Has the development of the private equity industry influenced persistence in fund performance?

Investigating the influence of the number of portfolio companies on fund performance persistence

Abstract

This thesis investigates the influence of number of assets acquired by a fund, on persistence in the private equity industry over time. Past literature is extensively reviewed, and finds that funds in the private equity industry show performance persistence. This persistence has weakened or decreased post-2001 and factors that could have influenced persistence show no significant impact. To reassess the persistence and findings from previous literature, a data set is constructed of private equity and venture capital funds. Afterwards, multiple regressions are executed. The results show that persistence exists in absolute and relative performance measures between sequential funds. The relation with 2nd previous funds is also positive and significant. Fund size and fund sequence numbers have no influence on this relationship. It can also be concluded that persistence still exists post-2001 and pre-2000, and that this has not changed over time. Finally, the results reveal that number of assets show no consistent and significant relation with performance persistence of funds. These results do not differ for private equity or venture capital funds.

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Declaration

This master thesis is a presentation of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature and acknowledgement of collaborative research and discussions.

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1. Introduction

For many years, capital allocation to buyout funds ("PE") and venture capital ("VC") funds has increased enormously. This has led to an abundance of cash that still needs to be allocated amongst various types of deals. The increased popularity of private equity funds may be due to multiple factors. One explanation may be the low interest rates on bonds, which make investors such as pension funds and insurance companies desperate to increase their yields. Lower yields on bonds may push investors to take extra risk in their equity allocations in a hunt for higher returns. These higher returns have historically been realized by fund managers in the private equity industry (Bloomberg News, 2019; Barber & Goold, 2007).

Bloomberg News (2019) states that in the 25 years up until March 2019, the private equity industry had achieved annualized returns of 13% while an investment in the S&P 500 would have yielded 9%. These higher returns are attributed to the use of high amounts of debt, high incentives for fund and company managers, margin improvements, and optimizing cash flows (Barber & Goold, 2007). Fund managers claim to have a "skill" which enables them to identify undervalued or underperforming companies. Within a certain period, they implement improvements, sell the company at a higher price, making a large profit. However, it seems times are changing for the industry. Over the past 20 years, the number of private equity firms has increased, with fewer managers beating the market. Additionally, the ones who do outperform the market seem to have lower excess returns.

Investors behind the PE industry consist, amongst others, of high-net-worth individuals and families, pension funds, insurance companies, and sovereign wealth funds. The latter three groups have drastically increased their exposure to the PE industry in recent years, with pension funds tripling their PE exposure since 2008 (Idzelis, 2020). This trend increases the importance for these investors, also called Limited Partners ("LP"), to apply adequate selection methodologies, enabling them to realize outperformance of the market. If there is an overall declining trend in outperformance, what General Partner ("GP") will have the skill to outperform the market going forward? LPs use the industry's common practice to base their investment decisions on the historical performance of a fund manager. This implies that LPs try to identify fund managers that have realized strong performance, after which they invest in their newly raised funds. This is based on the common belief that persistence in fund manager performance exists in the private equity industry.

Persistence in fund performance was first analysed by Kaplan and Schoar (2005), up until this research, there was very limited understanding of the returns and cash flows of the private equity industry. This limited understanding is mainly due to the lack of data within the industry. Fund managers are not obliged to disclose information on their performance or investments, which makes it harder to analyse performance. Kaplan and Schoar (2005) found that there is persistence in performance, confirming the common practice used by LPs and investors in relying on past performance of fund managers for

their investment decisions.

Afterwards, in 2014 Sensoy, Wang, and Weisbach published a paper in which they found that investors, who historically outperformed the market, subsequently no longer realized excess returns. This led to research into performance persistence over time by Harris, Jenkinson, Kaplan, and Stucke (2014). They found that performance persistence disappeared post-2000. However, not all papers agree with this conclusion (Harris, Jenkinson, Kaplan, & Stucke, 2020; Korteweg & Sorensen, 2017).

The disappearance of performance persistence post-2000 would have large implications on how investors and LPs should make their investment decisions. For these investors, it is interesting to gain insight into what factors could have had an impact on this trend. Harris et al. (2020) and Kaplan and Schoar (2005) test whether increased fund size has an influence on fund performance persistence. Their results show that the influence is not significant, and first-time funds do not perform worse. The persistence that is still present post-2000 seems to be in the worse performing funds, but not in high performing funds. To gain deeper insights in the development of persistence in recent years, this thesis assesses if the number of deals, and thereby the number of assets that a fund has bought, has an influence on the persistence in performance. It could be that diseconomies of scale apply to the number of deals that a team does and not the deal size. Additionally, human capital restrictions or span of control issues may arise when the number of bought assets within a fund increases. Therefore, it is interesting to analyse if the number of assets within funds influences the persistence in performance. This has not been researched before but could give valuable insights into understanding persistence in performance and fund selection strategies for investors. Therefore, the research question is:

Has the number of assets within a fund influenced the disappearance of performance persistence for private equity industry post-2001?

This question could have a high influence on the investment decisions of LPs. If they base their capital allocation strategy on past performance of a fund manager, it is very relevant to know if persistence is still present and whether it is effected by any other factors that influence this. The topic is scientifically relevant as it has not been researched before. As Korteweg and Sorensen (2017) note, risk-neutral LPs that maximize their expected returns (net of fees) are able to apply the outcome of this thesis directly to their portfolio allocation decision.

This thesis focuses on persistence in general, and assesses whether this persistence is present in the data set used. This may provide an answer to the question if it is rational for investors to base their investment strategy on the past performance of fund managers. To investigate persistence in general, a data set is used including fund performance from the Preqin database over the years 1972 to 2015. To ensure that the number of biases in performance reporting are limited, multiple performance measures are used and constructed. The analysis will also be on absolute and relative performance. The persistence in absolute performance is assessed using an Ordinary Least Squares regression ("OLS").

Persistence in relative performance is assessed using a Logit regression. The results of these analyses show that persistence is present over the sample period and that there is no significant influence of fund size and fund sequence number on performance persistence. It is also shown that performance persistence exists between the 2nd previous fund and current fund of a fund manager. However, if previous funds and 2nd previous funds are regressed together on current fund performance, the effect of 2nd previous funds disappears. In this case, the effect of previous funds gets economically stronger, and it seems like this variable absorbs the effect that 2nd previous funds have.

Afterwards, an analysis is conducted to test if performance persistence has disappeared or weakened over time as found in previous papers (Harris, Jenkinson, Kaplan, & Stucke, 2014). To test this, the same data set as used for the general persistence, which is divided into two subsets, pre-2000 and post-2001. Once again, an OLS and a Logit regression analysis is conducted using different performance measures. This analysis will indicate if it is still rational for investors and LPs to base their investment strategy on past performance of a fund manager. The results reveal that there is performance persistence pre-2000 and post-2001. Post-2001 performance persistence is even slightly stronger. Moreover, VC firms show more persistence in their performance than PE funds.

Lastly, the relationship between number of assets and performance persistence is analyzed. As it was previously found that size and sequence number of funds do not influence performance persistence in the PE industry, it is interesting to analyse other factors. With the data from Preqin, four different measures for number of assets can be calculated. Three of these measures are an absolute number of assets, respectively, the minimum, maximum and the average. The fourth measure is the growth from the previous fund to the sequential fund in the average number of assets. The number of asset measures are all rough estimations and show no significant and consistent relationship with performance persistence. For relative performance persistence, the number of asset measures are not consistent or significant. The only robust effectt is the negative and significant coefficient for the three number of assets measures in relation to funds that perform in the second quartile.

It can be concluded from results of the different tests that there is persistence, which has remained stable over time. These results are consistent for absolute and relative performance measures. The used number of assets measures do not show consistent and significant results. Therefore, it can be concluded that there is no impact of number of assets and that there is no change in persistence over time.

This thesis proceeds as follows. In Chapter 2, all the relevant literature is discussed including literature on performance persistence in general from different perspectives, persistence over time, and factors that influence performance persistence. Based on this previous literature, the different hypotheses that are tested are stated. Afterwards, Chapter 3 describes how the data is collected and how the different variables are constructed. Chapter 4 discusses the methodology that is used to test the hypotheses, and the results of these tests are described in Chapter 5. Finally, in Chapter 6 the results are used to conclude on the hypotheses and research question.

2. Literature review

2.1 Introduction

In this chapter discusses research regarding persistence in fund performance, with a focus on PE and VC funds. The number of papers written on this topic has been limited so far because of the lack of data. The first paper was published in 2005, but recently more research has been conducted. This thesis focusses on persistence in fund performance on a fund-by-fund basis. The review of past research will lead to different hypotheses to answer the main research question of this thesis. To do so, the theory has been divided in 3 main topics. First, the general performance of the PE industry is analyzed in Section 2.2. Afterwards, trends in fund persistence are discussed in Section 2.3. Lastly, the persistence over time and the influence of different factors on performance persistence are discussed in, respectively, Sections 2.4 and 2.5.[1]

2.2 Performance of private equity and venture capital funds

The private equity industry has always been puzzling to outsiders. Funds are not obliged to disclose any of their financials or investments. All information that is publicly available, has been voluntarily disclosed by general partners or limited partners, who have a self-interest in the reported information of the funds. This leads to very limited data which results in a lot of uncertainty about the real performance. Despite the opaque nature, the industry is more popular than ever, with a very high amount of dry powder currently in the industry (Bautista Suarez & Skornas, 2021).

The PE industry has gained popularity, because it is believed that the private market returns are higher than its public market equivalent. The first papers to report on the performance of the PE industry have been published in the 2000s. Ljungqvist and Richardson (2003) show that the PE industry generates excess returns compared to the public equity market on average by more than 5% per year. Jones and Rhodes-Kropf (2003) find that the outperformance (denoted by α in their paper) is equal to zero on average for VC funds. However, it should be noted that the VC funds that are relative high risk takers, also known as top quartile idiosyncratic risk, have alpha's of 2.50% per quarter, while the lowest risk quartile has -1.09% alpha per quarter.

Kaplan and Schoar (2005) and Phalippou and Gottschalg (2009) are somewhat more negative on the performance of the PE industry compared to its public market equivalent. They both find that, on average, buyout funds underperform compared to public equities. Additionally, they find that VC funds underperform the market on an equal-weighted basis, but outperform on a capital-weighted basis. Jones and Rhodes-Kropf, Kaplan and Schoar, and Phalippou and Gottschalg use datasets from Venture Economics which was proven by

[1] The results of the relevant papers on performance persistence, of which the results can be compared to the results of this paper, are summarized in Appendix A.2.

Stucke (2011) and Harris, Jenkinson, and Kaplan (2014), to be downward biased. This could have caused the somewhat negative results of the papers. Stucke corrects the results of the study of Kaplan and Schoar and finds that the underperformance of buyout funds is actually an outperformance. Therefore, the results of papers using Venture Economics data should be interpreted with caution.

Harris, Jenkinson, and Kaplan (2014) analyse the performance of the PE industry, which includes buyout and VC funds. They find that buyout funds outperform the public equity market by an average of 20% over the fund life. This could partially be caused by a premium that is given to LPs of the funds for the illiquid nature of the investments. There could also be a type of premium for the uncertainty surrounding capital calls, realization and the uncertain timeline of the funds. This is also called liquidity risk and are not present when an investor decides to buy public equities.

The paper of Higson and Stucke (2012) analyses a large sample of PE funds from 1980 to 2005. They show that the PE industry has significantly outperformed the S&P 500 for almost all vintage years. They show that over 60% of the PE funds outperform the public equity market, with mainly the top 10% performers driving the general outperformance of the whole sample. Higson and Stucke also discuss that there is a high cyclicality, which implies that funds tend to outperform mainly in the beginning of a decade. There is, however, a downward bias over the years.

Recent literature seems to agree on the performance of private equity compared to public equity. PE funds outperform in general, but there is some dispersion in this outperformance, driven by the top performers in the industry. The performance has been slightly decreasing over the years, but PE remains a very interesting industry for LPs.

2.3 Persistence in fund performance

2.3.1 Performance persistence from the LP perspective

In 2017, Korteweg and Sorensen publish a paper in which they investigate skill and luck in PE performance persistence. They argue that, in contrast to mutual funds (Berk & Green, 2004), LPs that invest in PE and VC funds can profit from a GPs' outperformance, leading to persistence in the returns of LPs. Information asymmetry arises because of non-elasticity of the capital flow from LPs to PE funds, and thereby, the long-term nature of PE funds. Funds raise capital several years apart in a sequence of funds, and the realized returns are only visible when a fund is liquidated. The fact that the information is only available at the end of the fund life, combined with a high uncertainty environment, leads to information asymmetry. This benefits LPs, because they will have more insights into the skills of a GP, leading to a better understanding of who outperforms the market and what funds to invest in. This only holds when the PE performance is persistent, and LPs can base their investment decisions on past performance. Korteweg and Sorensen (2017) find that substantial long-term persistence exists but that it is not investable persistence. This implies that it is very hard to identify which firms have this long-term performance persistence because LPs would have to observe a very high number of past funds, especially

for VC funds. It is relevant for LPs that they can benefit of the outperformance of GPs, because it makes it valuable to identify these outperformers before investing. If the theory of Berk and Green (2004) holds for PE and VC funds, the profit of outperformance would flow to the GP of a fund. This would imply that net-of-fee returns for LPs would not differ across average and outperforming managers. If this theory of Korteweg and Sorensen (2017) holds, it is important identify top performing funds for LPs and test persistence on fund-level data. This enables LPs to realize above-average returns from their PE investment portfolio.

2.3.2 Performance persistence from the GP perspective

Performance persistence on fund-level data

The first paper that investigates persistence in private equity performance is Kaplan and Schoar (2005). They investigate this by using a data set collected by Venture Economics. This database has systematic errors and a downward bias, which was shown by Stucke (2011). Therefore, the results of this study should be taken into account with some caution. The results show that performance persistence exists between a fund, the previous fund, and the second previous fund. They conclude that it is unlikely that other factors can influence this performance, such as selection biases, risk differences, or industry differences. Explanations discussed in the paper are that heterogeneity in skill and quality of GPs may induce heterogeneity in performance. This could lead to more persistence if new entrants cannot effectively compete with established funds because better general partners may be able to select better investments by having proprietary access to particular transactions. Next to this, LPs typically share information on their capital with GPs to boost the returns, leading to high-quality GPs having an information advantage compared to other GPs.

In 2010, Phalippou shows that persistence exists for venture capital funds that are selected by nonskilled investors without a significant flow-performance relationship. Skilled investors select the opposite funds. Moreover, top quartile funds outperform the S&P 500 with evidence of persistence in performance that is robust to various control variables, different samples, and controlling for sample selection bias. They conclude that all other characteristics that explain fund performance can be absorbed by the previous fund performance, as all other characteristics lose their significance after including the past performance.

Chung (2012) confirms that persistence exists between consecutive funds and in some cases, for the second previous fund. Chung also shows that similar market conditions for two consecutive funds explain a large part of performance persistence in the sample and that there is a negative correlation between fund performance and the total amount of capital raised in a year.

Similar to previous research, Harris, Jenkinson, Kaplan, and Stucke (2014) find evidence for persistence in performance using an improved data set collected via Burgiss, which is based on LPs' reporting, and confirm their results with Preqin, a dataset based on GPs' reporting. They do find a difference in the persistence of PE and VC funds, and

show that the persistence is generally stronger for VC funds.

The working paper by Harris et al. (2020) assesses persistence based on available information at the time of fundraising and shows that persistence disappears for buyout funds and weakens for venture capital funds. GPs of both VC and PE funds seem to raise capital for the next fund when the performance of their previous fund is strong. It is also confirmed that the first time funds, which were previously believed to perform worse, outperform the S&P 500 just like non-first time funds. The strong persistence in relative performance in the quartile analysis is driven by the worst performing funds in the bottom quartile.

Korteweg and Sorensen (2017) investigate long-term persistence of PE and VC funds. Their results show that top quartile GPs have 7 to 8 percentage points higher returns than bottom quartile firms on average across all fund types. This long-term persistence is higher for the Rest of the World, followed by Europe, and is the lowest for the United States. Finally, Robinson and Sensoy (2016) find that there is a significant positive correlation between the performance of a fund and the sequential fund.

Performance persistence on deal level data

Buchner, Mohamed, and Schwienbacher (2016) use a data set from the Center for Private Equity Research, which includes deal-level data for different funds. They find performance persistence using deal-level data for US funds, but not outside the US.

Braun, Jenkinson, and Stoff (2017) asses persistence on a deal level basis and find that there is a positive relationship between successive deals of the same GP, even after controlling for fixed effects. This persistence has also largely disappeared after 2000, but this could have a different explanation such as the maturing of the PE market or that the competition for deals has changed. It is shown that the competition has increased over time and that persistence decreases when a large amount of capital is sourcing deals. The persistence for top quartile GPs is also higher in the low competition state than in the high competition state, because it is easier to acquire good targets. Moreover, persistence in general is mainly driven by top and bottom quartile funds than by the other funds.

2.3.3 Hypothesis 1

Multiple papers have tested performance persistence of PE and VC funds. There seems to be consensus in previous literature that it is possible for LPs to base their investment decisions on past fund performance, as most papers find that there is performance persistence. To test if the previous findings are consistent with the data set collected in this thesis, the first hypothesis is:

Hypothesis 1: Is there persistence in performance of private equity and venture capital funds?

2.4 Persistence over time

Some previous literature has focussed on cyclicality of PE fund performance. Gompers and Lerner (2000) is the first to show that private equity follows the same business cycle as public equity. This is later confirmed by Gompers, Kovner, Lerner, and Scharfstein (2008) for VC funds and Kaplan and Stromberg (2009) for buyout funds. Capital inflows into PE funds seem to increase when the public equity market is doing well, and the number of newly established funds rises (Kaplan & Schoar, 2005). Despite the optimistic behaviour of the investors, the return of these funds raised in boom times, seems to be lower (Kaplan & Stromberg, 2009). Kaplan and Sensoy (2015) argues that this can be caused by the 'equity-like nature' of the private equity investments. On the other hand, it could also be the case that LPs tend to behave irrationally in good times, while GPs are too optimistic. Kaplan and Sensoy also made an overview of the performance that different papers have found, in which these patterns can be seen (see Appendix A.1).

It seems that returns of funds and capital flows fluctuate over business cycles. Harris, Jenkinson, Kaplan, and Stucke (2014) investigate changes in fund performance persistence pre-2000 and post-2000, because new research of Sensoy et al. (2014) had shown that certain types of investors that used to outperform the market in previous research, no longer seem to realize excess returns. They confirm the previous research that persistence in performance exists pre-2000. However, post-2000, they found that performance persistence has largely disappeared. Mainly buyout funds do not seem to show the strong persistence as shown in previous research. For the full sample, including venture capital and PE funds, the relation between previous and current funds has become weaker post-2000 than pre-2000 and is mainly driven by the poor performance of the bottom quartile funds. Possible explanations mentioned are that the buyout business has changed with operational leverage becoming important or that information spill-overs have led to GPs skills to become equal.

However, the view that the persistence has disappeared and mainly for PE firms is not shared by all papers. In the working paper of Harris et al. (2020), this is contradicted and they show that there is still persistence pre-2000 and post-2001. Korteweg and Sorensen (2017) show that persistence has decreased post-2000 relative to the 1990s, but this decline is mainly visible for VC firms. They show that there is still substantial persistence for PE firms and other funds than VCs.

2.4.1 Hypothesis 2

Previous literature concludes that returns of funds fluctuate over time and over the business cycle. However, there is no consensus regarding the performance persistence over time. Some papers have found a decrease in this persistence while others report the opposite. To test if a trend over time is visible in the data set, which is used in this paper, the second hypothesis is:

Hypothesis 2: Has persistence in performance post-2001 disappeared?

2.5 Factors that influence performance persistence

In 2005, Kaplan and Schoar are the first to report on other effects that could influence performance persistence. They test whether fund size has an influence on the performance persistence. Their results show that there is a significant negative relationship between fund size and performance. This means that if a GP raises a larger fund, the return of this fund will decline for the GP compared to his previous fund. This influences the persistence in performance negatively. Robinson and Sensoy (2016) confirms this result, and find that there is an increasing concave relationship between PME and fund size. Their result is significant for VC funds but not for PE funds. This was also the case in the paper of Kaplan and Schoar. Moreover, Korteweg and Sorensen (2017) show that small funds seem to have more persistent performance in the long term. This is explained by their greater volatility and higher signal-to-noise ratio, which implies that the current performance of small funds has a higher predictive power for future expected returns. The fund size is also strongly correlated with the years that the fund manager is active.

Harris, Jenkinson, Kaplan, and Stucke (2014) find that the logarithm of the current fund size and the logarithm of the change in fund size between the previous and current fund are insignificant for the buyout sample. This shows that there is no evidence that fund size or fund size growth influence the performance of buyout funds. Venture capital funds on the other hand, do have a significant positive relation for the logarithm of the current fund size on performance. This is in sharp contrast with the theory of decreasing economies of scale. This result is later contradicted in the most recent paper of Harris et al. (2020) in which they show that fund size does not have a significant impact on performance.

Chung (2012) shows that capital flows based on performance reduce performance persistence. If you can control for these capital flows, the persistence increases between a fund and its predecessor. The paper also shows that high performing funds raise larger follow-on funds relative to low performers. Especially funds that have the highest growth in size underperform. This effect is stronger for VC funds than PE funds, which could be explained by the view that the first is relatively labour intensive and requires more management care if the size increases. Chung (2012) also argues that an increase in fund size will lead to larger target sizes or a higher number of investments, which requires greater amount of management attention.

Marquez, Nanda, and Yavuz (2010) shows that general partners, especially of venture capital funds, have an incentive to limit the size of their funds. This is shown with a model in which there is an information asymmetry between the general partners and the entrepreneurs. In that scenario, the fund performance is higher with smaller funds, which leads to more persistence in the performance of a GP, because they are able to attract better quality assets for their portfolio. They also argue that PE funds can grow their size more easily because the diseconomies of scale are smaller than for VC firms.

Hochberg, Ljungqvist, and Lu (2010) found that networking effects could decrease the number of new entrants in the VC market. This occurs because incumbent funds have access to information on promising people, trends and ideas ahead of other investors.

This information advantage makes it easier to select good investments and is very costly and time consuming to obtain for new entrants. Moreover, the information advantage in more densely networked markets seems to lower valuations which increases performance. Hochberg et al. (2010) also assumes that investors of a fund have extra information that they can leverage to prevent excessive fund inflows. This drives performance if diseconomies of scale are assumed.

Buchner et al. (2016) argue that the persistence in performance that was observed in previous research could be caused by GPs taking persistently more risk than other fund managers. On a fund-level basis, it is not possible to investigate the amount of risk relative to the return because of the long-term cash flow pattern of the funds. Buchner et al. use data on deal level, which is used to calculate the volatility of the performance of deals. The volatility of the deal performance is used as a proxy for the total investment risk within a fund. The results show that total fund risk has a significant relation to performance within the US, and that there is no persistence in funds outside the US. Mainly for buy-out funds does total risk explain the persistence, while for VC funds the risk is mainly impacted by total fund risk. There is also a strong persistence in the amount of risk for the fund managers, which could alongside skill, be an explanatory variable for performance persistence following the authors.

2.5.1 Hypothesis 3

Previous research suggests that there should be diseconomies of scale, next to the trend of increasing fund sizes. This raises the question, if not the fund size but the number of deals influences the persistence in performance. If a GP has to split his attention over multiple deals, human capital restrictions could influence the performance. Moreover, if the number of assets within a fund increases, it could be harder to find only top performing targets because of increased competition (Braun et al., 2017). Therefore, the following hypothesis is conducted and tested:

Hypothesis 3: Does the number of assets within a fund influence performance persistence?

3. Data

3.1 Introduction

In this chapter, the collection and selection of the used data will be discussed. First, in Section 3.2, the used database is described and previous literature on using this database will be discussed. Afterwards, the construction of the regression variables and the sample selection will be shown in Section 3.3 and respectively Section 3.4.

3.2 Data collection

In this thesis, a fund-level data set is required to analyse the performance of sequential funds. Preqin is used as the database to collect this set and is a provider of private market information obtained via regulatory filings, press releases, news, and websites (Preqin, n.d.). It contains fund-level information on performance and fund characteristics such as size, region, and vintage years. Preqin has been used previously as the source in multiple studies on performance persistence of funds (Chung, 2012; Harris, Jenkinson, Kaplan, & Stucke, 2014; Harris et al., 2020; Korteweg & Sorensen, 2017). Harris, Jenkinson, and Kaplan (2014) that Preqin is a good database to use, but has the disadvantage that it contains very limited information on funds prior to 2003. However, the coverage for the 2000s is very comprehensive compared to other data providers. Next to that, the paper reports that Preqin has the most extensive data set on the performance of PE funds as well as VC funds and that the performance measured in IRR is not biased. This is the case for some other databases. Phalippou (2014) confirms that Preqin is a good database to use for PE funds, and that it is representative of the Burgiss and Cambridge Associates databases.

3.3 Construction of the regression variables

3.3.1 Performance measures

To answer the research question and subquestions, data on fund performance is analyzed. There are different possible measures for performance, such as the Internal Rate of Return ("IRR"), Multiple on Invested Capital ("MOIC), and Public Market Equivalent ("PME"). All these measures have been used in previous studies on persistence in PE performance. Kaplan and Schoar (2005) mainly use PME, which is a metric that controls for market movements by calculating the outperformance of a fund relative to the market. This was first introduced by Long and Nickels (1996) to create an appropriate benchmark for private investments, to overcome limitations of the IRR and MOIC. The methodology was adjusted by Kaplan and Schoar (2005) by introducing a PME which was measured in a market multiple. The formula is:

$$PME = \frac{FV_{Dist}}{FV_{Call}} \tag{3.1}$$

In this formula, the FV_{Call} is the total capital call of a certain fund, which is compared to an equivalent investment in a market index. FV_{Dist} is the total cash outflow of the investment made in a fund, compared to the distribution of selling that same investment in the market index. For example, \$100 is invested in a PE fund, at the same time \$100 is invested in the S&P 500. 5 year later, the fund distributes \$150 while the investment in the market index is now worth \$130. The PME is then:

$$PME = \frac{150/130}{100/100} = 1.15 \tag{3.2}$$

If the PME is greater than 1, a fund has outperformed the market, and is a market adjusted multiple (Kaplan & Schoar, 2005). Net Internal Rate of Return or Multiple on Invested Capital are also widely used metrics to calculate the performance of a fund, but they do not correct for the market. The IRR can be calculated by solving the following formula:

$$NPV = 0 = \frac{CF_t}{(1+IRR)^t} - C_0 \tag{3.3}$$

In which NPV is the Net Present Value of an investment. The NPV is assumed to equal zero, to calculate what the discount rate is for which all Cash Flows of the investment, CF_t are equal to the costs of the investment, C_0. This discount rate is called the IRR. For example, if \$100 is invested in a fund, which distributes \$150 5 years later, the IRR is calculated as follows:

$$NPV = 0 = \frac{150}{(1+IRR)^5} - 100 \tag{3.4}$$

Solving this formula gives an IRR of 8.4%. The formula for MOIC is:

$$MOIC = \frac{TotalDistributions}{TotalInvestment} \tag{3.5}$$

In which *TotalDistributions* is the sum of the all capital distributions received from a investment and *TotalInvestments* is the sum of all capital calls. The result is a multiple which is independent on the timeline of the investment and not adjusted for the market. It shows how many dollars are returned for every invested dollar. For example, a MOIC of 1.5x indicates that for every invested dollar, 1.5 dollars are returned.

Previously, it was shown that the results of a study on PE performance persistence do not significantly differ between PME, IRR, and MOIC (Kaplan & Schoar, 2005; Harris, Jenkinson, Kaplan, & Stucke, 2014; Harris et al., 2020). Preqin does not have cash flow data on a fund level, which makes it impossible to calculate the fair value of the distributions or capital calls. Therefore, PME cannot be calculated. Next to that, it is not available in Preqin. IRR and MOIC are both reported in the database and are used as the absolute performance measure.

Many studies also test their hypotheses with a relative performance measure next to an

absolute performance measure. Relative performance measures show how funds perform relatively to competitors. Previous research uses performance quartiles of funds (Kaplan & Schoar, 2005; Harris, Jenkinson, Kaplan, & Stucke, 2014; Harris et al., 2020). Performance quartiles are used in this thesis as the relative performance measure. The Preqin database reports these performance quartiles per fund.[1]

3.4 Sample selection

3.4.1 Persistence in general

To address the first two subquestions, data on fund performance is needed and all used funds need to have at least one previous fund. Preqin has performance information on 7,673 funds in their performance database from different regions. In this thesis, the data will not be restricted to a certain geographical focus to include as many observations as possible, while many previous studies have focused on funds based in the United States. It was also previously shown that the US companies have lower persistence in performance on the long-term than the Rest of World and Europe (Korteweg & Sorensen, 2017).

First, funds which are not closed or liquidated are removed from the data set, to reassure that the funds are not still raising money or cancelled. Next to that, all funds that have a vintage year post 2015 are removed to make sure that the funds have been able to show a meaningful performance, similar to the paper of Harris, Jenkinson, Kaplan, and Stucke (2014). This leads to a selection of 5,960 funds. The different funds have vintage years between 1969 and 2015.

To test persistence, funds which do not have a predecessor are removed from the database. 2,613 funds have a sequential fund. There are 1,380 funds which have two previous funds. To identify sequential funds in the analyses, a special fund ID is constructed for each fund type. This fund ID is based on the firm ID, fund name, and the sequence number. Sequential funds of the same fund manager have the same fund ID. This is required because most fund managers exploit multiple fund types. For example, the Blackstone Group has a special tactical opportunities fund besides their general buyout fund. It is important to distinguish the sequential funds of the same fund type offered by a fund manager from other fund types. These different fund types can perform differently and this could cause an error in the analysis. The disadvantage of removing all funds that do not have a predecessor is that these funds are on average worse performing funds and the exclusion could lead to systematic biases (Korteweg & Sorensen, 2017).

Some of these funds report only IRR, MOIC, or quartile performance. Therefore, separate data sets are used for every performance metric to include as many funds as possible.

[1] An Aggregate performance measure is additionally used to confirm the results of the IRR and MOIC. The advantage is that the resulting data set only contains funds that report all performance measures. The formula is as follows:

$$AggregatePerformance_{i,n} = \frac{IRR_{i,n} + MOIC_{i,n} + Quartile_{i,n}}{3} \tag{3.6}$$

In which $AggregatePerformance_{i,n}$ is the aggregated performance measure for fund i for fund sequence number n. $IRR_{i,n}$, $MOIC_{i,n}$ and $Quartile_{i,n}$ are the respective performance measures of fund manager i for the fund with sequence number n.

Table 3.1 includes the descriptive statistics of the full data set of funds with sequential funds that also have available performance information in the respective performance measures.

3.4.2 Influence of the number of assets

To measure the influence of the number of deals or companies that a fund acquires during its lifetime on performance persistence, an indication of this number is needed. This information is not available in Preqin or other data sources. However, Preqin does have information for some funds on the minimum and maximum asset value that is targeted for a fund. This information is used to calculate the minimum and maximum 'Number of assets' per fund by dividing the fund size by this targeted asset value, leading to an estimate. This estimate is used as an approximation of the number of deals or acquired companies of a fund, and to test its influence on the performance persistence. The number of funds in the data set decreases from 2,101 to 437 funds with the requirement that the number of assets is available and that it has a sequential fund. The descriptive statistics of this data set can be found in Table 3.2.

Next to that, based on the number of assets of a fund and its sequential fund. The growth rate of the estimated number of assets is calculated using the following formula:

$$NumberofAssetsGrowth = \frac{Numberof Assets_{i,n}}{Numberof Assets_{i,n-1}} \tag{3.7}$$

In which $NumberofAssets_{i,n}$ is the number of assets of fund i with sequence number n. $NumberofAssets_{i,n\text{-}1}$ is the number of assets of fund i's previous fund. The number of funds that have data on the number of assets for two sequential funds is very small. The data set with available funds decreases to 140 funds. The descriptive statistics of this set per performance measure can be found in Table 3.3.

3.4.3 Control variables

Control variables are used to increase the explanatory power of the regressions in this thesis. In previous research, it was shown that it matters for performance if a fund is a first time fund or more experienced. Kaplan and Schoar (2005) include a dummy to control for the conventional wisdom that more experienced general partners are able to outperform younger firms. They find a positive relationship between fund sequence number and performance. Korteweg and Sorensen (2017) states that single funds are usually the worse performing funds. Harris, Jenkinson, Kaplan, and Stucke (2014) find that first time funds have performed above the median. These funds seem to perform above median, while Harris et al. (2020) show that there is no significant difference between first time funds and other funds. To control for a possible influence of fund sequence on performance, the natural logarithm of fund sequence numbers is included as a control variable. This data can be obtained via Preqin.

Previous studies have also used the fund size as a control variable for persistence in PE performance. As discussed in Section 2.4 there is no significant result found for this

Table 3.1: Descriptive statistics total sample

Table 3.1 displays the descriptive statistics of the full sample of funds with sequential fund information. The data set is collected via Preqin and shows all funds that are closed or liquidated, and have a vintage year pre-2016 to make sure that the funds have had sufficient time to show meaningful performance.

	IRR			MOIC			Quartile		
Vintage year	**N**	**Average Fund Size ($m)**	**Average Performance in %**	**N**	**Average Fund Size ($m)**	**Average Performance in x**	**N**	**Average Fund Size ($m)**	**Average Performance in Quartile**
1972	1	8.0	21.5	1	8.0	5.5	-	-	-
1978	1	14.0	40.0	1	14.0	6.1	-	-	-
1980	3	156.7	19.7	3	156.7	3.3	-	-	-
1981	2	52.5	14.2	2	52.5	2.1	-	-	-
1982	6	110.9	14.5	7	117.1	2.1	3	59.0	1.7
1983	5	80.1	8.5	4	86.8	1.9	1	29.3	1.0
1984	8	208.3	17.2	9	187.4	3.0	7	212.2	2.0
1985	7	93.9	15.9	7	93.9	2.7	7	93.9	2.3
1986	10	170.4	20.8	10	170.4	3.8	9	191.4	2.3
1987	11	717.0	18.3	11	717.0	3.2	11	717.0	2.0
1988	16	393.0	25.0	16	405.9	2.7	16	405.9	2.4
1989	18	229.5	16.3	19	159.7	2.4	19	159.7	2.4
1990	14	145.3	23.9	15	127.1	2.8	15	127.1	2.2
1991	12	138.5	30.6	14	129.2	3.0	14	129.2	2.6
1992	23	266.3	32.6	25	236.5	3.4	26	245.9	2.2
1993	27	153.7	38.3	29	145.1	4.2	29	145.1	2.5
1994	32	257.6	35.5	35	220.4	3.9	37	255.4	2.4
1995	37	344.1	43.0	40	284.9	3.3	40	284.9	2.0
1996	32	197.5	24.8	32	197.5	2.8	33	194.8	2.4
1997	57	604.9	28.9	60	558.5	2.2	60	558.5	2.3
1998	82	613.9	12.5	83	540.6	1.6	83	540.6	2.4
1999	82	564.0	3.1	85	574.6	1.2	86	599.9	2.4
2000	100	749.8	7.4	115	689.8	1.4	115	689.8	2.4
2001	66	546.7	13.8	75	503.0	1.7	73	510.7	2.4
2002	44	595.3	13.7	48	580.2	1.6	47	592.4	2.2
2003	45	792.4	14.6	43	780.9	1.7	44	766.7	2.3
2004	64	730.7	14.2	75	703.9	1.8	75	711.0	2.4
2005	119	850.5	11.4	127	826.5	1.6	128	822.6	2.5
2006	136	1,514.5	8.6	148	1,543.0	1.7	151	1,526.8	2.4
2007	138	1,414.4	10.3	141	1,171.3	1.8	146	1,201.8	2.4
2008	141	1,204.6	11.2	140	1,175.4	1.9	141	1,169.4	2.4
2009	54	916.2	12.9	60	986.7	1.9	59	997.8	2.2
2010	71	559.1	14.7	68	601.5	2.1	68	601.5	2.4
2011	114	994.3	13.4	104	1,041.1	1.8	106	1,034.5	2.7
2012	109	976.4	18.0	106	1,126.7	1.9	108	1,111.5	2.5
2013	129	808.7	15.8	115	915.3	1.7	115	905.1	2.4
2014	136	999.5	17.1	111	1,378.9	1.7	112	1,367.8	2.6
2015	149	872.5	15.2	117	1,057.2	1.4	117	1,057.2	2.6
Total sample	*2,101*	*846.0*	*15.1*	*2,101*	*835.4*	*1.9*	*1,908*	*842.2*	*2.4*

factor in the majority of previous research. However, this will be once again analysed in this thesis to make sure that this is not the case for this data set. The data on fund size is available in the Preqin database and will be used as a control variable in selected regressions.

Table 3.2: Descriptive statistics sample with number of assets data

Table 3.2 displays the descriptive statistics of the data set including funds that have a sequential fund and have available information on the number of assets in the sequential fund. The data set is collected via Preqin and shows all funds that are closed or liquidated, and have a vintage year pre-2016 to make sure that the funds have had sufficient time to show meaningful performance.

	IRR			MOIC			Quartile		
Vintage year	**N**	**Average Fund Size ($m)**	**Average Performance in %**	**N**	**Average Fund Size ($m)**	**Average Performance in x**	**N**	**Average Fund Size ($m)**	**Average Performance in Quartile**
1998	1	116.1	11.3	1	116.1	3.5	1	116.1	1.0
1999	1	315.0	24.0	1	315.0	2.1	1	315.0	1.0
2000	4	1,007.8	8.3	4	1,007.8	1.5	4	1,007.8	2.5
2001	1	1,616.0	3.5	1	1,616.0	1.3	1	1,616.0	2.0
2002	1	142.1	3.8	1	142.1	1.7	1	142.1	1.0
2003	2	319.0	0.6	2	319.0	1.1	2	319.0	3.0
2004	1	365.4	15.3	1	365.4	2.0	1	365.4	2.0
2005	6	509.2	20.1	6	509.2	2.6	6	509.2	1.3
2006	11	1,175.7	6.8	12	1,112.9	1.4	13	1,039.9	2.3
2007	28	838.9	11.9	32	776.6	2.1	32	776.6	2.3
2008	28	878.8	9.3	33	949.7	1.7	35	901.6	2.5
2009	16	938.2	10.6	21	876.9	1.7	22	884.3	2.5
2010	32	588.3	15.3	34	556.6	2.2	35	544.1	2.4
2,011	36	1,228.5	9.7	43	1,126.1	1.6	43	1,126.1	2.9
2012	47	899.3	17.1	51	898.5	1.9	53	870.1	2.6
2013	47	785.9	15.1	54	699.8	1.6	57	682.6	2.5
2014	54	1,205.1	26.9	59	1,426.1	1.8	62	1,362.3	2.5
2015	59	884.1	16.3	64	825.3	1.5	68	808.0	2.4
Total sample	*375*	*767.4*	*12.5*	*420*	*757.7*	*1.8*	*437*	*743.7*	*2.2*

Table 3.3: Descriptive statistics sample with number of assets growth data

Table 3.3 displays the descriptive statistics of a sample of funds with at least one sequential fund and for both funds information on the number of assets within the funds. With this number of assets the growth is calculated. The data set is collected via Preqin and shows all funds that are closed or liquidated, and have a vintage year pre-2016 to make sure that the funds have had sufficient time to show meaningful performance.

	IRR			MOIC			Quartile		
Vintage year	**N**	**Average Fund Size ($m)**	**Average Performance in %**	**N**	**Average Fund Size ($m)**	**Average Performance in x**	**N**	**Average Fund Size ($m)**	**Average Performance in Quartile**
2000	1	172.0	13.2	1	172.0	1.8	1	172.0	2.0
2002	1	142.1	3.8	1	142.1	1.7	1	142.1	1.0
2003	1	138.0	-0.4	1	138.0	1.0	1	138.0	4.0
2005	1	851.5	24.1	1	851.5	2.4	1	851.5	1.0
2006	2	850.0	-3.9	2	850.0	0.8	2	850.0	3.0
2007	3	639.7	12.1	3	639.7	2.0	3	639.7	2.0
2008	5	700.3	19.3	4	862.9	2.4	5	700.3	1.6
2009	4	565.4	3.0	4	565.4	1.2	4	565.4	3.0
2010	8	653.7	19.5	8	653.7	2.2	8	653.7	2.0
2011	11	1,986.7	6.1	13	1,795.7	1.5	13	1,795.7	3.3
2012	13	522.6	16.6	14	513.6	1.8	15	480.1	2.8
2013	18	684.2	16.4	22	570.2	1.7	23	575.9	2.5
2014	25	707.7	21.0	29	809.7	1.8	30	783.9	2.5
2015	34	887.4	17.5	37	829.1	1.6	41	800.0	2.4
Total sample	*127*	*678.7*	*12.0*	*140*	*671.0*	*1.7*	*148*	*653.5*	*2.4*

4. Methodology

4.1 Introduction

This chapter contains an overview of the methodology that is used in this thesis to answer the research question. The methodology is described per hypothesis. For the first hypothesis on persistence in general, Section 4.2 gives an overview. Section 4.3 explains how the persistence in performance over time is analyzed, and the methodology for the third hypothesis is discussed in Section 4.4. Finally, in Section 4.5 the rationale behind the fixed effects that are included in the different analyses is set out.

4.2 Methodology performance persistence in general

Hypothesis 1 analyses if there is persistence in general in the data set, which has been researched in previous literature. The methodology used in this paper is based on the papers of, amongst others Kaplan and Schoar (2005), Harris, Jenkinson, Kaplan, and Stucke (2014) and Harris et al. (2020). They perform multiple regressions on their data sets to assess performance persistence for funds. The analyses are split into an absolute analysis and a relative analysis. For the absolute analysis, absolute performance of funds is used, which shows a percentage or a multiple. The relative analysis uses a performance measure, which indicates how a particular fund has performed relatively to other funds in the same year.

4.2.1 Absolute analysis

It is important that the dependent variable is continuous when using a linear regression. In this thesis, the performance of sequential funds is analyzed on an absolute and relative basis. Absolute performance is measured by IRR and MOIC (see Section 3.3). The Ordinary Least Squares ("OLS") regression methodology is used for the analysis of absolute performance. In this methodology, the independent variables of the regression are analysed in relation to the dependent variable, by analyzing the minimum difference between the variables. The regression formula for the first hypothesis is as follows:

$$Performance_{i,n} = \alpha + \beta_1 Performance_{i,n-1} + \beta_2 Performance_{i,n-2} + \beta_3 Ln(Size_{i,n}) + \beta_4 Ln(SequenceNumber_{i,n}) + \beta_5 VintageYearFixedEffects_t + \beta_6 GPFixedEffects_i + \beta_7 GeographicFocusFixedEffects_x + \varepsilon_{i,n} \quad (4.1)$$

In which $Performance_{i,n}$ is the performance measured by IRR or MOIC. $Performance_{i,n-1}$ is the performance of the prior fund in the same performance measure, and $Performance_{i,n-2}$ is the performance of the second previous fund. $Ln(Size_{i,n})$ is the natural logarithm of

the fund size of the current fund. *Ln(SequenceNumber$_{i,n}$)* is the natural logarithm of the fund number. *VintageYearFixedEffects$_t$* control for effects of the business cycle in which a fund was raised by including year fixed effects. *GPFixedEffects$_i$* control for fixed effects of the average out- or underperformance of fund managers. *GeographicFocusFixedEffects$_x$* includes the effect of differences in average performance per geographic focus.

4.2.2 Relative analysis

For the relative performance, quartiles of the funds are used. These quartiles show how a fund has performed relative to other funds, and range from top quartile funds ("Q1") to bottom quartile funds ("Q4"). An analysis of these quartiles will show whether an out- or underperforming fund is likely to deliver consistent results in the sequential fund. This was previously analysed by calculating the percentage of previous funds that perform in the same or another quartile. An example can be found in Harris, Jenkinson, Kaplan, and Stucke (2014). To analyse other factors that influence the relation between the relative persistence, Logit regressions are conducted in this thesis. This analyses whether the previous fund is the same quartile and the influence of other factors on this relation. The formula to test hypothesis 1 on general persistence in relative performance is:

$$\begin{aligned} PerformanceDummy_{Q,i,n} = \alpha + \beta_1 PerformanceDummy_{Q1,i,n-1} + \beta_2 PerformanceDummy_{Q2,i,n-1} \\ + \beta_3 PerformanceDummy_{Q3,i,n-1} + \beta_4 PerformanceDummy_{Q4,i,n-1} + \beta_5 Ln(Size_{i,n}) \\ + \beta_6 Ln(SequenceNumber_{i,n}) + \beta_7 VintageYearFixedEffects_t + \beta_8 GPFixedEffects_i \\ + \beta_9 GeographicFocusFixedEffects_x + \varepsilon_{i,n} \quad (4.2) \end{aligned}$$

In which *PerformanceDummy$_{Q,i,n}$* is 1 if fund with sequence number n of fund manager i has performed in quartile Q, and is 0 if the fund did not perform in the indicated quartile. *PerformanceDummy$_{Q,i,n\text{-}1}$* indicates if the prior fund of fund manager i has performed in quartile Q. It is 1 if the previous fund performed in quartile Q and 0 if it did not. *Ln(Size$_{i,n}$)* is the natural logarithm of the fund size of the current fund. *Ln(SequenceNumber$_{i,n}$)* is the natural logarithm of the fund number. *VintageYearFixedEffects$_t$* control for effects of the business cycle in which a fund was raised by including year fixed effects. *GPFixedEffects$_i$* control for fixed effects of the average out- or underperformance of fund managers. *GeographicFocusFixedEffects$_x$* includes the effect of differences in average performance per geographic focus. The result of this Logit regression shows the relation between a fund that performs, for example, in the top quartile and the relative performance of its previous fund.

4.3 Methodology performance persistence over time

As discussed in Section 2.3, there is some discussion on persistence over time. Some papers found that there is a difference in the level of persistence over time. Hypothesis 2 analyses this potential difference by splitting the data set in two different subsets, pre-2000 and

post-2001. Furthermore, the influence of fund strategies is assessed by splitting the sample in PE and VC funds.

4.3.1 Absolute analysis

To answer hypothesis 2 on differences in performance persistence over time, an Ordinary Least Squares regression is conducted on IRR and the MOIC. The formula used is similar to Equation 4.1. The regression is executed on both the pre-2000 and post-2001 level. Moreover, the data is split into venture capital funds and private equity funds to assess the impact of the different fund strategies on performance persistence over time.

4.3.2 Relative analysis

Hypothesis 2 is also analyzed using relative performance over time with a Logit regression. The formula used is equal to Equation 4.2. For this analysis, the data set is split into pre-2000 and post-2001 to assess the relative performance persistence over time. Lastly, the data set is also split based on the fund strategy to analyse if there is a difference over asset classes.

4.4 Methodology influence number of assets on performance persistence

The third hypothesis assesses the relation between the number of assets and persistence in performance. This relationship can be analyzed with the methodology used in previous literature for fund size or other external factors (Kaplan & Schoar, 2005; Harris, Jenkinson, Kaplan, & Stucke, 2014; Harris et al., 2020). There are multiple variables that can be used for the number of assets as explained in Section 3.4.2.

4.4.1 Absolute analysis

The absolute persistence in performance in relation to the number of assets and the growth in the number of assets are analyzed using an Ordinary Least Squares regression. IRR and MOIC are used as performance measures. The formula to test hypothesis 3 is as follows:

$$\begin{aligned} Performance_{i,n} = \alpha + \beta_1 Performance_{i,n-1} + \beta_2 Performance_{i,n-2} + \beta_3 Ln(NumberOfAssets_{i,n}) \\ + \beta_4 VintageYearFixedEffects_t + \beta_5 GPFixedEffects_i \\ + \beta_6 GeographicFocusFixedEffects_x + \varepsilon_{i,n} \end{aligned} \quad (4.3)$$

In which $Performance_{i,n}$ is the current performance of a General Partner i with fund sequence number n. This will be regressed against $Performance_{i,n-1}$, which refers to the performance of the fund preceding the fund referred to in variable *n-1* and the $Performance_{i,n-2}$ of the second preceding fund. The regression also includes the $Ln(NumberOfAssets_{i,n})$, which is the number of assets within fund sequence number n of fund manager i. $VintageYearFixedEffects_t$

control for possible influences of business cycles on fund performance. $GPFixedEffects_i$ control for GPs varying systematically in their average performance. $GeographicalFocusFixedEffects_x$ control for systematical. Moreover, $Ln(NumberOfAssets_{i,n})$ is replaced with the number of assets growth to assess the impact of a high growth in the number of assets for sequential funds on the persistence in performance.

4.4.2 Relative analysis

The impact of the number of assets on persistence based on relative performance is assessed using a Logit regression. The performance measure that is used is the performance quartile dummy of the included funds. The formula for the relative analysis of hypothesis 3 is as follows:

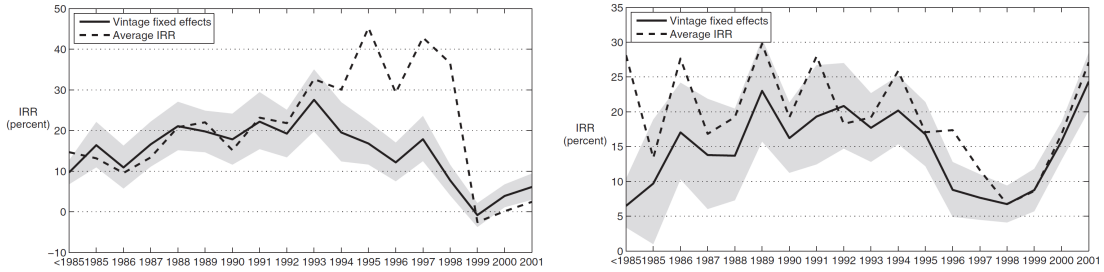
$$PerformanceDummy_{Q,i,n} = \alpha + \beta_1 PerformanceDummy_{Q1,i,n-1} + \beta_2 PerformanceDummy_{Q2,i,n-1} + \beta_3 PerformanceDummy_{Q3,i,n-1} + \beta_4 PerformanceDummy_{Q4,i,n-1} + \beta_5 Ln(NumberofAssets_{i,n}) + \beta_6 VintageYearFixedEffects_t + \beta_7 GPFixedEffects_i + \beta_8 GeographicFocusFixedEffects_x + \varepsilon_{i,n} \quad (4.4)$$

In which $PerformanceDummy_{Q,n}$ equals 1 if the fund of fundmanager i performed in quartile Q in the fund with sequence number n. $PerformanceDummy_{Q,n\text{-}1}$ equals 1 if the preceding fund n-1, of fund manager i performed in a certain quartile Q, and equals 0 if this is not the case. The regression also includes the $Ln(NumberOfAssets_{i,n})$, which is the number of assets within fund sequence number n of fund manager i. $VintageYearFixedEffects_t$ control for possible influences of business cycles on fund performance. $GPFixedEffects_i$ control for GPs varying systematically in their average performance. $GeographicalFocusFixedEffects_x$ control for systematical performance differences across regions as has been found in Korteweg and Sorensen (2017). Moreover, $Ln(NumberOfAssets_{i,n})$ is replaced with the number of assets growth to assess the impact of a high growth in the number of assets for sequential funds on the persistence in performance. The result of this Logit regression shows the relation between a fund that performs, for example, in the top quartile and the relative performance of its previous fund.

4.5 Fixed effects

The regressions above include multiple fixed effects that can influence performance in general for the different funds that are included in the data set.

First of all, business cycles can influence the performance of a certain fund. It was previously shown that funds which raise capital in down markets perform significantly better, this can be explained by a premium for providing liquidity to fund managers when opportunity costs are high (Robinson & Sensoy, 2016). To correct for the effects of raising capital in different years, vintage year fixed effects are included in the regressions. The effect of vintage year fixed effects on the performance of VC funds and PE funds was



Venture Capital funds Buyout funds

Figure 4.1: Vintage year effects on fund performance

Source: Korteweg and Sorensen (2017)

visualized by Korteweg and Sorensen (2017). The effects as reported in their paper for VC and PE are shown in Figure 4.1. This will make the intercept of the different regressions variable over time but with a constant influence on the different funds. This fixed effect is based on the inception year of the funds as reported by Preqin. The advantage of including year fixed effects is that the omitted variable bias of unobserved time effects and biases caused by cross-sectional correlations are removed (Brooks, 2019).

Moreover, General Partner fixed effects are included based on the Firm ID of the different fund managers in Preqin. This controls for systematical under- or outperformance of a particular GP and makes the intercept of the regression variable for the individual fund managers.

Finally, there is no limitation in this data set on geography. As it was previously shown by Korteweg and Sorensen (2017) and Buchner et al. (2016) that the performance can differ across continents. A geographic focus fixed effect is included on a continent basis. The included funds are categorized by their fund focus and not by the headquarter location of the GPs. The data set is divided in North-America, Europe, Asia-Pacific and Rest of World.

5. Results

5.1 Introduction

This chapter discusses the results of the performed analyses to answer the research question of this thesis. The structure is based on the hypotheses as described in the literature review (Chapter 2). First, the analysis on persistence in general is discussed in Section 5.2. Afterwards, the analysis on the trend in persistence over time is shown in Section 5.3. Lastly, the relation between persistence and number of assets is analyzed in Section 5.4.

5.2 Results of performance persistence in general

Many previous papers have researched if persistence exists in the Private Equity and Venture Capital industry (see Section 2.3). It was shown by, amongst others, Kaplan and Schoar (2005), Harris, Jenkinson, Kaplan, and Stucke (2014), Chung (2012), and Harris et al. (2020) that fund performance is positively correlated with previous fund performance. This indicates that the performance is persistent over sequential funds of the same fund manager. Many LPs base their investment strategy on this "Common wisdom". The first hypothesis examines if this conclusion can be confirmed.

5.2.1 Absolute analysis

Previous fund performance persistence

The results of the regressions on absolute performance, persistence of buyout and venture capital funds can be found in Table 5.1. The results show a significant and positive relation between the performance of two sequential funds that remains consistent after controlling for fixed effects. Column 2 of Panel A shows that an increase of 10 percent points in the previous fund's IRR leads to an increase of 1.9 percent points in the current fund's IRR. Panel B displays that an increase in the MOIC of 0.1x in the previous fund will lead to an increase of 0.02x in the current fund's MOIC. This implies that funds which have higher absolute performance in previous funds are more likely to have a higher IRR or MOIC in sequential funds. Column 3 shows that there is a negative relation between fund performance and the natural logarithm of fund size and fund sequence number, which is not consistent and significant. The R-squared of the regression improves after using fixed effects, which indicates that the variance of fund performance persistence can partially be explained by these fixed effects. Mainly the vintage year fixed effects seem to have a large impact on the regression and increase the explanatory power by circa 10%. This implies that the inception year, and thereby the business cycle, explains a large part of the variation in fund performance persistence.

Previous and 2nd previous fund performance persistence

Column 4 in Table 5.1 shows a positive relation between 2nd previous fund performance and current fund performance, which is only significant for MOIC in Panel B. The coefficient for 2nd previous fund performance becomes very small and insignificant when previous fund performance is included in regressions 4 and 5. The coefficient for previous fund becomes economically larger compared to the regression without 2nd previous fund performance and is very significant. An increase of 10 percent points in the previous fund's IRR will lead to an increase of 2.9 percent points in the current fund's IRR, compared to 1.9 percent point in the previous regression without 2nd previous performance. Columns 5 and 6 in Panel B show that an increase of 0.1x in the previous fund's MOIC leads to an increase of 0.03x in the current fund's MOIC. The natural logarithm of fund size and fund sequence number are negative and not significant. Finally, including the 2nd previous fund performance in a regression increases the R-squared of the regression by circa 5%.

Table 5.1: Results absolute performance persistence

Table 5.1 displays the results of the Ordinary Least Squares regressions between performance and previous performance of the relation between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3. Only funds with a previous fund are included. Performance is measured in IRR and MOIC (see Section 3.3.1). The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Panel A: Whole sample - IRR				
Performance previous fund	0.190***	0.185***		0.289***	0.280***
Performance 2nd previous fund			0.027	-0.021	-0.021
Log fund size		-0.220			-0.169
Log fund sequence number		-0.232			-0.544
Year FE	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y
N	2,245	2,189	1,155	1,155	1,138
R-Squared	0.160	0.158	0.141	0.211	0.205
	Panel B: Whole sample - MOIC				
Performance previous fund	0.209***	0.221***		0.328***	0.323***
Performance 2nd previous fund			0.047***	-0.037	-0.039
Log fund size		-0.048**			-0.028
Log fund sequence number		-0.005			-0.022
Year FE	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y
N	2,503	2,430	1,318	1,318	1,297
R-Squared	0.208	0.218	0.152	0.221	0.224

*$p<0.10$, **$p<0.05$, ***$p<0.01$

5.2.2 Relative analysis

The relative analysis of performance persistence in general uses two methodologies. First, Appendix A.4 shows how the probabilities of a fund to perform in the same quartile as the previous fund. The results show that the probability of fund performance in the same quartile is larger than in another quartile. The probabilities are the highest for top- and bottom quartile funds.

Moreover, a Logit regression is used to assess the impact of other factors on performance persistence in Table 5.2. A positive coefficient increases the probability of the dependent variable to be 1, while a negative coefficient decreases this probability. A higher positive coefficient increases the probability of the dependent variable to be 1 more compared to lower positive coefficients. In Column 2 of Panel A, the coefficient of 1.6 for the previous fund in Q1 implies that the probability of a sequential fund performing in the top quartile as well increases by 33.5% compared to the bottom quartile. The coefficients for Q2 and Q3 funds are economically smaller, but still positive and significant. This implies that the probability that a top quartile fund has previously performed in the same quartile is the highest, but that performance in Q2 or Q3 increases the probability of Q1 performance compared to bottom quartile funds.

Second quartile funds show a strong persistence in relative performance in Column 2 of Panel B. The coefficient for Previous fund Q2 is positive and economically the largest, followed by Q1 and Q3. Funds in the third performance quartile (Panel C) have a negative significant coefficient for previous fund performance in Q1 and Q2. This implies that previous performance in Q1 or Q2 significantly decreases the probability of a fund performing in Q3. The coefficient for Q3 funds is indistinguishable from Q4 funds, which implies that there is no increased probability of previous performance in Q3. Finally, the results in Column 2 of Panel D show that there is very strong persistence for bottom quartile funds. The coefficients for previous performance in Q1, Q2, or Q3 are negative and very significant, leading to a decreased probability of the current fund performing in the bottom quartile. The coefficient for Q1 is the lowest, which implies that the probability of a current fund being bottom quartile if the previous fund is top quartile is the lowest.

Fund size and fund sequence number do not show consistent and significant results across the different performance quartiles in Column 3. The R-squared of the Q1 and Q4 regressions are also much higher than those of the Q2 and Q3 regression. This implies a higher explanatory power and together with the significant and robust results of the Q1 and Q4 regressions, it shows stronger persistence for top and bottom quartile funds.

In Columns 4 and 5, the VC sample results are compared to the PE sample. It can be noted that the coefficients of venture capital funds are economically larger than the coefficients of the PE funds. This shows that persistence is stronger for VC funds. Moreover, the VC regressions have a higher explanatory power than the whole sample or PE fund regressions.

Hypothesis 1 can be answered affirmative. The results of the absolute and relative analysis show that there is persistence in general. The influence of a 2nd previous fund is absorbed by the previous fund, which is also an indicator of persistence. The persistence

is stronger for bottom and top quartile funds. Fund size and fund sequence number do not have a consistent influence on performance persistence. Including the vintage year fixed effects in a regression improves the explanatory power significantly. The inclusion of 2nd previous fund performance improves this explanatory power by 5%.

5.3 Results performance persistence over time

Section 2.4 shows that after Sensoy et al. (2014) had shown that some investors did no longer outperform the market, the paper of Harris, Jenkinson, Kaplan, and Stucke (2014) assessed performance persistence over time. They found that persistence had disappeared after the year 2000 and mainly buyout funds did not have persistent performance. However, this view was contradicted by the paper of Harris et al. (2020) and Korteweg and Sorensen (2017). Therefore, Hypothesis 2 analyses if there is a difference over time in performance persistence in the PE industry.

5.3.1 Absolute analysis

Table 5.3 displays the results of the absolute analysis for the second hypothesis. The coefficients for the performance of previous funds are very significant and positive pre-2000 in Column 2. Column 5 shows similar results post-2001, in which persistence of the whole sample and PE funds is economically larger than pre-2000. The results in Panel A for IRR show that a 10 percent point increase in previous fund performance in the whole sample leads to a 2.8 percent point IRR increase in the current fund pre-2000 and post-2001. In Panel B, the results show a decreased persistence for the whole sample measured in MOIC. A 0.1x increase in previous fund MOIC leads to a 0.04x increase in current fund MOIC, while this is 0.02x post-2001. Columns 3 and 6 show an increase in persistence for PE funds for IRR and MOIC. The results for VC funds in Columns 4 and 7 show the opposite, with economically smaller coefficients for previous fund performance post-2001. The persistence of VC funds has therefore decreased over time. Fund size and fund sequence show no consistent influence over time.

5.3.2 Relative analysis

The results of the relative analysis for Hypothesis 2 are displayed in Table 5.4. Top quartile funds in Panel A show strong persistence pre-2000 and post-2001 among sequential funds, with positive and significant coefficients for previous fund performance in the top quartile. These coefficients are economically equivalent over time. If the coefficient is positive, this implies an increased probability for the dependent variable to be 1. A higher positive coefficient increases the probability of the dependent variable to be 1 more compared to lower positive coefficients. The coefficients for Q2 and Q3 funds are significant and positive but economically smaller than Q1.

Second quartile funds do not show significant persistence pre-2000 in Columns 2, 3, and 4 in panel B. This increases to strong persistence post-2001 in Columns 5, 6, and 7. Panel C displays that funds which currently perform in the third quartile have a significant

Table 5.2: Results relative performance persistence

Table 5.2 shows the results of the Logit regressions on performance and previous performance between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3. Only funds with a previous fund are included on relative performance persistence. The observed funds are categorized in Q1, Q2, Q3, and Q4 funds which are the relative performance quartiles. The current quartile is regressed against dummy variables for performance quartiles of the previous funds. The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Whole sample		**Private equity funds**	**Venture capital funds**
			Panel A: Q1 funds	
Previous fund Q1	1.586***	1.576***	1.649***	1.459***
Previous fund Q2	0.927***	0.936***	0.939***	0.910***
Previous fund Q3	0.838***	0.829***	0.736***	0.966***
Previous fund Q4				
Log fund size		-0.024	-0.044	0.050
Log fund sequence number		-0.037	-0.054	-0.064
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	2,589	2,515	1,749	742
R-Squared	0.049	0.050	0.054	0.072
			Panel B: Q2 funds	
Previous fund Q1	0.442**	0.440**	0.339*	0.818***
Previous fund Q2	0.617***	0.600***	0.461***	1.012***
Previous fund Q3	0.378**	0.367**	0.269	0.707**
Previous fund Q4				
Log fund size		0.016	0.004	0.104
Log fund sequence number		0.125**	0.131*	0.183
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	2,589	2,515	1,765	742
R-Squared	0.013	0.016	0.018	0.037
			Panel C: Q3 funds	
Previous fund Q1	-0.645***	-0.664***	-0.781***	-0.454
Previous fund Q2	-0.284**	-0.305**	-0.260	-0.428
Previous fund Q3	-0.073	0.095	-0.100	-0.089
Previous fund Q4				
Log fund size		0.080**	0.098**	0.070
Log fund sequence number		-0.070	-0.056	-0.173
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	2,589	2,515	1,766	737
R-Squared	0.016	0.018	0.023	0.037
			Panel D: Q4 funds	
Previous fund Q1	-1.271***	-1.226***	-1.093***	-1.686***
Previous fund Q2	-0.993***	-0.963***	-0.869***	-1.209***
Previous fund Q3	-0.843***	-0.793***	-0.608***	-1.251***
Previous fund Q4				
Log fund size		-0.092**	-0.077	-0.233**
Log fund sequence number		-0.039	-0.041	0.012
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	2,589	2,504	1,755	721
R-Squared	0.045	0.047	0.041	0.097

**p<0.10, **p<0.05, ***p<0.01*

Note: Previous fund Q4 is omitted because it is perfectly correlated with Previous fund Q1, Q2 and Q3. If all these dummies are equal to 0, Previous fund Q4 must be 1.

Table 5.3: Results absolute performance persistence over time

Table 5.3 displays the results of the Ordinary Least Squares regressions between performance and previous performance of the relation between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3, and divided into multiple subgroups, over time and asset class, to analyse the difference in performance persistence. Only funds with a previous fund are included. Performance is measured in IRR and MOIC (see Section 3.3.1). The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Pre-2000			**Post-2001**		
	Whole sample	**Private equity funds**	**Venture capital funds**	**Whole sample**	**Private equity funds**	**Venture capital funds**
	Panel A: IRR					
Performance previous fund	0.280***	0.103	0.268***	0.278***	0.223***	0.223***
Performance 2nd previous fund	-0.042	-0.005	-0.029	-0.005	0.019	-0.003
Log fund size	-2.258*	-0.872	0.707	0.228	-0.196	2.972***
Log fund sequence number	-1.039	-1.663	-3.135	-0.366	-0.511	-1.306
Year FE	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
N	282	143	139	856	682	173
R-squared	0.199	0.402	0.272	0.166	0.155	0.392
	Panel B: MOIC					
Performance previous fund	0.391**	0.009	0.458**	0.175***	0.256***	0.059
Performance 2nd previous fund	-0.042	0.122***	-0.118	-0.012	0.037	0.009
Log fund size	-0.145**	-0.107*	-0.196	-0.012	-0.028	0.138*
Log fund sequence number	0.065	-0.104	0.577	-0.037	-0.021	-0.158
Year FE	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
N	310	157	153	987	770	216
R-squared	0.233	0.668	0.294	0.114	0.170	0.193

*$p<0.10$, **$p<0.05$, ***$p<0.01$

negative coefficient for previous funds that perform in Q1, implying a decreased probability that previous top quartile funds to become third quartile in the sequential fund. The coefficients for the other performance quartiles are not significant, which implies that only funds that have previously performed in Q1 are significantly less likely to become Q3 funds. Columns 4 and 7 in panel C show that third quartile VC funds show no significant persistence. Bottom quartile funds have a very strong negative relation with previous funds that have performed in Q1, Q2, and Q3, which has not changed over time (see Panel D). These very negative coefficients imply a decreased probability that these funds become bottom quartile. Fund size and fund sequence number do not have a consistent and significant influence on persistence, pre-2000 as well as post-2001.

Additionally, Appendix A.4 shows the relative probabilities over time that sequential funds perform in the same quartile. The data confirms that there is performance persistence, and that there seems to be an increase in performance persistence for top quartile funds over time. The persistence of bottom funds has slightly decreased based on these probabilities.

Concluding, the results of the absolute and relative analyses show that there is no change in persistence over time for the whole sample. Therefore, Hypothesis 2 can be answered negatively. For PE funds, the persistence has increased on an absolute basis while it has decreased on a relative basis. The absolute analysis shows a decrease in persistence for VC funds while the relative analysis shows an increase. These results for the subsamples are contradicting. Fund size and fund sequence number do not have an influence on performance persistence over time.

5.4 Results influence number of assets on performance persistence

Section 2.5 discusses the influence of multiple factors on performance persistence discussed in previous literature. Fund size is one of the frequently assessed factors and was previously found to not influence performance persistence (Kaplan & Schoar, 2005; Robinson & Sensoy, 2016; Harris, Jenkinson, Kaplan, & Stucke, 2014; Harris et al., 2020), which is confirmed in Sections 5.2 and 5.3. The findings on fund size raised questions on human capital restrictions and the number of good performing targets that are available when the PE industry keeps on growing. Therefore, Hypothesis 3 assesses the influence of number of assets on performance persistence.

5.4.1 Absolute analysis

The results of absolute performance persistence in relation to number of assets that a fund targets, can be found in Table 5.5. Consistent with the previous analyses conducted in this thesis, the results show a positive and significant relation between current fund performance and previous fund performance and no significant relation with 2nd previous funds.

Furthermore, multiple measures for number of assets are used to assess the influence on performance persistence. Columns 2 and 4 show that there is no consistent and significant influence of number of assets on performance persistence. Moreover, the growth of these number of assets does not show a significant and consistent result either in Columns 3 and 5. The difference over time cannot be assessed, as only six funds pre-2000 have information on number of assets available.

5.4.2 Relative analysis

Table 5.6 displays the results of the analyses on the influence of the number of assets within a fund on performance persistence. Consistent with the previously performed analyses,

Table 5.4: Results relative performance persistence over time

Table 5.4 shows the results of the Logit regressions on performance and previous performance between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3, and divided into multiple subgroups, over time and asset class, to analyse the difference in performance persistence. Only funds with a previous fund are included on relative performance persistence. The observed funds are categorized in Q1, Q2, Q3, and Q4 funds which are the relative performance quartiles. The current quartile is regressed against dummy variables for performance quartiles of the previous funds. The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Pre-2000			**Post-2001**		
	Whole sample	**Private equity funds**	**Venture capital funds**	**Whole sample**	**Private equity funds**	**Venture capital funds**
			Panel A: Q1 funds			
Previous fund Q1	1.615***	1.886***	1.366***	1.545***	1.591***	1.469***
Previous fund Q2	1.316***	1.626***	1.043**	0.782***	0.754***	0.883**
Previous fund Q3	0.763**	0.354	1.216**	0.851***	0.831***	0.833*
Previous fund Q4						
Log fund size	-0.113	-0.139	0.004	0.002	-0.012	-0.071
Log fund sequence number	0.110	-0.000	0.519*	-0.057	-0.059	-0.200
Year FE	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
N	630	316	289	1,885	1,433	450
R-Squared	0.069	0.106	0.105	0.046	0.051	0.065
			Panel B: Q2 funds			
Previous fund Q1	0.365	0.499	0.429	0.467***	0.327*	1.112***
Previous fund Q2	0.503*	0.446	0.538	0.634***	0.477**	1.272***
Previous fund Q3	0.487*	0.531	0.359	0.326*	0.223	0.871**
Previous fund Q4						
Log fund size	-0.000	0.046	0.017	0.021	-0.003	0.124
Log fund sequence number	0.084	0.311*	-0.287	0.128*	0.108	0.382*
Year FE	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
N	630	332	292	1,885	1,433	450
R-Squared	0.020	0.053	0.039	0.016	0.014	0.056
			Panel C: Q3 funds			
Previous fund Q1	-0.814***	-1.108**	-0.603	-0.624***	-0.722***	-0.425
Previous fund Q2	-0.457	-0.560	-0.467	-0.260	-0.206	-0.431
Previous fund Q3	-0.151	-0.149	-0.245	-0.084	-0.117	-0.009
Previous fund Q4						
Log fund size	0.113	0.086	0.061	0.066*	0.089**	0.071
Log fund sequence number	-0.038	-0.117	0.017	-0.067	-0.045	-0.238
Year FE	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
N	630	329	287	1,885	1,433	450
R-Squared	0.031	0.058	0.039	0.015	0.019	0.038
			Panel D: Q4 funds			
Previous fund Q1	-1.089***	-1.197***	-1.105**	-1.248***	-1.082***	-1.940***
Previous fund Q2	-1.216***	-1.340***	-0.923**	-0.886***	-0.769***	-1.357***
Previous fund Q3	-0.829***	-0.512	-1.143**	-0.776***	-0.637***	-1.253***
Previous fund Q4						
Log fund size	0.014	-0.016	-0.011	-0.112**	-0.093*	-0.297***
Log fund sequence number	-0.181	-0.184	-0.127	-0.027	-0.022	-0.088
Year FE	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
N	619	318	279	1,885	1,433	439
R-Squared	0.057	0.068	0.087	0.047	0.038	0.122

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Note: Previous fund Q4 is omitted because it is perfectly correlated with Previous fund Q1, Q2 and Q3. If all these dummies are equal to 0, Previous fund Q4 must be 1.

Table 5.5: Results absolute performance persistence in relation to number of assets

Table 5.5 displays the results of the Ordinary Least Squares regressions between performance and previous performance of the relation between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3. Only funds with a previous fund are included. Performance is measured in IRR and MOIC (see Section 3.3.1). The Log number of assets, is the natural logarithm of the average number of assets that are included in the respective fund. The log number of average assets growth is the natural logarithm of the change in average number of assets that are included in the respective funds. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Whole sample				**Post-2001**
	Panel A: IRR				
Performance previous fund	0.329***	0.242**	0.328***	0.326	0.328***
Performance 2nd previous fund			0.010	-0.150	
Log number of assets (average)	-0.475		0.236		-0.451
Log number of average assets growth		0.907		3.517***	
Year FE	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y
N	375	80	201	44	369
R-Squared	0.106	0.328	0.244	0.522	0.104
	Panel B: MOIC				
Performance previous fund	0.160***	0.068*	0.154**	-0.120	0.158***
Performance 2nd previous fund			0.000	0.093	
Log number of assets (average)	0.036		0.129**		0.041
Log number of average assets growth		0.036		0.149	
Year FE	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y
N	420	82	230	46	414
R-Squared	0.150	0.244	0.199	0.394	0.141

**p<0.10, **p<0.05, ***p<0.01*
Note: Pre-2000 is not reported in this table because of the limited number of observations (N=6)

the results show performance persistence on a relative basis mainly in the top and bottom quartile.

However, in Columns 2, 4, 6, and 8, the coefficients for the number of assets do not show consistent and significant results. The growth of these number of assets does also not show a significant and consistent influence on performance persistence. This implies that there is not an increased or decreased probability of performance in a certain quartile based on the number of assets.

Concluding, both the absolute and relative analyses do show performance persistence between funds, which is consistent with the previous results in Section 5.2 and 5.3. The number of assets and the growth of the number of assets do not have an consistent and significant influence on this Concluding, Hypothesis 3 can be answered negatively.

Table 5.6: Results relative performance in relation to number of assets

Table 5.6 shows the results of the Logit regressions on performance and previous performance between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3, and divided into multiple subgroups, over time and asset class, to analyse the difference in performance persistence. Only funds with a previous fund are included on relative performance persistence. The observed funds are categorized in Q1, Q2, Q3, and Q4 funds which are the relative performance quartiles. The current quartile is regressed against dummy variables for performance quartiles of the previous funds. The Log number of assets, is the natural logarithm of average number of assets that are included in the respective fund. The log number of average assets growth is the natural logarithm of the change in average number of assets that are included in the respective funds. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Current fund performance							
	Q1		**Q2**		**Q3**		**Q4**	
Previous fund Q1	1.404***	2.247**	0.504	-0.062	-0.430	-0.218	-1.187***	-0.675
Previous fund Q2	1.019**	3.652***	0.686*	-1.087	-0.306	-0.718	-1.099***	-0.895
Previous fund Q3	0.768	0.109	0.327	0.365	-0.133	0.367	-0.579	-0.103
Previous fund Q4								
Log number of assets (avg)	0.163		-0.221**		-0.002		0.131	
Log number of average assets growth		0.370**		-0.140		-0.191		0.056
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y
N	426	76	426	74	426	80	422	78
R-Squared	0.079	0.265	0.044	0.100	0.035	0.069	0.089	0.147

*$p<0.10$, **$p<0.05$, ***$p<0.01$*
Note: Previous fund Q4 is omitted because it is perfectly correlated with Previous fund Q1, Q2 and Q3. If all these dummies are equal to 0, Previous fund Q4 must be 1.

5.5 Robustness of the results

The analyses in this thesis have been executed as carefully as possible. To test the robustness of the results, multiple extra analyses have been conducted. The extended overview of the results can be found in the appendix in Table A.3 until A.9. The extra analyses confirm the robustness of the results.

Moreover, the regressions have been performed with an aggregate performance measure besides the IRR and MOIC. These results can also be found in the appendices. The aggregate performance measure requires that a fund reports a performance quartile, MOIC and IRR. Therefore, a potential bias that can occur because funds only report the performance measure that benefits their results. The results using this aggregate performance measure do not differ from the regressions using IRR and MOIC.

Furthermore, to assess the impact of number of assets on performance persistence two extra measures are used besides the measures shown in Table 5.5 and 5.6. The additional measures are the minimum and maximum number of assets, and the results can be found in Appendix A.8 and A.9. The results are consistent across all performance measures.

6. Conclusion

6.1 Introduction

This chapter discusses the conclusions that can be drawn based on the previous literature and the results of this thesis. First, the conclusion of the research question is described in Section 6.2. In Section 6.3, the implications for the investment decisions of Limited Partners are reviewed. Finally, Section 6.4 summarizes multiple discussion points and limitations of this study.

6.2 Conclusion

To answer the research question, multiple tests have been performed. The results for the first hypothesis in Section 5.2 show that there is performance persistence in general in the PE industry between sequential funds. The effect of the 2nd previous fund is absorbed by the previous fund performance. This result is consistent over different performance measures and robust for different control variables and fixed effects. The results of the relative analyses show that the persistence is stronger for bottom and top quartile funds. Moreover, fund size and fund sequence number do not have any influence on the persistence.

The results in Section 5.3 show that this performance persistence between two sequential funds has not disappeared over time. The results show persistence pre-2000 and post-2001. Fund sequence and fund size have no consistent influence on this result. The persistence of Private Equity funds has increased over time on an absolute basis, but decreased on a relative basis. VC funds show an opposite result, with declining performance persistence on an absolute basis, but increasing on a relative basis.

Other factors besides fund sequence number and fund size could influence the persistence in performance. Based on previous literature, hypothesis 3 was conducted. It analyses if the number of assets that GPs have to acquire and manage has an influence on the persistence. This could arise because of span of control issues or human capital restrictions. It could also be hard to find enough good targets. The results in Section 5.4 show that the different measures for number of assets do not have a consistent or significant influence. Therefore, it can be concluded that performance persistence in general is not influenced by an increasing or decreasing number of portfolio assets. These results are identical for absolute and relative performance. The influence of the number of assets on performance persistence over time could not be measured, because only 6 funds from the pre-2000 sample have this information available. The post-2001 fund results do not differ from the results as described above for the whole sample.

Conclusion on the research question

The results of the hypotheses can be used to answer the research question of this thesis, which is:

Has the number of assets within a fund influenced the disappearance of performance persistence for private equity industry post-2001?

It can be concluded that there is persistence in performance for PE and VC funds. This thesis does also show that this persistence has not disappeared over time, measured in absolute and relative performance. The number of assets measures do not show a consistent and significant relation with performance persistence. Therefore, it can be concluded that the number of assets did not have an influence on the persistence of the observed PE and VC funds and that the persistence has not disappeared. The conclusion of this paper confirms the majority of the findings of previous literature. [1]

6.3 Implications for the industry

The conclusion of this thesis does have some implications for the PE and industry. First of all, as mentioned in Chapter 1 it is common practice for investors in the PE industry to base their investment decisions on previous fund performance. This thesis shows that previous fund performance is a good estimator of sequential fund performance, and this confirms that the method used by LP's is appropriate. Some authors in previous literature argue that the performance of the previous fund is not available when LPs have to decide whether to invest in a fund or not. The results show that the investment decision can also be based on 2nd previous fund performance.

The results on relative performance show strong performance persistence for funds that perform in the first or fourth quartile. Therefore, if LPs base their investment decisions on relative performance, they should be reluctant to base their investment decision on relative performance when selecting funds that are perform in the second or third quaritle. For relative performance, it is not needed to include fund size or fund sequence number. It is shown that these factors do not have a consistent influence on relative fund performance, and this was not tested in previous literature. LPs do not have to include the number of assets or number of assets growth in their analyses as these measures do not have a significant influence on absolute or relative performance.

Moreover, multiple performance measures have been used in the analyses. The results in this thesis are consistent over different performance measures. MOIC has in the majority of the regressions the highest explanatory power, but there is no large difference compared to the other measures. Therefore, LPs could use IRR, MOIC, an Aggregate performance measure, and relative performance to assess fund performance.

[1] A comparison of the results of previous literature with the outcome of this thesis can be found in Appendix A.2.

6.4 Discussion and suggestions for further research

Despite all efforts made to execute this thesis as carefully as possible, some discussion points arise. These discussion points are mainly due to the lack of data.

6.4.1 Discussion of the data

The used data set in this thesis is selected as diligent as possible, but there are still some limitations. The first limitation is that the Preqin database could be positively biased. The data is collected by voluntary reporting of the respective GPs. This could lead to the GPs only reporting their well-performing funds and overestimation of the fund performance. This is a potential selection and reporting bias, but has previously not led to different results compared to other databases (Harris, Jenkinson, Kaplan, & Stucke, 2014).

Next to this, the observed funds are not evenly distributed over time. This is due to the fact that the number of funds has exponentially increased over time, but also because Preqin has limited coverage for older funds. This also leads to limitations in the regressions on number of assets. These regressions have a very low number of funds that are included. This makes it hard to draw any conclusions over the influence over time. Moreover, funds pre-2003 are underrepresented in Preqin (Harris, Jenkinson, & Kaplan, 2014).

Furthermore, the number of funds that can be observed is limited because of the sequential fund requirement. Korteweg and Sorensen (2017) argue that excluding single funds are generally the worse performing funds. The exclusion of these funds could lead to systematic biases. This problem is impossible to mitigate when investigating persistence in performance because sequential funds are needed.

Cash flow data can not be obtained for the used funds, whereby the PME cannot be calculated. It was argued by Long and Nickels (1996) that the PME should be the preferred performance measure for PE analysis. Despite the findings of Kaplan and Schoar (2005), Harris, Jenkinson, Kaplan, and Stucke (2014), and Harris et al. (2020) that no significant difference exists between persistence in performance using PME, IRR, or MOIC, the availability of the PME could have improved this study.

The precise number of deals that are executed for a fund is also not available in Preqin. The approximation made by using the targeted minimum and maximum asset value of a certain fund that is reported leads to an estimation. This estimation is a range of the number of assets and is of poor quality. A data set which includes the exact number of assets in funds could mitigate this problem.

6.4.2 Discussion of the methodology

OLS regressions are used in all sorts of research because it is a very effective method. The advantage of using OLS is that it is very suitable for small data sets. However, some limitations arise as well. The model assumes that the used data follows a linear model. This implies that over long ranges, the model is limited in following a shape that fits the data. This can make the analysis sensitive to outliers or can cause poor extrapolation. Next to that, as Korteweg and Sorensen (2017) mention in their paper,

there is a probability that spurious correlations arise in a regression on persistence. This can occur because sequential funds can overlap in time, while it is required that the observations are independent of each other for a regression.

Logistic regression is an efficient and commonly used method to assess the relationship in the case of a categorical dependent variable. However, logistic regressions assume, just like the OLS model, a linear relationship between the dependent and independent variables. This can cause some problems as mentioned before. Another disadvantage is that if not all the right independent variables are included in the regression, the predictive power of the analysis will be low. It also assumes that all observations are independent, which is not the case with funds managed by the same GP for example. It is also notable that the R-squared of the majority of the regressions is very low. This was also visible in previous research, but it should be taken in mind.

6.4.3 Recommendations for future research

For future research, the quality of the analysis can be improved if a more comprehensive database would become available, including the PME. Moreover, the number of deals done in a certain fund instead of the estimation of the number of assets could improve the analysis. It would give a better insight into the real influence of human capital restrictions and other issues that may potentially influence performance persistence. It could be interesting to assess the number of deals in relation to the number of managers of a particular fund or the number of FTEs[2], which is unavailable at this moment.

[2] FTE stands for fulltime equivalent and is an indicator of the amount of human capital available

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A. Appendix

Table A.1: Performance of buyout and venture capital funds over time

Table A.1 displays the overview of the performance of buyout and venture capital funds as presented in Table 1 and 2 of Kaplan and Sensoy (2015). It shows the results of the papers of Robinson and Sensoy (2013) and Harris, Jenkinson, and Kaplan (2014), which is the performance over time of venture capital and buyout funds over time. IRR is the internal rate of return and can be calculated by solving:

$$NPV = 0 = \frac{CF_t}{(1+IRR)^t} - C_0 \tag{A.1}$$

In which NPV is the Net Present Value of an investment. The NPV is assumed to equal zero, to calculate what the discount rate is for which all Cash Flows of the investment, CF_t are equal to the costs of the investment, C_0. The MOIC is the multiple on invested capital and can be calculated as follows:

$$MOIC = \frac{TotalDistributions}{TotalInvestment} \tag{A.2}$$

In which *TotalDistributions* is the sum of the all capital distributions received from a investment and *TotalInvestments* is the sum of all capital calls. The result is a multiple which is independent on the timeline of the investment.

	Buyout Funds						Venture Capital Funds			
	IRR			MOIC			IRR		MOIC	
Vintage year	Robinson & Sensoy (2013)	Harris, Jenkinson & Kaplan (2014)	Higson & Stucke (2014)	Robinson & Sensoy (2013)	Harris, Jenkinson & Kaplan (2014)	Higson & Stucke (2014)	Robinson & Sensoy (2013)	Harris, Jenkinson & Kaplan (2014)	Robinson & Sensoy (2013)	Harris, Jenkinson & Kaplan (2014)
1980	-	-	30.9	-	-	5.87	-	-	-	-
1981	-	-	33.6	-	-	4.67	-	-	-	-
1982	-	-	38.7	-	-	3.24	-	-	-	-
1983	-	-	20.2	-	-	2.46	-	-	-	-
1984	38	15.8	23.6	3.23	3.28	3.92	10	7.9	1.48	1.73
1985	24	13.7	24.2	2.62	2.66	2.39	12	7.1	2.05	1.93
1986	13	16	20.1	2.05	3.27	3.2	-10	9.4	1.4	1.82
1987	20	15.3	11.7	2.66	2.58	1.92	6	20.2	1.78	2.77
1988	9	18.4	14.1	1.57	2.32	1.82	15	24.4	1.8	2.88
1989	20	21.1	20.4	2.42	2.75	2.53	18	25.7	2.13	3.09
1990	28	52.9	20.4	2.64	3.37	2.26	15	29.5	1.43	3.3
1991	16	27.8	29.5	1.92	2.54	2.68	-	28.5	-	2.92
1992	37	15	26.5	2.3	1.88	2.64	6	24.8	1.27	2.72
1993	44	26	22.7	2.74	2.48	2.09	36	51.9	1.96	6.34
1994	28	34.5	29.8	2.14	3.29	2.57	52	41.4	3.31	6.58
1995	18	16.9	18.9	2.09	1.82	1.88	21	46.4	1.89	3.55
1996	9	2.4	5.8	1.43	1.17	1.3	27	76.7	1.99	6.33
1997	13	8.8	9.7	1.67	1.5	1.55	42	76.1	2.26	3.28
1998	6	3.6	4.7	1.39	1.28	1.26	30	15.5	1.67	1.6
1999	-3	4.8	8.5	1.36	1.4	1.41	-27	-4.5	0.64	0.94
2000	6	14.3	15.3	1.31	1.75	1.72	-11	-1.3	0.83	0.97
2001	4	15.1	19.8	1.26	1.67	1.79	-22	-0.7	0.82	1.01
2002	27	18.4	21.1	1.53	1.84	1.8	3	0.6	1.05	1.07
2003	50	22.5	22.1	1.6	1.8	1.71	-	0.9	-	1.11
2004	17	15.4	13.3	1.23	1.64	1.45	-	0.3	-	1.07
2005	14	7.1	7.4	1.19	1.27	1.23	-6	3.3	0.93	1.31
2006	-	0.5	1	-	1.02	0.98	-	0.6	-	1.04
2007	-	4.4	1.7	-	1.09	0.97	-	3.2	-	1.09
2008	-	1.5	0.2	-	1.04	1.01	-	4.5	-	0.97

Table A.2: Comparison of literature on performance persistence

Table A.2 contains an overview of the results of previous literature on performance persistence in the Private Equity industry. The results are compared to the findings in this thesis. If no information is given, the topic is not tested in the respective paper.

			Previous literature							
		Groenewegen (2021)	**Kaplan & Schoar (2005)**	**Phallippou (2010)**	**Chung (2012)**	**Harris, Jenkinson, Kaplan & Stucke (2014)**	**Korteweg & Sorensen (2017)**	**Robin & Sensoy (2016)**	**Braun, Jenkinson & Stoff (2017)****	**Harris, Jenkinson, Kaplan & Stucke (2020)**
	Previous	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	2nd previous	Yes	Yes	-	Sometimes	Yes, for VC	No	-	-	No
	Previous and 2nd previous	Only previous	Yes	-	-	Only previous	Only previous	-	-	
Persistence stronger for	Private Equity	No	No	-	Yes	No	Yes	Yes	-	No
	Venture Capital	Yes	Yes	-	No	Yes	No	No	-	Yes
Persistence disappeared post-2000		No	-	-	-	Yes for PE	No	-	Yes	No
Persistence weakened post-2000		No	-	-	-	Yes	Yes for VC	-	No	No
Persistence driven by	Top and bottom quartile	Yes	-	-	-	Yes	-	-	Yes	No
	Bottom quartile	No	-	Yes	Yes	No	-	-	No	Yes
Influence of other factors	Fund size									
	Fund sequence number	No	Positive	No	Negative for VC*	Positive for VC	Small firms more persistent	Negative for VC funds only	Negative, based on deal-size	No
	Number of assets	No	Positive	No	-	No influence first time funds	No	No	Negative effect of deal sequence	-

**Based on capital flows*
*** Based on deal-level data*

Table A.3: Robustness results absolute performance persistence

Table A.3 displays the results of the Ordinary Least Squares regressions between performance and previous performance of the relation between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3. Only funds with a previous fund are included. Performance is measured in IRR, MOIC and Aggregate (see Section 3.3.1). The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

Whole sample - IRR

Performance previous fund	0.213***	0.190***	0.190***	0.190***	0.186***	0.189***	0.185***					0.338***	0.289***	0.289***	0.289***	0.280***	0.289***	0.280***
Performance 2nd previous fund								0.018	0.027	0.027	0.027	-0.044*	-0.021	-0.021	-0.021	-0.020	-0.022	-0.021
Log fund size					-0.262		-0.220									-0.219		-0.169
Log fund sequence number						-0.223	-0.232										-0.504	-0.544
Year FE	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y
Region FE	N	N	N	Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	Y	Y	Y
N	2,245	2,245	2,245	2,245	2,193	2,240	2,189	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,138	1,155	1,138
R-Squared	0.058	0.154	0.154	0.160	0.157	0.156	0.158	0.000	0.141	0.141	0.141	0.108	0.211	0.211	0.211	0.205	0.211	0.205

Whole sample - MOIC

Performance previous fund	0.225***	0.208***	0.208***	0.209***	0.217***	0.211***	0.221***					0.387***	0.329***	0.329***	0.328***	0.324***	0.328***	0.323***
Performance 2nd previous fund								0.055***	0.046***	0.046***	0.047***	-0.052***	-0.038**	-0.038	-0.037	-0.038	-0.038	-0.039
Log fund size					-0.049**		-0.048**									-0.031		-0.028
Log fund sequence number						-0.020	-0.005										-0.024	-0.022
Year FE	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y
Region FE	N	N	N	Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	Y	Y	Y
N	2,503	2,503	2,503	2,503	2,435	2,496	2,430	1,318	1,318	1,318	1,318	1,318	1,318	1,318	1,318	1,297	1,318	1,297
R-Squared	0.109	0.206	0.206	0.208	0.217	0.209	0.218	0.008	0.152	0.152	0.152	0.119	0.220	0.220	0.221	0.224	0.221	0.224

Whole sample - Aggregate

Performance previous fund	0.220***	0.196***	0.196***	0.196***	0.193***	0.196***	0.192***					0.346***	0.297***	0.297***	0.297***	0.288***	0.297***	0.288***
Performance 2nd previous fund								0.022	0.031	0.031	0.030	-0.047**	-0.025	-0.025	-0.023	-0.022	-0.023	-0.023
Log fund size					-0.103		-0.087									-0.084		-0.068
Log fund sequence number						-0.111	-0.105										-0.186	-0.194
Year FE	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y
Region FE	N	N	N	Y	Y	Y	Y	N	N	N	Y	N	N	N	Y	Y	Y	Y
N	2,121	2,121	2,121	2,121	2,074	2,116	2,070	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,064	1,080	1,064
R-Squared	0.063	0.163	0.163	0.165	0.166	0.165	0.167	0.007	0.142	0.142	0.142	0.113	0.215	0.215	0.215	0.210	0.216	0.210

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table A.4: Relative probabilities performance persistence over time

Table A.4 displays the relation between two sequential funds, based on performance quartiles as reported by Preqin. The data is selected as described in Section 3.3, and the quartiles are as reported in the Preqin database. The data is split in Whole sample, Private equity and Venture capital. The table also reports the difference between pre-2000 and post-2001 funds, which is based on the vintage years of the included funds. Only funds with a previous fund are included.

		Current fund quartile				**Current fund quartile**				**Current fund quartile**			
		1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
		Whole sample				**Private equity funds**				**Venture capital funds**			
Previous fund quartile	1	37.8%	28.2%	19.4%	14.5%	46.4%	30.6%	21.2%	21.8%	42.7%	32.3%	28.8%	20.6%
	2	24.2%	32.2%	25.3%	18.2%	26.7%	31.6%	29.4%	23.7%	26.5%	35.5%	25.7%	27.5%
	3	22.6%	27.5%	29.5%	20.4%	19.3%	23.5%	27.7%	24.2%	23.7%	23.0%	27.2%	20.6%
	4	11.3%	21.0%	30.6%	37.2%	7.7%	14.4%	21.7%	30.3%	7.1%	9.2%	18.3%	31.3%
Total		*25.8%*	*27.9%*	*25.4%*	*20.8%*	*25.2%*	*28.0%*	*25.7%*	*21.0%*	*27.1%*	*27.9%*	*24.5%*	*20.5%*
		Whole sample pre-2000				**Private equity funds pre-2000**				**Venture capital funds pre-2000**			
Previous fund quartile	1	43.4%	26.9%	19.9%	19.5%	40.7%	24.7%	15.6%	18.8%	40.0%	29.4%	25.4%	20.3%
	2	30.6%	29.7%	26.7%	19.5%	38.5%	27.8%	26.7%	14.5%	26.3%	31.8%	26.8%	25.0%
	3	19.9%	28.0%	31.7%	24.8%	14.3%	29.9%	34.4%	29.0%	27.4%	25.9%	28.2%	20.3%
	4	6.1%	15.4%	21.7%	36.1%	6.6%	17.5%	23.3%	37.7%	6.3%	12.9%	19.7%	34.4%
Total		*29.2%*	*27.1%*	*24.0%*	*19.8%*	*26.2%*	*28.0%*	*25.9%*	*19.9%*	*30.2%*	*27.0%*	*22.5%*	*20.3%*
		Whole sample post-2001				**Private equity funds post-2001**				**Venture capital funds post-2001**			
Previous fund quartile	1	47.0%	32.5%	24.7%	22.1%	47.8%	32.0%	22.6%	22.5%	44.8%	34.1%	30.8%	20.8%
	2	24.4%	33.8%	28.8%	26.5%	23.8%	32.4%	30.1%	25.7%	26.7%	37.9%	25.0%	29.2%
	3	20.7%	21.8%	26.2%	22.6%	20.5%	22.0%	26.1%	23.2%	20.7%	21.2%	26.7%	20.8%
	4	7.9%	12.0%	20.3%	28.7%	7.9%	13.7%	21.3%	28.6%	7.8%	6.8%	17.5%	29.2%
Total		*25.0%*	*28.1%*	*25.8%*	*21.1%*	*25.0%*	*28.0%*	*25.7%*	*21.3%*	*25.0%*	*28.4%*	*25.9%*	*20.7%*

Table A.5: Robustness results relative performance persistence

Table A.5 shows the results of the Logit regressions on performance and previous performance between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3. Only funds with a previous fund are included on relative performance persistence. The observed funds are categorized in Q1, Q2, Q3, and Q4 funds which are the relative performance quartiles. The current quartile is regressed against dummy variables for performance quartiles of the previous funds. The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Whole sample								**Private equity funds**	**Venture capital funds**
						Panel A: Q1 funds				
Previous fund Q1	0.861***	1.029***	1.568***	1.591***	1.586***	1.536***	1.624***	1.576***	1.649***	1.459***
Previous fund Q2		0.385***	0.924***	0.942***	0.927***	0.897***	0.966***	0.936***	0.939***	0.910***
Previous fund Q3			0.835***	0.856***	0.838***	0.797***	0.868***	0.829***	0.736***	0.966***
Previous fund Q4										
Log fund size						-0.033		-0.024	-0.044	0.050
Log fund sequence number							-0.027	-0.037	-0.054	-0.064
Year FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
Region FE	N	N	N	N	Y	Y	Y	Y	Y	Y
N	2,591	2,591	2,591	2,591	2,589	2,520	2,582	2,515	1,749	742
R-Squared	0.028	0.032	0.032	0.048	0.049	0.048	0.050	0.050	0.054	0.072
						Panel B: Q2 funds				
Previous fund Q1		0.176*	0.393*	0.444***	0.442**	0.430**	0.448**	0.440**	0.339*	0.818***
Previous fund Q2	0.291***	0.369***	0.586***	0.617***	0.617***	0.600***	0.606***	0.600***	0.461***	1.012***
Previous fund Q3			0.360**	0.378**	0.378**	0.368**	0.374**	0.367**	0.269	0.707**
Previous fund Q4										
Log fund size						-0.036		0.016	0.004	0.104
Log fund sequence number							0.134**	0.125**	0.131*	0.183
Year FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
Region FE	N	N	N	N	Y	Y	Y	Y	Y	Y
N	2,591	2,591	2,591	2,591	2,589	2,589	2,520	2,515	1,765	742
R-Squared	0.003	0.004	0.006	0.013	0.013	0.015	0.015	0.016	0.018	0.037
						Panel C: Q3 funds				
Previous fund Q1				-0.653***	-0.645***	-0.636***	-0.673***	-0.664***	-0.781***	-0.454
Previous fund Q2		0.102	0.340**	-0.298**	-0.284**	-0.288**	-0.299**	-0.305**	-0.260	-0.428
Previous fund Q3	0.273***	0.312***	0.550***	-0.083	-0.073	-0.084	-0.087	0.095	-0.100	-0.089
Previous fund Q4			0.605***							
Log fund size						0.069**		0.080**	0.098**	0.070
Log fund sequence number							-0.047	-0.070	-0.056	-0.173
Year FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
Region FE	N	N	N	N	Y	Y	Y	Y	Y	Y
N	2,591	2,591	2,591	2,589	2,589	2,520	2,582	2,515	1,766	737
R-Squared	0.002	0.003	0.009	0.015	0.016	0.017	0.017	0.018	0.023	0.037
						Panel D: Q4 funds				
Previous fund Q1				-1.271***	-1.271***	-1.222***	-1.272***	-1.226***	-1.093***	-1.686***
Previous fund Q2			0.271*	-0.994***	-0.993***	-0.960***	-0.987***	-0.963***	-0.869***	-1.209***
Previous fund Q3		0.271**	0.407***	-0.850***	-0.843***	-0.793***	-0.837***	-0.793***	-0.608***	-1.251***
Previous fund Q4	1.028***	1.110***	1.246***							
Log sund size						-0.095**		-0.092**	-0.077	-0.233**
Log fund sequence number							-0.091	-0.039	-0.041	0.012
Year FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
General Partner FE	N	N	N	Y	Y	Y	Y	Y	Y	Y
Region FE	N	N	N	N	Y	Y	Y	Y	Y	Y
N	2,591	2,591	2,591	2,589	2,589	2,509	2,582	2,504	1,755	721
R-Squared	0.029	0.031	0.033	0.042	0.045	0.047	0.045	0.047	0.041	0.097

**p<0.10, **p<0.05, ***p<0.01*

Note: Previous fund Q4 is omitted because it is perfectly correlated with Previous fund Q1, Q2 and Q3. If all these dummies are equal to 0, Previous fund Q4 must be 1.

Table A.6: Robustness results absolute performance persistence over time

Table A.6 displays the results of the Ordinary Least Squares regressions between performance and previous performance of the relation between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3, and divided into multiple subgroups, over time and asset class, to analyse the difference in performance persistence. Only funds with a previous fund are included. Performance is measured in IRR, MOIC and Aggregate (see Section 3.3.1). The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Pre-2000												**Post-2001**											
	Whole sample				**Private equity funds**				**Venture capital funds**				**Whole sample**				**Private equity funds**				**Venture capital funds**			
	IRR																							
Performance previous fund	0.181***	0.173**	0.293***	0.280***	0.156***	0.156***	0.124	0.103	0.163*	0.158*	0.273***	0.268***	0.209***	0.211***	0.284***	0.278***	0.143***	0.138***	0.230***	0.223***	0.240**	0.264**	0.259***	0.223***
Performance 2nd previous fund			-0.046	-0.042			-0.010	-0.005			-0.030	-0.029			-0.003	-0.005			0.021	0.019			0.002	-0.003
Log fund size		-1.865**		-2.258*		-1.372*		-0.872		2.283		0.707		0.170		0.228		0.062		-0.196		1.499		2.972***
Log fund sequence number		3.330*		-1.039		0.99		-1.663		5.864		-3.135		-0.736		-0.366		-0.467		-0.511		-4.281		-1.306
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	605	580	287	282	320	311	146	143	285	269	141	139	1,640	1,609	868	856	1,263	1,242	690	682	375	365	177	173
R-squared	0.177	0.183	0.202	0.199	0.320	0.337	0.389	0.402	0.259	0.262	0.282	0.272	0.088	0.090	0.166	0.166	0.108	0.112	0.153	0.155	0.127	0.138	0.354	0.392
	MOIC																							
Performance previous fund	0.222***	0.213***	0.400**	0.391**	0.105***	0.105***	0.018	0.009	0.252**	0.248**	0.452**	0.458**	0.200***	0.223***	0.179***	0.175***	0.185***	0.181***	0.260***	0.256***	0.200***	0.228***	0.069	0.059
Performance 2nd previous fund			-0.044	-0.042			0.112**	0.122***			-0.106	-0.118			-0.011	-0.012			0.041	0.037			0.006	0.009
Log fund size		-0.112*		-0.145**		-0.067		-0.107*		0.012		-0.196		-0.037*		-0.012		-0.021		-0.028		-0.036		0.138*
Log fund sequence number		0.122		0.065		0.009		-0.104		0.208		0.577		-0.022		-0.037		-0.015		-0.021		-0.074		-0.158
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	664	635	315	310	343	333	160	157	321	302	155	153	1,839	1,795	1,003	987	1,395	1,365	781	770	442	428	221	216
R-squared	0.181	0.184	0.228	0.233	0.364	0.374	0.647	0.668	0.244	0.244	0.292	0.294	0.231	0.262	0.114	0.114	0.118	0.121	0.166	0.170	0.328	0.370	0.173	0.193
	Aggregate																							
Performance previous fund	0.188**	0.180**	0.306***	0.293***	0.162***	0.171***	0.113	0.094	0.171*	0.166*	0.281***	0.279***	0.214***	0.220***	0.277***	0.271***	0.130***	0.123***	0.219***	0.213***	0.262***	0.308***	0.231***	0.202***
Performance 2nd previous fund			-0.052	-0.048			0.014	0.016			-0.025	-0.025			-0.001	-0.002			0.039**	0.038**			0.000	-0.002
Log fund size		-0.671**		-0.748*		-0.499*		-0.276		0.876		-0.001		0.053		0.068		0.038		-0.079		0.447		0.981***
Log fund sequence number		1.167*		-0.411		0.047		-0.376		2.244		-1.145		-0.281*		-0.130		-0.201*		-0.154		-1.467		-0.844
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	567	547	261	257	304	296	135	133	263	251	126	124	1,554	1,523	819	807	1,198	1,177	649	641	354	344	169	165
R-squared	0.183	0.188	0.204	0.200	0.325	0.346	0.369	0.383	0.266	0.268	0.282	0.272	0.095	0.099	0.178	0.179	0.111	0.117	0.164	0.167	0.141	0.156	0.381	0.420

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table A.7: Robustness results relative performance persistence over time

Table A.7 shows the results of the Logit regressions on performance and previous performance between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3, and divided into multiple subgroups, over time and asset class, to analyse the difference in performance persistence. Only funds with a previous fund are included on relative performance persistence. The observed funds are categorized in Q1, Q2, Q3, and Q4 funds which are the relative performance quartiles. The current quartile is regressed against dummy variables for performance quartiles of the previous funds. The Log fund size is the natural logarithm of the fund size in million US dollars. Log fund sequence number is the natural logarithm of the number of funds that a particular fund manager has managed. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Pre-2000						**Post-2001**					
	Whole sample		**Private equity funds**		**Venture capital funds**		**Whole sample**		**Private equity funds**		**Venture capital funds**	
	Panel A: Q1 funds											
Previous fund Q1	1.818***	1.615***	1.950***	1.886***	1.674***	1.366***	1.495***	1.545***	1.583***	1.591***	1.313***	1.469***
Previous fund Q2	1.502***	1.316***	1.732***	1.626***	1.270***	1.043**	0.712***	0.782***	0.734***	0.754***	0.642	0.883**
Previous fund Q3	0.978***	0.763**	0.509	0.354	1.400***	1.216**	0.793***	0.851***	0.807***	0.831***	0.678	0.833*
Previous fund Q4												
Log fund size		-0.113		-0.139		0.004		0.002		-0.012		-0.071
Log fund sequence number		0.110		-0.000		0.519*		-0.057		-0.059		-0.200
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	660	630	322	316	309	289	1,929	1,885	1,463	1,433	464	450
R-Squared	0.070	0.069	0.101	0.106	0.089	0.105	0.045	0.046	0.051	0.051	0.060	0.065
	Panel B: Q2 funds											
Previous fund Q1	0.337	0.365	0.444	0.499	0.405	0.429	0.484***	0.467***	0.339*	0.327*	1.159***	1.112***
Previous fund Q2	0.448	0.503*	0.366	0.446	0.477	0.538	0.680***	0.634***	0.507***	0.477**	1.425***	1.272***
Previous fund Q3	0.430	0.487*	0.486	0.531	0.334	0.359	0.365**	0.326*	0.262	0.223	0.904**	0.871**
Previous fund Q4												
Log fund size		-0.000		0.046		0.017		0.021		-0.003		0.124
Log fund sequence number		0.084		0.311*		-0.287		0.128*		0.108		0.382*
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	660	630	341	332	313	292	1,929	1,885	1,463	1,433	464	450
R-Squared	0.020	0.020	0.047	0.053	0.031	0.039	0.014	0.016	0.013	0.014	0.043	0.056
	Panel C: Q3 funds											
Previous fund Q1	-0.729**	-0.814***	-0.999**	-1.108**	-0.557	-0.603	-0.627***	-0.624***	-0.728***	-0.722***	-0.410	-0.425
Previous fund Q2	-0.368	-0.457	-0.502	-0.560	-0.366	-0.467	-0.266*	-0.260	-0.199	-0.206	-0.469	-0.431
Previous fund Q3	-0.061	-0.151	-0.065	-0.149	-0.200	-0.245	-0.086	-0.084	-0.113	-0.117	-0.013	-0.009
Previous fund Q4												
Log fund size		0.113		0.086		0.061		0.066*		0.089**		0.071
Log fund sequence number		-0.038		-0.117		0.017		-0.067		-0.045		-0.238
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	660	630	338	329	313	287	1,929	1,885	1,463	1,433	464	450
R-Squared	0.030	0.031	0.057	0.058	0.040	0.039	0.014	0.015	0.017	0.019	0.037	0.038
	Panel D: Q4 funds											
Previous fund Q1	-1.269***	-1.089***	-1.288***	-1.197***	-1.366***	-1.105**	-1.257***	-1.248***	-1.113***	-1.082***	-1.943***	-1.940***
Previous fund Q2	-1.320***	-1.216***	-1.479***	-1.340***	-1.065**	-0.923**	-0.889***	-0.886***	-0.805***	-0.769***	-1.372***	-1.357***
Previous fund Q3	-0.981***	-0.829***	-0.641	-0.512	-1.256***	-1.143**	-0.792***	-0.776***	-0.677***	-0.637***	-1.238***	-1.253***
Previous fund Q4												
Log fund size		0.014		-0.016		-0.011		-0.112**		-0.093*		-0.297***
Log fund sequence number		-0.181		-0.184		-0.127		-0.027		-0.022		-0.088
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	660	619	328	318	302	279	1,929	1,885	1,463	1,433	453	439
R-Squared	0.059	0.057	0.073	0.068	0.081	0.087	0.042	0.047	0.036	0.038	0.101	0.122

**p<0.10, **p<0.05, ***p<0.01*

Note: Previous fund Q4 is omitted because it is perfectly correlated with Previous fund Q1, Q2 and Q3. If all these dummies are equal to 0, Previous fund Q4 must be 1.

Table A.8: Robustness results absolute performance persistence in relation to number of assets

Table A.8 displays the results of the Ordinary Least Squares regressions between performance and previous performance of the relation between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3. Only funds with a previous fund are included. Performance is measured in IRR, MOIC and Aggregate (see Section 3.3.1). The Log number of assets, is the natural logarithm of the minimum and maximum number of assets that are included in the respective fund. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	IRR			
Performance previous fund	0.326***	0.330***	0.343***	0.325***
Performance 2nd previous fund			0.010	0.010
Log number of assets (min)	-0.130		-0.879	
Log number of assets (max)		-0.616		0.341
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	375	375	201	201
R-Squared	0.105	0.106	0.247	0.245
	MOIC			
Performance previous fund	0.162***	0.159***	0.176**	0.155**
Performance 2nd previous fund			-0.005	-0.001
Log number of assets (min)	0.021		0.061	
Log number of assets (max)		0.034		0.124**
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	420	420	230	230
R-Squared	0.149	0.150	0.186	0.199
	Aggregate			
Performance previous fund	0.337***	0.341***	0.336***	0.317***
Performance 2nd previous fund			0.013	0.014
Log number of assets (min)	0.050		-0.192	
Log number of assets (max)		-0.221		0.204
Year FE	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
N	358	358	192	192
R-Squared	0.110	0.111	0.257	0.258

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table A.9: Robustness results relative performance in relation to number of assets

Table A.9 shows the results of the Logit regressions on performance and previous performance between two sequential funds, based on performance as reported by Preqin. The data is selected as described in Section 3.3, and divided into multiple subgroups, over time and asset class, to analyse the difference in performance persistence. Only funds with a previous fund are included on relative performance persistence. The observed funds are categorized in Q1, Q2, Q3, and Q4 funds which are the relative performance quartiles. The current quartile is regressed against dummy variables for performance quartiles of the previous funds. The Log number of assets, is the natural logarithm of the minimum or maximum number of assets that are included in the respective fund. The Year FE are the vintage year fixed effects, and control for possible influences of business cycles. General Partner FE, are the general partner fixed effects and control for average out- or underperformance of a fund manager. Region FE are fixed effects controlling for differences in performances per geographic focus.

	Current fund performance							
	Q1		**Q2**		**Q3**		**Q4**	
Previous fund Q1	1.463***	1.401***	0.494	0.495	-0.461	-0.423	-1.189***	-1.181***
Previous fund Q2	1.063**	1.018**	0.692*	0.677*	-0.328	-0.302	-1.110***	-1.094***
Previous fund Q3	0.798*	0.770	0.340	0.318	-0.151	-0.131	-0.595	-0.573
Previous fund Q4								
Log number of assets (min)	0.078		-0.313***		0.115		0.225	
Log number of assets (max)		0.158		-0.192*		-0.172		0.112
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
General Partner FE	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y
N	426	426	426	426	426	430	422	422
R-Squared	0.076	0.079	0.050	0.043	0.036	0.035	0.091	0.088

**p<0.10, **p<0.05, ***p<0.01*

Note: Previous fund Q4 is omitted because it is perfectly correlated with Previous fund Q1, Q2 and Q3. If all these dummies are equal to 0, Previous fund Q4 must be 1.