms are naturally incentivized to pursue excessive fundraising, as LPs pay a fixed fee for participating as an investor. A high proportion of fixed fees compared to carried interest benefits GPs in terms of size increases as they earn more due to for example fewer employees per committed capital. The key for aligning interests between GPs and LPs is the fee structure. Under a structure with less carried interest, GPs of VC funds are the "winners of the PE curse". A principal-agent problem harms the LPs as they struggle to separate top performing VC funds from mediocre due to low persistence and high volatility in returns. In order to align interests, the fee structure would need to consist of a higher proportion of performance-based fees. In this way, GPs would be incentivized to reach high returns, meaning that they should consciously limit fund size.

Concerning the case of BO funds, where no prominent size disadvantage can be confirmed, there are reasons for LPs to keep investing in large funds. The opportunity to invest in a few large funds compared to many small is beneficial as LPs can rationalize their network of GPs and portfolio companies and large funds have often proved themselves in the market, signaling quality. Additionally, large funds are in a way internally diversified due to investments in many different companies or large companies with geography and industry diversification. The current market development shows that LPs are allocating more capital to a selected few funds. As our results do not support the existence of a "PE curse" for BO, it is logical that LPs turn to a few large and established funds with a skill factor in managing size increases.

## 7.3 Further research

By using net IRR, we partially capture the effect of firm skill. However, as skilled firms charge higher fees according Robinson and Sensoy (2013), the variations in gross IRR should be greater and more representative of firm skills. Further research could look at gross results and test if the magnitude of the skill-based firm factor is enhanced.

We also suggest looking more into the concept of dry powder and try to find a better proxy than fund lifetime, especially as the amount of dry powder is increasing.

Finally, it would be valuable to include the number of portfolio companies per employee in a fund, as previous research has found this has an effect on fund performance. Due to unavailability of data, we have not been able to include this variable, but believe it could add explanatory power to the results.

# 8 Conclusion

Through this study, we can confirm that the "curse of private equity" exists, but only for certain funds. On an aggregate level, there is a negative fund size-performance relationship. However, fund characteristics such as industry focus, fund type and region play a significant role in explaining why certain funds are affected differently by larger sizes.

We find that there is a firm specific skill factor in responding to size increases, where returns are more negatively affected by the same 1 percent size increase for some firms than for others. This skill factor could help to explain the rise of mega-funds. A majority of the committed capital is raised by the 50 largest funds and as these are currently outperforming the market, this suggests that LPs have found a way to distinguish the skill factor in PE.

In conclusion, a way for LPs to avoid being trapped in the "the curse of private equity" is to invest in skilled PE firms with funds that are positively exposed to increases in size, such as European BO funds specializing in infrastructure.

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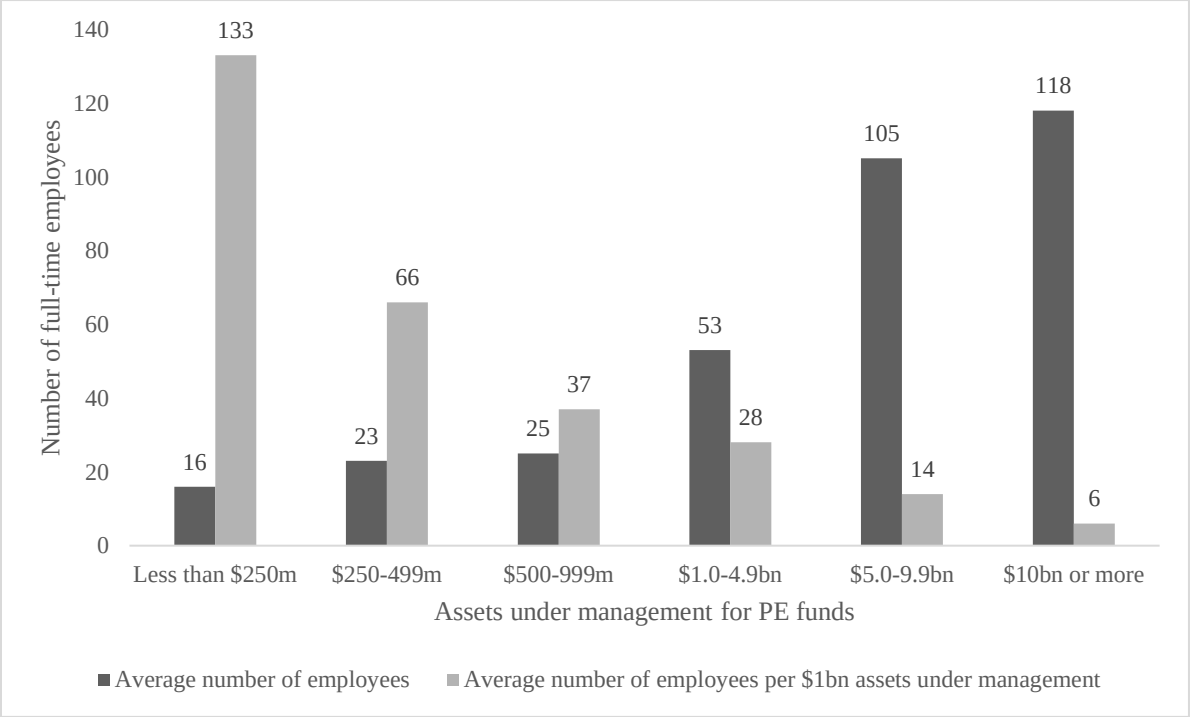
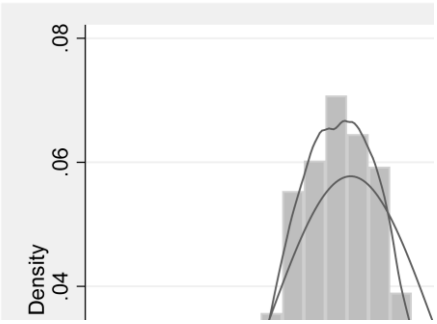
# 10 Appendix

**Appendix 1.** Decreasing average number of employees per Assets under management (USDbn)




***Note:*** *As the assets under management for a fund increases the average number of employees per fund commitment decreases (Preqin Private Capital Compensation and Employment Review, 2015).*

**Appendix 2.** Confirming normally distributed error term




***Note:*** *When conducting a Jarque-Bera normality test, we obtained significant results of the error term being normally distributed, meaning our data fulfils the assumptions for using the OLS and HLM models.*

**Appendix 3**. The table below shows the industry categorization used for analysis

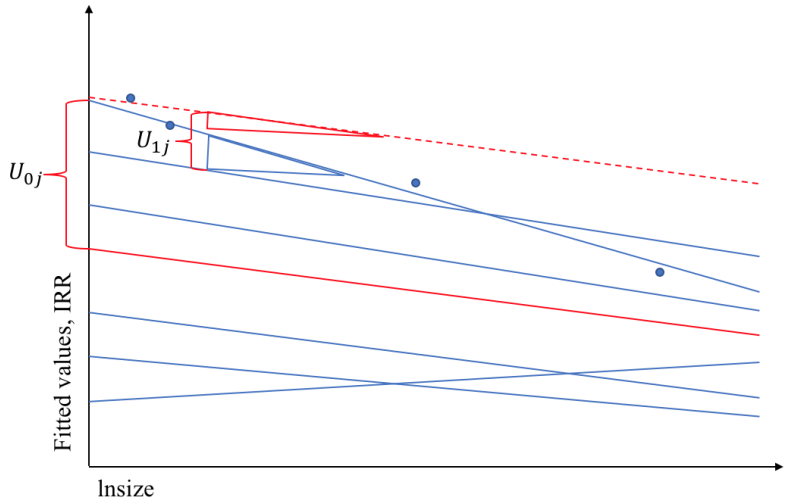
| *Main industry focus* | *Group* | *Main industry focus* | *Group* | *Main industry focus* | *Group* |
|---|---|---|---|---|---|
| Advertising | Consumer/Leisure | Communications | Infra/NR | Engineering | Mixed Diversified |
| Beverages | Consumer/Leisure | Distribution | Infra/NR | Financial Services | Mixed Diversified |
| Consumer Products | Consumer/Leisure | Energy | Infra/NR | Hardware | Mixed Diversified |
| Consumer Services | Consumer/Leisure | Environmental Services | Infra/NR | Industrial | Mixed Diversified |
| Education / Training | Consumer/Leisure | Infrastructure | Infra/NR | Insurance | Mixed Diversified |
| Entertainment | Consumer/Leisure | Logistics | Infra/NR | Manufacturing | Mixed Diversified |
| Food | Consumer/Leisure | Mining | Infra/NR | Materials | Mixed Diversified |
| Gambling | Consumer/Leisure | Natural Resources | Infra/NR | Production | Mixed Diversified |
| Gaming | Consumer/Leisure | Oil & Gas | Infra/NR | Semiconductors | Mixed Diversified |
| Hotels and Offices | Consumer/Leisure | Power | Infra/NR | InfoTech Sec. | TMT |
| Leisure | Consumer/Leisure | RenewEnerg. | Infra/NR | CleanTech | TMT |
| Marketing | Consumer/Leisure | Shipping | Infra/NR | Computer Services | TMT |
| Publishing | Consumer/Leisure | Timber | Infra/NR | DigiMed | TMT |
| Restaurants | Consumer/Leisure | Transportation | Infra/NR | High-Tech | TMT |
| Retail | Consumer/Leisure | Util. | Infra/NR | Information Services | TMT |
| Tobacco | Consumer/Leisure | Armaments | Mixed Diversified | InfoTechInfra | TMT |
| Biomedical | Healthcare | Defence | Mixed Diversified | Internet | TMT |
| Biotech | Healthcare | Diversified | Mixed Diversified | IT | TMT |
| Healthcare | Healthcare | Intellectual Prop. | Mixed Diversified | Media | TMT |
| HealthInfoTech | Healthcare | Outsourcing | Mixed Diversified | Nanotech | TMT |
| Life Sciences | Healthcare | Property | Mixed Diversified | Network | TMT |
| Medical Devices | Healthcare | Unknown | Mixed Diversified | Software | TMT |
| Medical Instruments | Healthcare | Aerospace | Mixed Diversified | Technology | TMT |
| Medical Technologies | Healthcare | Business Services | Mixed Diversified | Telecoms | TMT |
| Pharmaceuticals | Healthcare | Chemicals | Mixed Diversified | TelMed | TMT |
| Predictive Medicine | Healthcare | Construction | Mixed Diversified | Wireless | TMT |
| Agriculture | Infra/NR | Electronics | Mixed Diversified | | |

**Appendix 4.** Correlation table for significant variables

| | lnsize | Vintageyear | Buyout | xBuyout | xRegion | InfraNR | xInfraNR |
|---|---|---|---|---|---|---|---|
| lnsize | 1.0000 | | | | | | |
| Vintageyear | 0.4377 | 1.0000 | | | | | |
| Buyout | 0.3806 | 0.1417 | 1.0000 | | | | |
| xBuyout | 0.5927 | 0.2223 | 0.9476 | 1.0000 | | | |
| xRegion | 0.3780 | 0.1460 | -0.0381 | 0.0563 | 1.0000 | | |
| InfraNR | 0.0702 | 0.0810 | -0.1854 | -0.1795 | 0.1452 | 1.0000 | |
| xInfraNR | 0.1444 | 0.1156 | -0.1763 | -0.1595 | 0.1702 | 0.9732 | 1.0000 |

***Note**: The correlation table is based on significant values for our OLS regression 4.*

**Appendix 5.** Illustration of HLM




***Note:** The figure aims to illustrate how the HLM regression operates. The linear part obtains fitted values for the average fund (solid red line). The hierarchical part compares individual firms to this line. It runs a separate regression between funds in each firm (disaggregation) and then compares these lines to the fitted line (aggregation) in terms of slope and intercept. The comparison in intercept provides the random effect $U_{0j}$ and the comparison in slope provides $U_{1j}$. STATA then provides the variation in these random effects, $var(\_cons)$ for intercept and $var(lnsize)$ for slope. STATA also provides the covariance between the intercept and slope. A negative value means that the lines are fanning in, as seen in the graph.*

**Appendix 6.** Firms in our dataset

| *Firm name* | *Region* | *Firm name* | *Region* |
|---|---|---|---|
| 3i | Europe | BC Partners | Europe |
| Aberdare Ventures | US | Behrman Capital | US |
| Abingworth Management | Europe | Benchmark Capital | US |
| ABRY Partners | US | Berkshire Partners | US |
| ABS Capital Partners | US | BioVentures Investors | US |
| Accel Partners | US | Birchmere Ventures | US |
| Accel-KKR | US | Blackstone Group | US |
| ACON Investments | US | BlueRun Ventures | US |
| Adams Street Partners | US | Boulder Ventures | US |
| Advent International | US | Brantley Partners | US |
| Advent International | Europe | Brentwood Associates | US |
| AEA Investors | US | Bridgepoint | Europe |
| Allegra Partners | US | BS Private Equity | Europe |
| Alloy Ventures | US | Camden Partners | US |
| Alta Communications | US | Candover Partners | Europe |
| Altos Ventures | US | CapMan | Europe |
| Ampersand Capital Partners | US | Carlyle Group | US |
| Angelo, Gordon & Co | US | Carlyle Group | Europe |
| Apax Partners | US | Centennial Ventures | US |
| Apax Partners | Europe | Centre Partners | US |
| Apex Venture Partners | US | Charlesbank Capital Partners | US |
| ARCH Venture Partners | US | Charterhouse Equity Partners | US |
| ArcLight Capital Partners | US | CHI Equity | US |
| Ardian | Europe | CHS Capital | US |
| Ares Management | US | Clairvest Group | US |
| Argos Soditic | Europe | Colorado Venture Management | US |
| Arsenal Capital Partners | US | Columbia Capital | US |
| Ascent Venture Partners | US | Commonwealth Capital Ventures | US |
| Astorg Partners | Europe | Coral Group | US |
| Audax Private Equity | US | Cortec Group | US |
| August Equity | Europe | Crescendo Ventures | US |
| Aurora Capital Group | US | CVC Capital Partners | Europe |
| Aurora Funds | US | DCM | US |
| Austin Ventures | US | DH Private Equity Partners | Europe |
| Avalon Ventures | US | Domain Associates | US |
| Bain Capital | US | Duke Street | Europe |
| Bain Capital | Europe | DW Healthcare Partners | US |
| Baird Capital Partners | US | ECI Partners | Europe |
| Banc Funds Company | US | Edison Partners | US |
| Baring Vostok Capital Partners | Europe | Edmond de Rothschild Investment Partners | Europe |
| Battery Ventures | US | El Dorado Ventures | US |
| Bay Partners | US | EnCap Investments | US |
| BBH Capital Partners | US | Enterprise Investors | Europe |

| *Firm name* | *Region* | *Firm name* | *Region* |
|---|---|---|---|
| Enterprise Partners Venture Capital | US | KKR | Europe |
| EPIC Ventures | US | Kleiner Perkins Caufield & Byers | US |
| EQT | Europe | Kohlberg & Company | US |
| Equistone Partners Europe | Europe | L Catterton | US |
| Essex Woodlands | US | L Catterton | Europe |
| EV Private Equity | Europe | Leeds Equity Partners | US |
| First Analysis | US | Leonard Green & Partners | US |
| Forstmann Little & Co | US | Levine Leichtman Capital Partners | US |
| Forward Ventures | US | LGV Capital | Europe |
| Frazier Healthcare Ventures | US | Liberty Partners | US |
| Freeman Spogli & Co | US | Lightspeed Venture Partners | US |
| Frontenac Company | US | Lime Rock Partners | US |
| FTV Capital | US | Lincolnshire Management | US |
| Galen Partners | US | Lindsay Goldberg | US |
| Genstar Capital Partners | US | Linsalata Capital Partners | US |
| Geocapital Partners | US | Litorina Capital Management | Europe |
| Globespan Capital Partners | US | Littlejohn & Co. | US |
| Goldner Hawn Johnson & Morrison | US | LLR Partners | US |
| Graham Partners | US | Lovell Minnick Partners | US |
| Great Hill Partners | US | Madison Dearborn Partners | US |
| Groupe Alpha | Europe | Mason Wells | US |
| GTCR | US | Matrix Partners | US |
| Hammond, Kennedy, Whitney & Co. | US | Mayfield | US |
| HarbourVest Partners | US | McCown De Leeuw & Co | US |
| Harvest Partners | US | Menlo Ventures | US |
| Hellman & Friedman | US | Merit Energy Partners | US |
| HM Capital Partners | US | Meritech Capital Partners | US |
| HM Capital Partners | Europe | Mohr Davidow Ventures | US |
| Icon Ventures | US | Montagu Private Equity | Europe |
| Ignition Venture Partners | US | Morgan Stanley Global Private Equity | US |
| IK Investment Partners | Europe | Morgenthaler Ventures | US |
| Innova Capital | Europe | MPM Capital | US |
| Innovacom | Europe | MTI Ventures | Europe |
| InnovationsKapital | Europe | Murphree Venture Partners | US |
| Insight Venture Partners | US | New Enterprise Associates | US |
| Institutional Venture Partners | US | New Mountain Capital | US |
| Intersouth Partners | US | NGP Energy Capital Management | US |
| InterWest Partners | US | Nordic Capital | Europe |
| J.H. Whitney & Co | US | North Bridge Venture Partners | US |
| JK&B Capital | US | Oak Investment Partners | US |
| JLL Partners | US | Oaktree Capital Management | US |
| JMI Equity | US | Oaktree Capital Management | Europe |
| Kelso & Company | US | Odyssey Investment Partners | US |
| Kirtland Capital Partners | US | Olympus Partners | US |
| KKR | US | Onex Corporation | US |

| *Firm name* | *Region* | *Firm name* | *Region* |
|---|---|---|---|
| OrbiMed Advisors | US | Syncom Venture Partners | US |
| OVP Venture Partners | US | TA Associates | US |
| KPS Capital Partners | US | TCW Group | US |
| Oxford Bioscience Partners | US | Technology Crossover Ventures | US |
| PAI Partners | Europe | Technology Partners | US |
| Palladium Equity Partners | US | Thomas H Lee Partners | US |
| Partech Partners | US | Three Arch Partners | US |
| Partech Partners | Europe | TL Ventures | US |
| Parthenon Capital Partners | US | TowerBrook Capital Partners | US |
| Pegasus Capital Advisors | US | TowerBrook Capital Partners | Europe |
| Permira | Europe | TPG | US |
| Polaris Partners | US | TSG Consumer Partners | US |
| Polaris Private Equity | Europe | TVM Capital Life Science | Europe |
| Primary Capital | Europe | Updata Venture Partners | US |
| Primus Capital | US | US Venture Partners | US |
| Prism Venture Partners | US | VantagePoint Capital Partners | US |
| Procuritas Partners | Europe | Vector Capital | US |
| Providence Equity Partners | US | Veritas Capital | US |
| Quad Partners | US | Veronis Suhler Stevenson | US |
| RFE Investment Partners | US | Vestar Capital Partners | US |
| RHO Capital Partners | US | Wellspring Capital Management | US |
| Rhône Group | Europe | Welsh, Carson, Anderson & Stowe | US |
| Riverside Company | US | Weston Presidio Capital | US |
| Riverside Company | Europe | Wexford Capital | US |
| RRE Ventures | US | Wicks Group | US |
| RRE Ventures | Europe | Wind Point Partners | US |
| Sanderling Ventures | US | Wingate Partners | US |
| SCF Partners | US | WL Ross & Co | US |
| Scottish Equity Partners | Europe | Worldview Technology Partners | US |
| Seaport Capital | US | | |
| Segulah | Europe | | |
| Seidler Equity Partners | US | | |
| Sentinel Capital Partners | US | | |
| Sequoia Capital | US | | |
| Seventure | Europe | | |
| Sevin Rosen Funds | US | | |
| Shamrock Capital Advisors | US | | |
| Sierra Ventures | US | | |
| Silver Lake | US | | |
| Sovereign Capital | Europe | | |
| Spectrum Equity | US | | |
| Summit Partners | US | | |
| Sun Capital Partners | US | | |
| Swander Pace Capital | US | | |