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**Private Equity funds and their performance
in the post-crisis period**

Bachelor thesis

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Abstract

The work covers the topic of private equity funds performance and attempt to identify the impact of macroeconomic conditions on the entire industry. The recent central banks' actions put a question about the impact of changes in interest rates on the private equity funds performance. With the sample of 100 observations provided by Cambridge Associates, we identified the significant negative effect of prevailing low interest rates on the growth of private equity funds performance. We further attempt to answer the question, whether private equity funds operating in post-crisis years has on average higher growth rate, however, we could not provide the answer as we failed to reject the null, neutral effect hypothesis. Additionally, with a sample of 3092 observations provided by Bloomberg, we found that the effect of cheap debt has increased on average in the post-crisis period, predicting that the private equity performance can suffer once the interest rates rises enough.

JEL Classification	E44, E58, G21, G23, G24, G34
Keywords	Private Equity, Venture Capital, Leveraged Buyouts, Interest rates, Private Equity Performance, Net Internal rate of Return
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Abstrakt

Tato práce se zaměřuje na téma fondů soukromého kapitálu a jejich ovlivněním ze strany makroekonomických faktorů. Nedávné změny v politikách hlavních centrálních bank zapříčinily popularizaci otázky ohledně vlivu jejich akcí na výkonnost těchto

fondů. S použitím vzorku 100 pozorování z databáze Cambridge Associates jsme identifikovali negativní dopad nízkých úrokových sazeb na mezi kvartální růst výkonnosti těchto fondů. Následně jsme se pokusili zodpovědět otázku, zdali fondy soukromého kapitálu operující v post-krizových letech mají v průměru větší růst než fondy v předkrizových letech. Bohužel, se nám nepodařilo odmítnout nulovou hypotézu o neutrálním efektu, tak tato otázka zůstává jako potenciální téma pro další výzkum. Poslední hypotézu o mezi dekádním zvýšení vlivu nízkého úrokového prostředí na výkonnost fondů soukromého kapitálu jsme testovali s použitím vzorku 3092 pozorování z databáze Bloomberg, Následně jsme tuto hypotézu potvrdili, přičemž výsledný efekt o větším pozitivním vlivu nízkého úrokového prostředí na výkonnost těchto fondů naznačuje, že s aktuálním zvedáním úrokových sazeb by výkonnost těchto fondů mohla poklesnout v budoucnu.

JEL Klasifikace	E44, E58, G21, G23, G24, G34
Klíčová slova	Private Equity, Venture Capital, Leveraged Buyouts, Interest rates, Private Equity Performance, Net Internal rate of Return
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Range of thesis: 118 340 characters with spaces

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.
2. The author hereby declares that all the sources and literature used have been properly cited.
3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague, 31 July 2019

Štěpán Koníř

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Bachelor's Thesis Proposal

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Language of the thesis: English

Proposed Topic:

Private equity funds and their performance in the post-crisis period

Preliminary scope of work:

Research question and motivation

I am going to study the performance of PE funds in the recent times when many macroeconomic models stopped working. I am focusing on whether macroeconomic indicators can explain the performance of PE funds and if this fact can cause the results

from previous papers to be biased. Furthermore, I am going to analyze several possible macroeconomic scenarios and report the expected influence of them on the PE funds' performance. I find this topic very interesting and important in the current economic environment with all-time high stock valuations and low bond yields, where investors try to find alternative ways to investment their capital, with the ultimate goal to beat the market. PE is one of the options and additionally the significance of PE funds in the financial system has been growing recently again. Therefore, I believe that my research can be useful in both the academic world and the real world.

Contribution

Because of the limited access to data describing the performance of PE funds, which also usually includes the reporting bias, this topic is not frequently analyzed in the academic world, especially in the CEE and other developing regions. My research is going to build on the old findings and evaluate their contribution to this topic. Nevertheless, the main contribution of my research is going to be the idea of macroeconomics indicators being one of the potential drivers of PE funds' performance. In the majority of recent papers, the authors attempt to explain the performance of PE funds by linking it to microeconomics indicators, but all of these results can be biased as they are exposed to overall macroeconomic conditions. Moreover, I am going to provide the analysis of possible future scenarios, which I also failed to find anywhere else. This paper could serve as a foundation for further research of PE funds' performance, evaluation of my proposed scenarios and possibly as an evaluation of whether PE funds are a good investment.

Methodology

I am going to work with data on the performance of PE funds (dependent variable) from one or more global and local databases including CapitalIQ, Preqin, EVCA, CVCA and Invest Europe. Furthermore, I will use macroeconomic data on interest rates, GDP, inflation, etc. (independent variables) that are publicly available. I am going to combine them into several econometric models (using the best estimators and time series analysis), in order to find out, what are the indicators of PE funds' performance. In addition, I am going to analyze some possible future scenarios and

their expected effect on PE funds' performance (this part is going to be similar to the stress test in the banking industry).

Outline

- ❖ Introduction of the terms Private equity, Leveraged Buyout and Venture Capital, their focus, specialization and brief history. (2 standard pages)
- ❖ Description of PE funds' lifecycle, their purpose and significance in the financial system, their investments and a discussion of their investment strategies. (3 standard pages)
- ❖ Measurement of PE funds' performance using IRR, MoM, MIRR, TVPI, DPI (2 standard pages)
- ❖ Subprime mortgage crisis, a description of the state of the financial system during 2007-2009, the creation of an unusual investment opportunity to acquire companies at a large discount and the reaction of PE funds to this development. Introduction to the first tested hypothesis which states that the performance of PE funds in these years should be better than their historical performance. Monitoring of successful, failed, local and all PE funds in 2012-2017 following the exits from their investments made during the subprime mortgage crisis. (5 standard pages)
- ❖ The consequences of the subprime mortgage crisis and the low interest rates over the last decade
 - Description of the macroeconomic situation in the post-crisis world and the influence of low interest rates on the financial sector, valuation of assets and portfolios. Analysis of conditions for purchases and sales of companies from a general point of view. Specific development in Czech Republic and in the CEE region. Subsequent consequences on the local PE funds' performance and their importance. (2 standard pages)
 - Introduction to the second possible hypothesis outlining the increasing importance of PE funds in the financial system and the rising volume and number of transactions, in the capital-oriented countries in comparison to the banking-oriented countries, and in the developing countries against the developed countries. (2 standard pages)

- Introduction to the third possible hypothesis outlining the effect of low interest rates on PE funds' performance and the effect of cheap money creating positive conditions for LBO transactions. Comparison of the performance of VC and LBO funds regionally and globally. (2 standard pages)
- Introduction to the analysis of conditions for purchases and sales of companies from a general point of view and from the point of view of Czech Republic and of the CEE region, thanks to the recent economic transformation (2 standard pages)
- ❖ Time series analysis, main model. Testing of several hypotheses with a multilinear regression model: The impact of macroeconomic indicators (GDP, inflation, interest rates) on the performance of PE funds by region (US, UK, Benelux, CEE, Asia); Finding the most important variables that determine the performance of PE funds and possibly an analysis of selected scenarios in the future years for PE funds.
 - Specification of data for hypotheses, description of tested hypotheses and test itself. (5 standard pages)
 - Interpretation of results. (5 standard pages)

List of academic literature:

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Acronyms

PE (PEF)	Private equity (funds)
CEE	Central & Eastern Europe
GDP	Gross Domestic Product
IRR	Internal Rate of Return
MoM	Multiple of Median
MIRR	Modified Internal Rate of Return
DPI	Discounted Profitability Index
TVPI	Total Value to Paid-In
VC	Venture Capital
LBO	Leveraged Buyout
US	United States
UK	United Kingdom
Benelux	Belgium, Netherlands & Luxembourg
FoF	Fund-of-Funds
LP	Limited Partner
GP	General Partner
WWII	World War Second
ARD	American Research and Development Corporation
PE-LBO	Private Equity - Leveraged Buyout

NAV	Net Asset Value
CDO	Collateralized Debt Obligation
CDS	Credit Default Swap
Fed	Federal Reserve
LIBOR	London Inter-bank Offered Rate
TARP	Bank bailout bill
QE	Quantitative Easing
DPI	Distribution to paid in capital
PME	Public Market Equivalent
CA	Cambridge Associates
BL	Bloomberg
SLR	Simple linear Regression
ADF	Augmented Dickey Fuller
KPSS	Kwiatkowski–Phillips–Schmidt–Shin
FGLS	Feasible generalized least square
IPO	Initial public offering
pp	percentage points

Introduction

The recent macroeconomic development showed a global shift from the low interest rate policy, which central banks conducted in the last decade. Moreover, this extreme environment causes an enormous popularity of stock market and alternative investments such as private equity. As this industry is known for using high portions of debt for acquiring companies, provide risk capital to start-up founders or benefit from real estate market, it seems reasonable to assume that the macroeconomic variables should influence it up to some range. Our work will be structured logically, so the reader can easily follow the content and gradually become an expert on the covered topic. All these topics are linked to the final datasets, so the reader can eventually understand author's motivation for choosing particular variables, its potential limitations and the power of inference, suggested by this work. The chapter 2 describes in detail the focus of private equity industry. It touches private equity strategies, history and current role in the financial market, legal entities and their relationships, value creation process and lifecycle of the fund itself. The chapter 3 describes a financial markets development as well as main macroeconomic events, which lead to the current situation in the private equity industry. The chapter 4 covers the main methods for the evaluation of the private equity funds. It provides technical description as well as discussion of limitations and convenience. The chapter 5 provide an overview of academic literature related to the private equity industry and financial turmoil events, and attempt to identify the gap, which this work should narrow. The chapter 6 includes a description of obtained datasets, variables statistics and the treatment of inconvenient observations. The chapter 7 contains the main scope of this work, the time-series and cross-sectional models, tested hypothesis and results discussion. The Conclusion summarize the entire work and provide the reader with key findings and propose topics for further research.

1. Private Equity Industry overview

1.1 Basic terms

1.1.1 Industry introduction

Although Private Equity (“PE”) is a widely used term, its meaning can be ambiguous. In general, PE refers to an alternative asset class and falls into the category of alternative investments among hedge funds, mutual funds, commodity, art and antiques, derivative contracts and managed futures. PE invests into private companies, physical assets, such as real estate, and public companies that will be eventually delisted.

As mentioned in Sedlakova (2008), in some academic papers and related literature we can find slightly different meaning of this term, and contrarily some other terms such as Venture Capital or Leveraged Buyout with the same meaning. This misuse is usually a result from different geographical origination of academic papers and country-specific expressions.

As a type of investment, PE has unique characteristic of high illiquidity, long investment horizon, particularly 3-7 years and significant degree of risk. As a result, this complex nature sharply predetermines its potential investors, who are mainly institutional and accredited investors.

PE firms raise significant amount of money through closed-end funds from these investors. PE funds (“PEFs”) are then used as an entity to conduct the investments. There is a variety of types of these funds, depending on their size, investment strategy as well as industry and geographical focus. According to their strategy, these funds then acquire significant share of equity in target companies and are therefore actively involved in the management. Furthermore, depending on their strategy, the funds use debt to conduct their investments, which lever their position and boost the returns of the fund.

Among the most pronounced PEFs strategies belong Venture Capital (“VC”), Leveraged Buyout (“LBO”) and Fund-of-Funds (“FoF”). In this thesis, we define VC as a type of private equity focused on start-up companies. In the same way, we define LBO as an acquisition of a company using a significant amount of borrowed money. We will cover each strategy in more detail later in this work.

At last, private equity industry is a broad system of firms, including PE firms, PE-backed firms, advisors such as commercial or investment banks, and specialized firms for valuation, law and accounting. Some of the well-known PE firms are Carlyle Group, The Blackstone Group, KKR, Sequoia Capital, Accel Partners.

1.1.2 Investors

By nature, PE investments require huge amount of money, as they acquire significant minority or majority share of equity in the target company. In our sample, the median PEF contains \$500mm with the smallest and largest values of \$10mm and \$24bn respectively. Nevertheless, the complexity and long-term investment horizon does not enable many retail investors to participate in this asset class. For this reason, vast majority of PE investors, so called Limited Partners (“LPs”), are institutional investors and accredited individuals.

Among institutional investors belong companies which take care of large amounts of money of third-party entities. Therefore, the most usual institutional investors are banks, pension funds, fund-of-funds, insurance companies, public sector Sovereign Wealth Funds and asset managers. The second group of common PE investors is called accredited individuals. It refers to families and individuals whose investing approach is sophisticated with some level of knowledge and experience. In reality, the level of knowledge of these investors is hard to verify and so this label mainly refers to the families and individuals with high-net-worth, as it is expected that their investing knowledge fulfils at least the minimum standards.

As we mentioned previously, the last group of investors, which has very limited access to PE investments, is called retail investors. There are several fundamental reasons why retail investors usually do not participate in the PE investments asset class. Mainly, it is the extremely high illiquidity of the investment. The PEF are

formed for a minimum of 10 years life, but usually last even longer. During this period, investors who committed the capital to the fund can't withdraw their commitments and must fulfil all the capital calls from the fund. Although there exists one option how to divest, it is highly time demanding as well as expensive. Furthermore, it often indicates some troubles, which is not convenient for the selling price. These divestments are called Secondaries and we can find PEF with strategy focus purely on these events. Another problem is the transparency of PEF investments. The PE industry has a seriously low disclosure requirements about any kind of information, including the relationship between investors and PEF management – LP and GP relationship. Moreover, there is no oversight over the PEF management from the investors side. The reason for this comes from the structure of PE firms, funds and investors which provides PEF with favourable tax duties. We will cover more of this later in this work. Thus, the LPs could be poorly informed about the funds progress and must put a significant trust into the PEF management team. Again, this low information protection requires deep understanding of the PE industry. On the other hand, GPs also would not prefer to have so diluted investors base in the fund. Even though PEF disclose few information, it is much easier to retain confidentiality in low numbers than in high. And although there is no oversight over the PEF management, GPs still sometimes need an approval for undertaking specific actions from the PEF investors. Another reason for excluding retail investors from the process, but this time more practical, are the huge marketing expenses, which would be necessary to incur when attracting enough retail investors who contribute with small amounts of \$. In some countries, there is a legal requirement for a minimal amount of \$ to invest in this particular type of investment. In the Czech Republic, a new law requires a minimal investment of \$50 000.

The limited transparency and illiquidity of the investments implies that the investors are less protected than in the capital markets. They must accept this risk and understand the PE industry obstacles and moods if they want to participate in it. All these reasons are unfavourable for retail investors who account for a negligible number of in the entire industry then.

Let's now look at the data breakdown of the PE fundraising. Mravec (2012) provides breakdown of commitments to PEFs by type of investor in Europe. As the

main contributors he listed pension funds, banks, fund-of-funds and insurance companies, which through years 2007-09 constantly add up to 75% of all commitments. However, we can mention that between years 2007 and 2008, there is a slump in the capital markets contribution from 12% to only 1%. In general, this drop was caused mainly by the crash of capital markets and the start of the Mortgage crisis in 2007. When comparing Mravec (2012) figures with the current trend in fundraising from EVCA Private Equity report (2017), we can mention that the decomposition has changed slightly. The main contributors, pension funds, followed by fund-of-funds, keep their places on top of the scheme. However, the significance of insurance companies and banks dropped drastically, while being offset by high-net-worth families and individuals who have doubled their contribution share. Other contributors more or less stay at the 2009 levels.

1.1.3 Investment strategies

Let's now focus our attention to the PEF investment strategies. As we mentioned in this work previously, funds have various criteria in what they are allowed to invest. These criteria could be restrictions on the industry, company's life stage, geography, amount of \$ to invest and type of the deal. It is usual that funds define all these criteria prior to the fundraising, so that investors can evaluate the potential risk and return of the fund. Once the fund reaches first-closing stage, it must stick to these criteria adamantly with little flexibility provided by investors approval. We will now discuss the most pronounced strategies and their common features in more detail.

- **Venture Capital**

First strategy we will focus on is Venture Capital. It is common in academic and professional literature that the term VC is used interchangeably with Private Equity and Leveraged Buyout. Nevertheless, we will stick to the European understanding and so VC will refer to the PE strategy, focused on investments into start-ups, companies in an early life stage operating in technology, internet, digital environment and healthcare.

Despite of this definition, VC funds can still differ in their investment focus, since the early young stage has many phases ranging from Seed up to Series F raising. Size of the fund and its investments depends on its investment focus, as earlier phases require smaller capital injections. In general, VC funds are much smaller by amount of \$ than another PEF.

Unlike LBO, VC investments do not intend to acquire a majority stake in a start-up, but rather a minority stake of 5-20%. This is logical, as a successful start-up requires multiple fundraising rounds from many investors and a bigger stake would limit the fundraising potential of the company as well as the goal of any VC investor. Moreover, VC investor does not only provide the capital, but also the business knowledge to the founders. Finally, VC plays a crucial role in a technology development ecosystem and belongs to the riskier strategies in PE industry. As the fail rate of investments is extremely high, one VC fund conducts usually two dozen of investments, expecting that one or two of them would return the entire fund. Because of this, VC investments are the most popular deal type in PE industry by numbers. According to the EVCA Private Equity report (2017), VC investments represent 53.4% of deals conducted but with a value of only 8.9% amount of \$ invested.

- **Leveraged Buyout**

Probably the most pronounced PE strategy is known as Leveraged Buyouts. LBO funds focus on mature companies with predictable cash flows, operating in stable industries with low capital intensity requirements. The LBO funds intend to acquire a controlling share in the target company, often 100% share, in order to conduct their improvements. The logic is therefore to buy as much equity as possible with a minimum of own resources. The strategy works with the leverage effect in order to boost the returns from the investment. Leverage effect means using huge portion of third-party debt to purchase the target assets or equity. The debt is then repaid from cash flows generated by the purchased assets.

An LBO funds goal is then to maximize the selling price of equity after their investment horizon, usually 3-7 years, when they will be forced to sell the company anyway. There are several ways, how LBO funds can boost the value of a company,

either through operational efficiency, financial engineering or market timing. We will discuss this in more detail later in this work. Apart from additional resources, they can also provide industry knowledge as these funds always cooperate with experienced management teams.

The main risk of this strategy is the bankruptcy risk, which results from the enormous debt portion in the capital structure of the target company. During normal times, the fail rate of investments is not as high as VC, but during financial turmoil the strategy becomes much riskier. Despite of this risk, LBO is the most popular PE strategy by the amount of \$ invested. According to the EVCA Private Equity report (2017), LBO investments represent minority share of 15.9% of deals conducted, however, they dominate the market with 71.4% amount of \$ invested. Also, in our data sample, this is the most plentiful PE strategy.

- Growth Equity and Mezzanine Debt

The funds investing into Growth Equity are specialized in expansion strategies for stable companies. Their goal is to provide capital in exchange for minor equity stake or mezzanine debt with equity kicker and benefit on the appreciation of it. The target companies for this type of deals often has a huge expansion potential but lack the resources to conduct it. The investments themselves are not as big as the LBO's, as they receive only minor stakes in the companies. In this case, the risk is represented by the failure of expansion, and depreciation of the equity stake in the target. According to the EVCA Private Equity report (2017), growth equity is the second most famous strategy by the number of deals with 28.5% as well as the second most famous strategy by the amount of \$ invested with 16.1%.

- Distressed Debt

This PE strategy specializes in companies with financial difficulties. As the equity in such company could be worthless in that time, Distressed Debt PE funds often prefer buying the debt obligations which they can exchange then for a significant equity share. Funds intend to acquire at least a controlling share in the company, so they can conduct their restructuring business plan. The return for the fund is then determined by the change in equity valuation.

- Real Estate

As the name indicates, PE Real Estate strategy focuses purely on Real Estate investments ranging from industry and office properties to raw land. This strategy has some similar features with an LBO in the way that these investments use a significant portion of debt, 50-70%. Nevertheless, there are still some differences in the riskiness and rewards of investments. The most conservative funds invest into buildings with no or little further investments needs, but the aggressive funds invest into buildings with a potential of reconstruction.

- Fund-of-Funds

The next strategy which we will cover in this work is called fund of funds. It is not a pure investment strategy, but rather serve as an intermediary for risk diversification in PE industry. The FoF has similar investing criteria like a common PEF but its focus is not on specific companies but on specific funds with the same or dissimilar PE strategies. Thanks to the lower exposure to idiosyncratic risk factors represented by each fund, the overall risk of this strategy is lower, but so is the return. Therefore, this strategy is convenient for conservative investors, who would like to participate in this asset class. Its popularity is unquestionable when it constantly holds a second place for a decade in the PE investors categorization.

- Secondaries

As we mentioned earlier in this work, Secondaries funds conduct a PEF strategy focused on buying up the commitments of third-party to another PEF. The divestment can be caused by liquidity need of the initial investor or by bad expectations about the future. In general, secondaries are perceived negatively throughout market and the funds usually negotiate discount for the investment, as this is the only way that a third-party can dispose its commitment. The returns can then be lowered, because a part of the fund could be returned prior to the transfer of sold share. Negotiation therefore plays a crucial role in the final return of the fund.

1.2 History

1.2.1 Inception and early development

While describing the PE strategies, we could mention that there are 2 main ones, particularly VC and LBO, and the rest of strategies are offsets or combinations of these. Surprisingly, these 2 branches of PE industry are based on 2 different notions.

The first development branch is the VC. Prior to the WWII, the small businesses with new ideas were financed mainly by wealthy individuals and families. Nevertheless, after the WWII with an upswing of new technologies and ideas, there comes a requirement for further financing options through institutional investors. Gompers and Lerner (1999) mention the American Research and Development Corporation („ARD“), established in 1946, as a first VC fund. However, institutional investors were sharply reluctant to similar investment vehicles, and for another 2 decades VC funds did not become quite popular.

The second development branch is the LBO. According to Jensen (1989), after the WWII, big corporations were managed ineffectively and a new phenomenon, financial engineering, emerged, which was able to benefit from these inefficiencies. It started with mergers and acquisitions during 1960s, followed by the hostile tender offers in 1970s and LBO's in 1980s.

The rise of LBO comes at the same time as the rise of VC investments. There was a clear reason for this progress, since both investment strategies use mostly the limited partnership as a legal structure, which was made more favourable after the 1978 tax reform and 1979 pension bill reinterpretation.

During the 1980s there was a true hike in both industries, when capital committed to VC increases more than ten times, while capital committed to LBO reaches \$60bn peak in 1988, representing sixtyfold of the 1980 amount. Such growth indicated some troubles to come and later in 1989 the LBO bubble busted due to a high-yield bond market crash. The industry shrunk by 93% and stayed deadened for another decade. In the meantime, VC industry thrived during the 1990s, reaching its maximum of \$75bn in 2000, prior to the burst of the dotcom bubble. Afterwards,

both industries experienced a new boom era which ended up in the financial turmoil of the Mortgage crisis in 2008.

1.2.2 Current situation and role in the financial system

While using biological terminology, PE firms are predators who operate in both ends of the market and make it more efficient. Their first rise in the 1980s was caused by inefficiencies in the financial market such as poor management decisions resulting from little punishment and diluted shareholders structure with huge agency problems. Jensen (1989) even believed that PE model of concentrated ownership of different businesses will replace the old ownership model with diluted ownership of only 1 business. Even though this has not happened, this ownership model is called „Kereitsu“ and is widely-used in Japan. The poor management decisions were not strictly punished prior the PE industry emerge, but this has changed with the rise of acquisition activities and PE industry. Nowadays, weak financial performance leads to decrease in market value, making company's equity cheaper and potential target for a hostile takeover. Nevertheless, PE firms push the level of inefficiency even upward, as they are using extreme capital structure with a huge portion of debt. Thus, corporate companies truly need to choose wise investment decisions as well as maintain optimal capital structure, otherwise they could become an interesting target for the PE firms. One can argue that due to this extreme pressure on maintaining optimal capital structure, PE firms endorse the fragility of financial system. However, Bernstein, Lerner, Mezzanotti (2017) found that PE backed firms relatively increased their investments during the financial turmoil and overall performed better than their peers. On the other side of the market, VC funds finance high risk companies, which would not be able to obtain financing otherwise. Therefore, in general PE firms can handle much higher risk in their activities than any other entity could without losing its reliability. They appear to be a necessary part of the financial markets.

While discussing the significance of PE firms in the financial system, let's focus on the data. In EVCA Private Equity report (2017) we find that the PE investments represent 0.45% of European GDP, ranging from 2% of Luxembourg GDP to 0% in Greece. Firstly, we can mention that the PE share of countries GDP is much higher

in western developed economies than in those developing. These numbers are not as high as we could expect, and in comparison, to other financial sectors such as pensions funds or even mutual funds are relatively low. But before making a misleading conclusion, we should take into account 2 things: The PE industry operates in a high risk – high reward business, so the capital must be dimensionally lower than some conservative pension funds sector. The second thing is the PE ownership model. The PE investments capture only the acquisition prices of targets, but it does not reflect the controlling effect which PE firm has on its portfolio companies. Since it has a power to appoint its own management there, we can conclude that the PE firms' role is underestimated by that number and their influence is particularly higher.

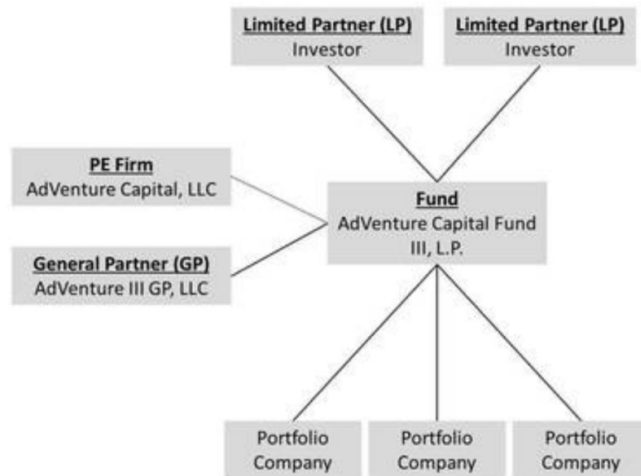
1.3 Legal structure of limited partnerships

1.3.1 Structure of funds and entities identification

As investing in PE industry is a complex procedure, so is the common legal structure of PE firms and funds. The typical legal form of PE structure is organized as a limited partnership. This form became popular during the first boom of PE industry in 80s in both main strategies, VC and LBO and still stays popular up to today. As we mentioned in the history section, the boom was caused by a change in tax bill in 1978, which has made the PEF more convenient for investing. The figure 1 illustrates the scheme of limited partnership PE structure.

Figure 1: Limited partnership structure

Below is an illustration of the fund with the PE Firm shown.



Source: www.allenlatta.com

Let's now focus first on the entities included in the structure, their roles, relationships and related cash flows. The limited partnership basically refers to the relationship between GP and LP. We touched the terms GP and LP previously in the work and will do so many times again, because they are the most important entities here [those are the entities where the magic happens]. Due to their importance, we will cover them separately in more detail later in this work. For simplicity let's say that GP is the entity which manages and is responsible for the performance of the PEF and LP is the investor who commits capital to the fund.

While looking at other entities, we can mention that there are two entities on the managing side of the fund. Apart from GP, there is also a PE firm. The PE firm is the founding entity of the entire PE structure and the one representing the name and brand of it. So, it is this entity whose name is the most pronounced such as The Blackstone Group, KKR and Carlyle Group. It also employs most of the investment professionals who provide advisory services to its funds and cover the basic necessities for the PE structure such as renting a building, etc. Its remuneration then comes from the fee the fund pays for those advisory services which is obviously related to the party's transactions.

Another entity in the structure is the PEF which is usually established for a fixed lifetime and serves a separate entity that collects the capital commitments and acquires the target companies. Under some jurisdictions, the PEF entity must be established simultaneously with the GP entity, since the fund cannot manage itself by a law, but it has to obey the superior GP entity. The GP then provides advisory and management services to the fund for which it receives a fee similarly as the PE firm. While the fund is also on the receiving side, it collects the capital from LP when needed and holds the investments on its balance sheet during the fund's life. In contrast with the corporate structure where investors provide a capital in exchange for right to elect the board of directors, here the LP are restricted from taking any control over the GP, as long as they intend to stay a LP.

The last entities in the structure are the portfolio companies or targets. When such company is acquired by a fund and the deal is successful, the fund records a cash outflow, while obtaining a debt or equity of the target company in exchange. These assets are recorded on the fund's balance sheet and stay there until the fund exits them. Nevertheless, the effective controller of the target's equity or debt is the GP, since the fund often cannot manage itself. When the fund enters harvesting stage and sells its investments, it receives the cash from them. This cash is then distributed to the LP as soon as possible and the cycle is closed.

So, we can ask, what are the pros of this complicated structure, where are so many related party's transactions? The answer is taxes and control. The main reasoning why PEF are organized as limited partnerships is that there is only 1 tax level on the investors' profit, compared to the corporate model when the profit is taxed on 2 levels, the corporate profit tax and the tax from dividends. Such effect has a huge impact on the final return of the capital committed for LP. The second thing is the limited liability of LP. As limited partners, LP are responsible only to the level of their committed capital, whereas GP is responsible for all liabilities resulting from the fund's actions. For a LP there are many pros why they prefer this structure, however, there are conditions for being a LP as well. LP provide capital to the fund but are restricted to have any control or oversight over the management of the fund. Also, GP prefer this structure for obvious reasons, since their funds are

more competitive while being taxed only once on profit level, and their control over the raised cash is poorly limited.

1.3.2 General Partners

In the previous section, we described the PE structure and its supplementary entities. Now, we will discuss the main one in more detail.

As an action controller, GP is effectively the main entity in the structure. It often consists of 2-10 partners who set the fund investment criteria, persuade investors to commit their capital into the new fund and afterwards make the investment decision for the fund and manage the fund's cash flows. This management team of the fund is usually under the tough diligence, since their experience is the only asset the fund has while raising capital. Management team should also commit some of its own capital, at least 1%, to the fund as a signal that it believes in its success and mitigate the agency costs.

As we mentioned in the previous section, the GP has unlimited responsibility for the liabilities and obligations resulting from the fund's actions. However, this is not convenient for the partners who represent the GP entity and so GP are established as a limited liability companies, which solves this danger.

Since it is the GP who makes the investment decisions and cash management, he/she is responsible for the performance of the fund. Nevertheless, GP has a very little interim reporting duty due to confidentiality of some deals during the life cycle of the fund. LP are often therefore forced to believe the information from the GP which can be distorted in many ways and is not provided to any third party. Brown, Gredil and Kaplan (2017) conducted a research on the manipulation of PEF reporting biases, but surprisingly found little evidence for reporting manipulation. But even GP shouldn't know how their investments perform as they hold the private companies whose value can be determined only after the exit of these. The true nature of all investments conducted is recognized after the fund closure, 10-15 years after the first raising.

Based on the performance, we could expect the remuneration of GP to take place. The entire concept of remuneration solves the agency problems, resulting from management of third party's money. Remind that all fees are subject to initial negotiation, but we will describe the industry standards. There are 2 sources of remuneration for GP. First is the management over money, from which it takes the fixed management fee. This fee ranges from 1-2% yearly from the total committed capital and initially ensures that the GP can cover its expenses during the fund's life. This should not be the main source of money for GP. The second is the profit participation, called carried interest. Here, the GP participates on the profit from an investment exited with a share ranging from 20-30%. In practice, there are multiple features included in the carried interest remuneration such as preferred hurdle rate – minimum rate of return that GP must provide to LP before it can participate on the profit; whole fund vs deal by deal distribution – where the GP receives its profit share after the fund's closure vs after each investment exit. All these fees and profit distributions are included in the final evaluation of the PEF performance and can be a significant differentiator.

The motivation of GP is unsurprisingly the remuneration resulting from managing and investing third party's money. But it is noteworthy that the expected appreciation of investments is much higher thanks to the illiquidity and associated risk, as well as the remuneration for the GP, which provides only 1% of the committed capital, but can participate with 20% on the final profit. Another reason is the structure of PE-LBO investments which uses an enormous portion of debt in order to conduct its investments and so further leverages its returns. The point therefore is that with a small amount of own capital, GPs can participate on a huge profit.

1.3.3 Limited Partners

Let's discuss the second important entity, LP. We identified the LP in the section 1.1.2., describing them as a provider of capital to the PEF. There is nothing much to say about their role in the PE industry while knowing this, however, we can dig into more detail, how they determine the funds to invest in and how they assess the fund performance, laying the basis for our own analysis.

The GP role is to raise capital, LP role is to provide it. The criteria of the fund are set by the GP, and it is also his activity to present its fund to potential investors, LP. While deciding where to invest, LP considers the criteria of the fund and the experiences of GP partners. This approach is highly reasonable, since many research papers such as Anson (2007), Kaplan and Schoar (2005), Phallipou and Gottschald (2014) found high persistence in the PEF performance over time, potentially explainable by the experiences of fund's managers. The risk and return then depends on these two factors and on the impact of macroeconomic situation on the fund.

When LP invest into the fund, it should then wait for a capital calls, which is an event, when GP ask for a part of committed capital and LP must provide it quickly. More on the timing of cash flows in the section 2.5. Second activity of LP is to analyse the performance of the fund. However, this is not always easy, since LP's have little oversight over the GP activities and rely on the information provided by GP about the investments and its performance. LP's measure the performance based on cash flows provided and obtained from the fund. The problem occurs when a LP provides capital to the fund and the respective investment is not realized yet. In that case, LP's must rely on the reporting from GP's about the Net Asset Value ("NAV") of the investment and therefore measures the performance based on unrealized cash flows. Since 2007 a new law, which requires that GP must report the NAV at fair value in the interim results, comes into play. This helps LP's to track the fund's performance more precisely. Nevertheless, the fair value excludes many factors which influence the final value as well as the fact that the future situation will look differently.

1.3.4 Identification of the point of view of our analysis

It would be useful to take a step back at this point and recall, why it is essential for us to understand the PE structure and the roles of its entities.

The aim of this work is to analyse the performance of PE funds and the impact of macroeconomic conditions on it. We also try to provide some answers to LPs in

their analysis of potential future performance of the funds with respect to general macroeconomic market conditions and significant macroeconomic events e.g. recessions. Nevertheless, because of very limited data availability in the PE industry and potential reporting biases, we should understand the motivation of reporting sides, so that we can consider it, while working with our dataset and making an inference.

We took as a standpoint the LP point of view and our analysis works with the data provided by LP. The returns in our dataset therefore represent the cash flows outlays and inflows between the PEF and LP.

1.4 Value creation

1.4.1 Areas of value creation in portfolio companies

In a PE structure, there are multiple areas of value creation, depending on the standpoint of the observers and their interest in particular entity. We can then assess the value creation at GP's level, LP's level and in the portfolio companies themselves.

For the GP and LP, the value creation process is based on the simple notion consisting of valuation of present and future cash flows. GP's invest their money and time into the fund to eventually receive a remuneration in the form of fees and profit participation. LP's contribute capital to the fund initially and then receive all exited investments cash flows except for the GP remuneration. There are various techniques, how GP's and LP's can obtain the performance from cash flow data and we will cover them in the chapter 4. But this value creation is only the result of the main area of our interest here, which is the value creation in portfolio companies.

Let's refer to Vinten (2008), the main areas of value creation are the corporate governance, operational efficiency and timing of investments. Also, Ivashina and Kovner (2010) suggest that the financial engineering creates value in some deals. We focus now on these listed areas in more detail.

- Corporate Governance

The first area is the ownership of the company. In a common public company, the ownership base is highly dispersed with many small institutional and retail investors. The management of the company is therefore very powerful with modest oversight and directly determines the company's strategy. On the contrary, after the PE investments are conducted, the company is solely owned by the PEF's, which serve as active management observers and often influence the strategy of the company as well. Also, the decision-making process is much more flexible with the concentrated ownership, but the main advantage is the mitigation of agency costs by a managerial stock option plan. The options are illiquid, because the company is private in that time, so managers can't convert them into money anytime they want. This solves the short-term window dressing events in the portfolio company. Management is also under more pressure to stick to the predetermined strategy, as the debt burden laying on the company and the bankruptcy risk is higher.

The portfolio company can also benefit from the PEF ownership in the case that it needs to implement risky actions such as restructuring, aggressive expansion or a capital increase, which would not be appreciated by the financial market.

Overall, the corporate governance area does not create value directly, but provides an effective tool, how to do so. According to Jensen (1989), the PE ownership model should be superior to the traditional public corporate one. Nevertheless, Kaplan and Stromberg (2008) labelled this hypothesis as premature regarding the latter development.

- Operational Efficiency

First, we should recall how PEF's make profit on their investments. In a simplified acquisition, there are two cash flows; initial outlay for which PEF's buy the company – usually determined by a multiple of company's EBITDA; capital inflow from the company's sale again based on a multiple of EBITDA. PEF are therefore incentivized to improve operating indicators of the company as much as it can during the holding period. This is conducted through organic and inorganic strategies, including production efficiency, staff reduction and other cost cutting strategies and increasing market share conducted through M&A activities. These

strategies are prepared and implemented by GP's industry experts and the management of the portfolio company. According to Achya, Gottschalg, Haha, Kehoe (2011), success of the operational performance depends on the match between GP's expert background and the nature of the implemented strategy. While experts with financial background perform better in inorganic strategies, former consultants and industry managers do better work with organic strategies.

We can demonstrate on a simple acquisition example the value creation process:

Figure 2: Operational efficiency

<i>in \$mm</i>	Purchase	Exit
EBITDA	500	750
EBITDA multiple	5,0x	5,0x
Company price	2 500	3 750
PEF profit		1 250

Source: Author's computations

- Financial Leverage

The most obvious element in LBO acquisitions, is the enormous presence of debt, which serves as a leverage for boosting the returns to the PEF. We describe below the process of deleveraging, which is a source of value in LBO. In this deal type the company benefits from the combined effects of concentrated ownership and debt capacity. With a strict business plan and efficient management, the company can benefit from additional debt and further boost its returns without experiencing its stock depreciation from increased riskiness.

Whereas in LBO, the financial leverage provides modest advantage to the company itself, in other types of deals the situation is different. As PE firm is a frequent borrower with trustworthy reputation, lenders often provide to its portfolio companies favourable loans with cheaper financing to its peers.

We can demonstrate on a simple acquisition example the value creation process:

Figure 3: Deleverage value creation

<i>in \$mm</i>	Purchase	Exit
EBITDA	500	500
EBITDA multiple	5,0x	5,0x
Debt to Assets	75,00%	25,00%
Equity	625	1 875
Company price	2 500	2 500
PEF profit		1 250

Source: Author's computations

- Timing of investments and bargaining power of GP

Undoubtedly, M&A activities are highly influenced by stock and debt market cycles. As suggested by Kaplan and Stromberg (2008), the PE firms can benefit from the respective mispricing in stock and debt market and potentially create value by correctly evaluating the future performance in both markets. Moreover, the purchase and sale of the companies depends on the negotiation skills and bargaining power of each party involved. It is probable that a PE firm, who conducts several transactions per year, is more skilful here than the selling counterparty.

We can demonstrate on a simple acquisition example the value creation process:

Figure 4: Timing of investments

<i>in \$mm</i>	Purchase	Exit
EBITDA	500	500
EBITDA multiple	5,0x	8,0x
Company price	2 500	4 000
PEF profit		1 500

Source: Author's computations

1.4.2 How do we measure the value creation?

Using our examples in the previous section, we described the simplified PE investment process with an initial outlay and final exit. The value creation is then measured as the difference between purchase price outlay and exit price inflow. There are several ways how the investment exit can be realized, none of them serve exclusively for one strategy only. The portfolio company can be divested through either an Initial Public Offering (“IPO”), when first shares are offered to the public market, or strategic/financial acquisition, when the beneficiary ownership is transferred to an industry competitor or another PE firm. Although the IPO may seem as the most prestigious option for exit, it is not always preferred and convenient. According to the EVCA (2017), the IPO makes up only 14% of exits by the number of companies. The cause is the expensive process of IPO, as well as the requirement of good reason for going public. The last significant exit option is the write-off of the investment, which is the most common exit in the VC industry, with as much as 18% of portfolio companies ending with it.

1.5 Life cycle of funds and J-curve description

1.5.1 4 life stages of funds

The PEF’s are characterized as investment vehicles with illiquid investments and finite lifetime. The underlying logic for their finite life comes from the mentioned illiquidity of LP’s stakes, so that LP’s can capitalize once on their contributed capital. Also, for GP’s the finite life brings advantages, because it allows to plan the fund’s activities. The activities depend on the life stage, in which the fund is currently located. We use here the categorization of fund’s life stages, that is in compliance with our dataset.

- **Fundraising**

Once the fund’s managers team decides to raise a new fund, it must create a fund’s strategy, investment criteria and legal conditions. Afterwards, it approaches potential investors, LP’s, to persuade them to contribute capital into their new fund. This preparatory phase is expensive and time consuming and last from several months to years, while all expenses are incurred by the managers in that time.

Once managers obtain enough capital, they manage the so called “first closing”, which is a request for LP’s to send a first portion of their committed capital, and after which the fund is officially formed. After the first closing, the fund begins to manage its first investments and starts evaluating the potential targets, while the fund managers are still performing their fundraising activities, in order to boost the fund size. Also, GP’s start receiving the management fee for its services. A fund moves to the next category after the list of LP is complete, and fund managers finish their promoting activities. In our dataset, the funds are classified as Fundraising after they made the first closing and their performance indicator started ticking, and this period lasts on average 3 years.

- Investing

Once the fund moves from the fundraising stage to the investing; the most crucial stage begins. During this period, the fund should employ most of its capital, and evaluate hundreds or thousands of potential targets and pick the cherries among them. After the end of investing stage, the fund can be restricted from making additional acquisitions, and so the fund managers should be truly persuaded about the quality of the targets. In the case that GP receives a floating management fee, in this stage the fee will be the highest as the work pace is truly hectic. During this stage, the capital calls are the most frequent. According to our dataset, the investing stage lasts on average 6 years, and funds are classified as investing if they are allowed to employ their capital in the future.

- Harvesting

The fund moves to the harvesting stage after it officially declares end of its investment activities or after it does not conduct any investment for a significant time period. Even though funds cannot invest into new companies in this stage, they are allowed to invest into their portfolio companies to support their growth and maintain their operating activities. When the time comes, funds divest their investments and distribute the inflows to LP’s. Even though most of the committed capital is called during the first two stages, Ljungvist and Richardson (2003) state that around 90% is called on average in the first 6 years, it is not uncommon that fund make a capital call even in this stage.

This stage tends to be the longest one as it lasts until all the investments are divested. The original fund's lifetime is usually set to be 10 years. GP's have an option to prolong it for a few years, if they predict that some portfolio companies would rise in that time rapidly. The funds thus last longer on average and so does the harvesting stage. In our dataset, the average active harvesting fund lasts for 8 years after the investing stage is over.

- Liquidated

The fund is considered liquidated, after it divests all its investment, distributes all cash flows to LP's and is formally terminated. Only after the last distribution is made, the performance indicator stops ticking and it becomes possible to evaluate the fund's final performance.

1.5.2 J-curve and interim performance

From the previous section it is obvious that the investment pace and cash flow distribution differs a lot throughout the fund's lifetime, with huge cash outflows at the beginning and significant cash inflows in the end. We further mentioned, that the final performance can be evaluated only after the fund is fully divested, which can take more than a decade from the first closing. Nevertheless, GP's as well as LP's require to know, how the fund performs up to date. GP's can use this information in its new fundraising materials, while LP's use those materials to decide, whether to invest in another GP's fund. The fund therefore provides interim reporting of its investments, which should imply the pattern for a final performance.

Unfortunately, the interim performance is highly volatile across funds, and is subject to reporting bias and to the phenomenon called J-curve pattern. While the reporting bias emerges in the accounting treatment of existing portfolio companies, the J-curve pattern is present in the entire industry with some slight variations in different PE strategies. It is caused by the characteristics of PE life with different stages and actions conducted in particular time. The name J-curve comes from the pattern, which interim results metrics such as Net IRR and TVPI follow. In figure

x, we illustrate the ideal pattern which resembles the flattened letter J. The pattern is similar for both metrics, so we provide only the Net IRR chart.

In the early years, the performance of the fund stays in the negative values and reaches the bottom approximately in the middle of investing stage. Afterwards, the performance rises steeply in the next few years, while in the end of the fund's life, there is a small increase. The early negative performance results from the one-way flow of cash from LP to the fund. The fund incurs expenses such as management fees, legal and travelling expenses from fund's forming, and meanwhile conduct first investments. However, in practice, these investments need time to grow up and their value either stays the same, especially in VC, where the start-up is valued based on the last financing round or shrink in a case that mature company starts restructuring or in case of expensive expansion strategy. With no appreciation and realized expenses, the fund has a negative performance in the early years. However, when the time passes and the fund starts divesting its mature investments, the performance increases rapidly.

The performance differs among PE strategies, among which J-curve best describes the VC industry performance, as the VC write-offs are realized earlier than the top performers. In general, the J-curve pattern will not hold for every PEF, but it provides a solid lead indicator for the future performance of the fund.

2. Financial Market overview

2.1 Mortgage crisis

In 2007, the Mortgage crisis has officially started, the cause of the biggest economic downturn since the Great Depression in 1930s. The environment for the crisis, however, originated a decade earlier. Since the country with the biggest impact on this crisis is the USA, we will focus on its development for a while now. In 1977, the US Congress enacted a Community Reinvestment Act, which in effect supported lenders to provide more loans, especially mortgages to low-income individuals. This policy had a goal to make the American dream affordable for more American families. Further in 1999, president Clinton has revised the 1933 Glass-Steagall Act (Mah-Hui Lim 2008), which prevented banks to operate in commercial and investment banking services simultaneously, by allowing them to do so. This action puts banks into a severe conflict of interest, as they could originate the lending products, package them as a collateral into a Collateralized Debt Obligation (“CDO”) and trade them on the secondary market. This has changed the traditional model of lending, where the bank originates a loan and then holds it in its balance sheet, while earning interest in return and taking the risk of borrower’s default as opposed to the borrower’s house as a collateral. Under the new model, the bank sells the security and is therefore transferring the risk of default to the investor.

However, the investors, mainly hedge funds, banks and pension funds, were under severe pressure for making profit that they did not fully understand the riskiness of these securities and bought them without proper diligence. To understand their behaviour, we should remind the situation they were in. In 2001, the dotcom bubble burst, and the stock market crashed. Thus, for the following years, Federal Reserve (“Fed”) lowered the interest rates to negligible levels, in order to stimulate the economic revival. Such low interest rates pushed Debt Capital market’s returns downward and investors were seeking how to earn more on this less risky asset class. This behaviour created an enormous demand for relatively safe CDO securities, which banks were willing to cover.

Thanks to the low interest rates in the early 2000s, many people took a mortgage to buy a house in that time. The monthly instalments were low and even low-income people could obtain a mortgage, because banks seriously relaxed their credit scoring, and even provided products with lower instalments but no principal redeem. Banks did it to meet the demand from investors for CDO's, as they serve as an intermediary between two demanding parties. Although banks knew that the low-income people would be in trouble to cover their instalments once the interest rates have risen, they assumed that the house could be sold for a profit or its higher value could serve for a refinancing option to the borrower.

This assumption originated in the historical trend in the housing market prices, which constantly rose since 1990. Due to the affordable financing and general appetite for own housing, the uptrend even strengthened after 2001. Overall, this means that when bankers provided a mortgage with a house as a collateral, and the house price should have risen in the next years, they were willing to accept more risk than commonly, notoriously in the circumstances when they aim to aggregate mortgages and trade with them.

CDO's were aggregated securities, which included not only mortgages, but also other debt type products of various quality. They were so complex that investors often weren't capable to value them and rely on the agency's rating. However, the rating agencies turned out to be in the conflict of interest as well, and their rating was positively biased. They were under pressure, as their remuneration comes from the banks' contracts, and bankers wouldn't be willing to spend money in exchange for bad rating of their securities. On top of that all, investors, especially hedge funds, preferred to buy CDO's together with a Credit Default Swap ("CDS"), an insurance product which should have covered the CDO in a case of default. From this point of view, CDO's were safe investments with diversified risk, properties as a collateral, rating from renowned agency and insurance against default. The investor's demand was so high that they spread around the entire world in a few years, highly outnumbering any expectations.

Meanwhile, Fed reacted to the rise at the housing market by increasing interest rates from 1.00% in 2003 to 5.25% in 2006. This significantly increased instalments

for people with floating interest rate on mortgage, and these people were mainly low-income households. In the meantime, the US yield curve inverted suggesting that investors expected the financial turmoil in 2 years. And in 2006, as the market conditions were less favourable, the US housing market declined for the first time since 1990. In the subsequent months, the demand for housing dropped significantly, and the prices of houses followed this trend. Low-income households needed to refinance their mortgages, but banks, in order not to hold more liabilities than assets, were forced to strictly tighten their credit requirements and rather foreclosed the borrower's property. With the lack of credit provided by banks, demand for housing became even weaker and the housing market started to collapse. It lost almost 30% of its value between years 2006-2009, when in the last year foreclosures reached its maximum of almost 3,000,000 per single year.

2.2 Liquidity crisis

Heading In 2007, the Mortgage crisis was just at its beginning. The housing market constantly dropped due to the poor credit conditions and excess supply of houses from developers and bank's foreclosures, which led to even more people's defaults. While this trend continued, banks and other institutional investors started to incur considerable losses from their mortgage assets and CDO securities, despite the high-quality credit agencies' rating. Moreover, no one knew, how much the institutions are actually exposed to the worthless mortgage assets. This fact caused that trading partners, bankers, lost the confidence in each other, London Inter-bank Offered Rate ("LIBOR") skyrocketed, and the inter-bank market froze in the mid-2007. The frozen inter-bank market couldn't allocate the capital as demanded and banks became reluctant to provide any capital to the economy, which even worsened the situation. The lack of capital prevents companies from expansion, few new jobs were created, and the real economy fell into the recession. Thus, the Mortgage crisis gave rise to the Liquidity crisis, which eventually led to the 50%+ depreciation at the global stock markets, the biggest since the 1930s Great Depression.

Fed attempted to stabilize the inter-bank market by lowering the interest rates, which would usually lower the LIBOR as well. Unfortunately, banks were

so afraid of receiving worthless mortgage assets as collaterals in the inter-bank market that the LIBOR receded from Fed's interest rate level, widening the gap to the record 4% after the Lehman Brothers bankruptcy in September 2008, and the tighten credit conditions endured. In 2008, the Liquidity crisis intensified with financial difficulties of several large financial institutions. The interest rate tool of monetary policy showed as ineffective, so Fed provided the essential liquidity to the market through other channels such as guarantee of \$30bn JPMorgan Chase acquisition of suffering Bear Stearns, buying up mortgage assets programmes, bail out of Freddie Mac, Fannie May and American Insurance Group. In September 2008, the situation with the lack of capital became critical with the collapse of Lehman Brothers. On the next day, investors withdrew over \$140bn from the money market, which serves as a short-term capital provider and essential component of every economy. Without the money market, the entire US economy would run out of cash soon and collapse. To avoid this scenario, Fed initiated the Bank bailout bill ("TARP") worth \$700bn, aiming at the liquidity rescue of systematically important banks, called "Too big to fail" and proposed it to the US Senate, which enacted it on the second attempt in October 2008. On the first attempt the bill was rejected, which resulted in the worst trading day in Dow Jones Industrial Index history in that time and the global stock market crashed.

2.3 Central banks and government policies

In September 2008, after the Lehman Brothers fall and money market withdrawn, Fed initiated a deep cooperation between monetary and fiscal policy with the goal to end the Mortgage and Liquidity crisis, restore trust in the financial industry and reach certain levels in macroeconomic indicators. The cooperation eventually led to several economic and legal programmes, where deployment aids ended the Liquidity crisis by the start of 2009 and mitigate its consequences as well as prevents the other crisis of the same type.

Among the main programmes we can include TARP, \$700bn bank bailout bill aiming at restoring the mutual trust in the financial industry, Dodd-Frank Act, Wall Street Reform enacted in 2010 imposing federal oversight authority over all financial industries as well as limiting the impact of large institutions on the entire industry –

effectively preventing companies to become “Too big to fail”. In 2009, newly elected president Obama initiated the American Recovery and Reinvestment Act, the \$787bn economic stimulus programme based on the Keynesian ideas focused on three areas: tax cuts incentives, unemployment benefits and requalification, and public sector job creation. These fiscal programmes supplemented the expansionary monetary policy that Fed was conducting since late-2007 when it had lowered interest rates to 2%. But events from September 2008 pushed interest rates to historical minimum at 0% instead of 2%. Consequently, Fed could not effectively use this tool to further stimulate the economy further and the situation with other conventional monetary policy tools wasn’t different. Thus, in November 2008, Fed announced the deployment of Quantitative Easing (“QE”), enhanced open market operations policy aiming at buying mortgage assets, bank’s debt and long-term treasury notes, thus stimulating the housing market and financial system health. Fed has finally conducted QE for 7 years during 3 - 4 phases while the interest rates have stayed at historical minimum for that time. Its goal changed with time, when first QE phase aimed at ending the Liquidity and Mortgages crisis, second QE phase tried to mitigate the consequences of it and reached healthy inflation level at 2%, third QE phase goal was to boost the economic growth.

The overall success of these policies is highly disputed as well as its ceteris paribus effect regarding the fiscal policy, but QE indisputably succeeded in keeping the interest rates low after 2008, and in buying up the dangerous mortgage assets from financial institutions. As the 2008 financial turmoil spread across the globe through the trades with CDO, the situation in many economies was similar to the American one. While facing the financial crisis, the main central banks such as Bank of Japan, Bank of England and European Central Bank, employed QE method at some stage, pushing the world’s interest rates to historical minimum levels globally.

2.4 Subsequent effects of conducted policies and current situation update

After the crisis was over in late-2009, the global policy of low interest rates continued. The Debt Capital markets’ yield was extremely low, and investors were forced to turn their attention to the stock market and alternative investments such as

PE, while seeking for a higher return. This constant pressure pushed stock valuations higher and higher, enabling the stock market to quickly recover. In 2013, most American indexes reached pre-crisis levels, with some lag followed by European ones as Eurozone experienced the Eurozone-Greece crisis in 2012. The lasting QE policy pushed valuations further above the historical maximum and this uptrend continuous even after the end of QE and rise of interest rates. Moreover, the global stock market is experiencing one of the longest upward rallies in its history, which further supports the valuation rise. Nowadays, investors are more afraid of the stock market overvaluation, even though the market experienced several big corrections, the latest in December 2018. However, none of them was big enough to stop the long-term uptrend.

Similar development as the stock market was experienced by the PE industry. While the PEF raised after the crisis, it halved its size compared to the pre-crisis years, nowadays, the contributed capital sets a \$700bn record in the industry. Nevertheless, referring to the section 2.4. where we discussed the value creation of PEF, the record fund raising would not be so convenient in these market conditions. Recall the hypothesis of Gompers and Lerner (2000) when too much money is chasing too few deals.

During the early post-crisis period, when the stock market was still depressed and interest rates were low, we would have expected that newly raised PEF would thrive in this environment. But, when PEF have too much money to deploy, they often relax investment criteria and the due diligence part as they are under severe pressure to invest which could lead to worse performance of the fund. In addition, the high valued stock market requires higher prices in all types of deals as well as higher premiums, which further depress the return of PEF. According to the Mergermarket report (2018), the M&A market today is dominated by strategic investors with 75% share. Vinten (2008) suggests that strategic M&A are more likely to take place in high valuation stock market, because strategic investors do not care so much about the timing of the deal, can pay the purchase price with its own highly valued shares and finally can justify higher premium paid because of synergies. None of these is true for PEF, which are especially jeopardized by the bad market timing, which we identified as a value creation area in section 1.4. This timing is

highly sensitive to the market moods and therefore, when a market expects a forthcoming recession in the next few years, as in today's situation, PEF must be extremely cautious in their sudden raising and investment decisions. Unfortunately, they are at the same time under enormous pressure to deploy their capital and to outperform the rising public market, which could lead to poor investment decisions and so it is extremely difficult to predict their future performance.

3. Measurements of private equity performance

3.1 Rate of return

In this chapter, we will cover the methodologies how LP's measure the PEF performance. We will look at the technical descriptions of each methodology and discuss the pros and cons of them. Afterwards, we will explain our motivation for using such methods and link them to our sample.

For the evaluation of the PEF returns, LP's use 3 technical methods. These are Multiples, Internal rate of return and Public Market Equivalent. Each of these methods is computed from the fund's cash flows and provide an absolute return, which is meaningful by itself, however, for a comparison purpose, LP's also evaluate the relative performance of the fund. This is a supplement method using the absolute return as a basis for further analysis.

We should note that all the methods are subject to the concept of J-curve described earlier in the section 1.5. and interim reporting. Therefore, we should always be cautious about the quality of information provided by each method.

Let's first cover the rate of return methods. This method is the most general one, as it is widely used not only in the PE industry, but almost everywhere in the financial sector. It is based on the concept of time value of money – net present value and the different distribution timing. We discussed in the section 1.5. that the timing of PEF cash flows varies with each fund and that the poor cash flow management can significantly influence the final PEF performance.

3.1.1 Internal rate of return

Internal rate of return (“IRR”) is a general formula for calculating the return of various cash flows. Sometimes it is called yield-to-maturity, especially in the debt market. The formula is as following:

Figure 5: IRR formula

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

Source: [Corporate finance institute](#)

To successfully compute the IRR, we need to know the distribution of cash flows over the time. The outcome is then an annual percentage appreciation [depreciation] of the cash flows. When the percentage is positive, then the investment creates value and vice versa. Although we don’t know all the distributions in the interim reporting yet, we assume that the NAV represents the last cash flow in current year.

Nevertheless, IRR has many limitations. The computation is less intuitive than the multiples for instance and so is the interpretation then. There are also mathematical conditions for the computation apart from knowing the cash flows distribution. IRR works well when we have negative cash flows at the beginning periods and positive cash flows thereafter. However, whenever this path is violated e.g. when we observe a negative cash flow in the middle period, which can be caused by a capital call in a later year, the IRR can lead to multiple solutions or no solution at all. Also, in the PE industry, when talking about the IRR, we usually mean the gross IRR of the fund.

3.1.2 Net internal rate of return

The gross IRR of the fund however reflects the cash flows received by the fund from target companies. This is more relevant information for a GP than for a LP,

since the cash flows distributed to LP's are adjusted for management fees and carried interest. From this logic, we can introduce the Net IRR formula, which reflects only the cash flows provided and received by the LP.

In our dataset, the Net IRR metric is the most frequent one and despite its pitfalls, we will conduct our analysis mainly on this metric as it reflects the reality credibly.

3.1.3 Modified internal rate of return

Although the Net IRR seems as the best option, it still has several limitations that are inconvenient. The problem is mainly with the reinvestment rate assumption. Common IRR calculation assumes that the early distributions are reinvested at the IRR rate. Obviously, this is hardly true, and the IRR thus overstates the return. Potential solution is the Modified IRR ("MIRR"), where we assume that the early distributions are reinvested at the new, usually lower rate. Then we obtain the adjusted cumulative cash flows from the investment at the end of the lifetime, and from this we can compute the true IRR – MIRR. Even though this approach would give a more precise information, there is no industry standard which reinvestment rate to use, and thus we would eventually end up in the situation, where we would have even less precise information. From this perspective the Net IRR still seems to be the best option to use.

Even though the rate of return is the most popular metric, it does not tell the whole story and in practice it is often combined with other methods.

3.2 Multiples

Heading of the Most often the IRR is complemented by the multiple's method. This method is quick and intuitive, and therefore popular among LP's. The only issue is to identify the right numerator and denominator of cash flows. Nonetheless, its ease also brings some limitations to the table. Mainly it is the fact that multiples do not reflect the time value of money and provide only the raw information about the starting and ending amount of cash flows without any context.

Prior we dig into the PE multiples themselves; we must introduce the term Paid-in-capital. Recall that in the section 1.5. we discussed the capital calls and its timing. The paid-in-capital is the sum of all capital calls up to the date of valuation.

3.2.1 Distribution to paid in capital

The first multiple is the Distribution to paid in capital (“DPI”). While referencing again to the section 1.5., we also discussed there the distribution of cash flows from the fund to LP and its timing. We know, that distributions are paid successively and differ with respect to the fund life stage with no distributions at the beginning and spikes during the harvesting period. Distribution here means the sum of all distributions up to the date of valuation over the paid in capital. In general, the bigger and earlier DPI, the happier the LP is.

This metric is most used for unfinished funds Demaria (2014) as it provides information about the current stage of its investments. Interim reporting of DPI is trustworthy as there is no estimate included, but only the repaid distributions. LP’s can thus predict the future performance of the fund based on this metric.

3.2.2 Residual value to paid in capital

The Residual value to paid in capital reflects the Net Asset Value of the fund. In other words, it is the fund’s potential. However, this uncertainty comes from the fact that NAV is an estimate of fair market value of all investments, but those are subject to change over time. RVPI is a significant metric, especially in the early life of a fund when majority of investments is on the balance sheet and distributions are low. As time progresses, RVPI shrinks over time to disappear completely at the fund’s closing.

The fair market value estimate is the power of GP in reporting duties. GP's should report at fair market value since 2007 by law, but due to the little oversight, they can slightly skew the value in their favour.

3.2.3 Money multiple

The total value to paid in capital, or the multiple of money is as intuitive as it sounds. This multiple reflects the absolute appreciation of the committed capital to the fund. Moreover, the TVPI can be decomposed to the DPI and RVPI, since the paid in capital is always either held on the fund's balance sheet and reflected in RVPI or distributed back to the LP.

While the fund progresses, TVPI often follows the J-curve, while its components differ in their interim performance. At the fund's closure, DPI equals TVPI as no remaining value is left and all distributions were paid.

Our sample contains the multiple values for some funds, unfortunately it covers only a few strategies and years, so we can't use them as an equivalent of Net IRR.

3.3 Public market equivalent

Another method for evaluating the performance is the Public Market Equivalent ("PME"). We describe this method briefly, since we do not have any data provided in our dataset for it.

This method allows to compare PEF performance, basically IRR, to the public market return. The idea is based on fund's cash flows and public market index performance. When PEF's call or distribute capital, the hypothetical portfolio at the public market follows those cash flows and buys or sells the index. The final paid in capital as well as distributions of both strategies are identical, and the difference is made by the appreciation or depreciation of the public portfolio NAV.

Although this method enables to compare two completely different strategies, it has many pitfalls. The choice of index is highly subjective. Then by strictly

following the timing of the PEF cash flows, the public strategy can suffer from bad timing in its investments. The last big thing is the related risk in each strategy, because public market portfolio is highly liquid compared to the PE investment.

3.4 Relative performance

The last method we mention is the relative performance or sometime called quartile analysis. This method uses the previously computed absolute performance and compares it with the performance of other PEF's with the same vintage year and strategy. The founding year is called Vintage year and there are some variations how to identify it. The main ideas are in the year that the fund was established or in the year the first capital call was made. It is crucial to be consistent while identifying vintage years as the quartile analysis is meaningful only for funds with the same vintage year. Afterwards, the PEF's are distinguished based on their strategies, their respective metrics are compared and quarterly ranked. The ranking terms are quartiles and sometime deciles, when talking about the top funds.

In our dataset, we have quartile metrics for almost each fund, and we are therefore able to analyse particular years deeply.

In practice, this is the most important metric while comparing funds and managers, as this indicates how the manager is able to outperform others under the same risk conditions. Moreover, the quartile metrics are simple and easy to interpret. It is much easier for a manager with top quartile fund to raise a new one than for the bottom performer.

On the other hand, the quartiles do not provide any information about the absolute performance of the fund. Hypothetically, when all managers would suffer heavy losses, there would still be top quartile performers, but in reality, the investors would be really reluctant to provide capital to another fund.

4. Academic literature overview

4.1 Discussion of main papers

In this chapter, we will cover the most relevant academic literature related to the PE industry, prevailing arguments and hypothesis as well as conclusions, identifying potential drivers in the industry and put into context, how our paper complements the current state.

With the emerge of PE industry in the 1980s, PE started to be in the academic research interest at the end of this decade. The first papers such as Jensen (1986, 1989) perceived PE more like a new tool of financial engineering than as an asset class and attempted to explain the characteristic features and its role in the financial markets. After the junk bond market crash in 1989, and retreat of PE industry, academic research of this industry follows similar development and its popularity returns after the burst of the dotcom bubble. Since that time, the PE related academic literature has developed enormously, nevertheless, we still do not understand all the underlying drivers behind the PE industry mechanism.

The main problem is the limited data availability in the entire industry and many papers discuss this limitation in their final inference. GP's are not obligatory to disclosure almost any information publicly, and even the information channel between GP's and LP's is subject to potential skewness. The release of the data to the industry databases is then completely voluntary, which brings an obvious question about the survivorship bias, the positive bias in the PEF performance as neither GP's nor LP's have a motivation for disclosing their failure. Demaria (2014) summarizes those concerns, while suggesting that prior researches used biased data sets either from a single LP or from PE industry databases. His point suggests that none of these data sources fully represents the entire industry because of the small variety in the sample or the toxic treatment of the observations in the databases. Another point to mention here is the enormous lag in final PEF performance, which exceeds at least a decade and thus lowers the confidence while studying current effects from interim results.

The topic of data biases is widely common in PE related academic literature. Kocis et al (2009) suggests that interim reporting has very limited predictive power about the final PEF performance and one should not use them to evaluate the fund. On the contrary, the work of Demaria (2014) shows that the PEF's follow a J-curve pattern on average, which promotes the notion that we can study effects in current performance, when controlling the pattern. Despite that arrangement, interim reporting can be manipulated as implied by Ljunqvist and Richardson (2002), who rather write off the NAV from their dataset to mitigate the concerns of positive bias. In comparison, the paper of Kaplan and Schoar (2005) perceived NAV in their dataset as a solid predictor of future cash flows. The recent paper by Brown, Gredil, Kaplan (2017) confirmed their approach, when concluded that the GP do not significantly manipulate their NAV to skew the interim performance. Although they found that bottom quartile PEF overestimate slightly the interim results, as well as top quartile funds apply high conservatism as a safety measure, LPs' behaviour indicates that these short-term manipulations are detectable and often punished. This conclusion might be surprising but is in compliance with papers by Anson (2007), Phalippou and Richardson (2014) who found a conservative treatment of NAV. Furthermore, it provides reliability to the LPs' behaviour, when deciding whether to invest in a particular fund, as paper by DaRin and Phalippou (2016) found that LPs' decisions are based on the few years recent performance.

The fundraising topic has been under scrutiny as well, as most of the papers try to find key drivers of the fundraising process and general PE activity. Ljunqvist, Richardson, Wofenton (2007) simultaneously as Vinten (2008) found that LBO funds are more active in the low interest rates environment, which implies potential cyclicity in PE activities. Furthermore, Vinten (2008) links the LBO activity to the M&A market cycles, while arguing that LBO funds drive the market in low stock valuations and debilitate in probably overvalued stock market. This reasoning supports previous researches such as Shleifer and Vishny (2001), Rhodes-Kropf, Viswanathan, Robertson (2004), which concluded that strategic acquisitions more likely occur when the stock market peak. They argued that strategic investors benefit from high stock market, because they can pay the purchase price in their shares, which PEF cannot. Moreover, the papers by Gompers and Lerner (1998), Kaplan and Schoar (2005), Kaplan and Stromberg (2008) suggest that the PE fundraising

activity is exposed to the general macroeconomic conditions, which drive the cyclicity of the industry. Gompers and Lerner (1998) explained the invert relationship between PE activity and capital gains tax rate. They also suggest that rise in interest rates results in rise in VC fund size, however, this conclusion can be ambiguous and resulted from the development of interest rates in the 1980s and the abnormal boom of PEF. Kaplan and Schoar (2005) claim that the fundraising abilities are driven by the overall amount of money in the economy and GPs' previous performance, implying persistence in the GP's performance. As long as the low interest rates environment signals expansionary monetary policy, this claim is in compliance with Vinten's conclusion. Kaplan and Stromberg (2008) further found that the activity of PEF is sharply affected by general credit market conditions. Ljunqvist and Richardson (2003), Ivashina, Kovner (2010), Phalippou and Gottschalg (2014) proposed other factor that influence the PE fundraising activity. Ljunqvist and Richardson (2003) suggested that the capital commitments from LP does not serve only as an investment for return, but also as a tool, how to establish relationship with GP, who could potentially use their services. Ivashina and Kovner (2010) finally found an evidence for banks LP and the side effect, while Phalippou and Gottschalg (2014) acknowledged their conclusion as a potential determinant.

As we mention above, Kaplan and Schoar (2005) identified previous performance as a significant variable for fundraising GP's. This high persistence was found also by Kaplan and Stromberg (2008), Phalippou and Gottschalg (2014) implying that GP's experience matters. Nevertheless, Anson (2007) disclaims this conclusion, arguing that the implied performance persistence is in fact only lagged public market noise.

Several papers have studied the performance and relationship between the public market and PEF's with a mixed result. Ljunqvist and Richardson (2003) found an 8% excess return of PEF's over the indices S&P500 and NASDAQ composite, while Phalippou and Gottschalg (2008) found the return gross of fees indistinguishable and Kaplan and Schoar (2005) found underperformance of PEF to the S&P500 index. However, as mentioned in Damoradan (2001), it is not possible to simply compare the PEF returns to those of public market, because of different timing and associated risk, the conclusions highly rely on the applied method and

can be rather deceptive. The arguments for the excess return can be illiquidity of the PE investment, as well as the high risk from huge debt or technology failure. The invert relationship between High Yield Debt rate (“junk bonds”) and PE performance was discovered by Kaplan and Stein (1993), when they identified as a cause of PE industry slump the crash of junk bonds market. Later Axelson, Jenkinson, Kaplan, Weisbach (2013) supported their conclusion, when they concluded that the capital structure of a PE deal is determined by credit market conditions, especially the High Yield Market. This approach is also acknowledged by Mravec (2012).

While the overall availability of money plays its role, Kaplan and Stromberg (2008) suggest that the PEF’s cash management matters too, as early capital calls lower the PEF performance. Their idea comes from the Gompers and Lerner (2000), which concluded that excessive cash in fund can lead to impoverish due diligence, poor investment decisions and lower PEF performance. Whether it is the effect of cash management or the overall capital in the fund was the question attempted to answer by Kaplan and Schoar (2005). Unfortunately, their findings of concave relationship between the PEF size and performance was not confirmed by later papers. While Robinson and Sensoy (2011a) confirmed the findings in log(PME) performance, Harris, Jenkinson, Kaplan (2013) found the relationship only in LBO performance, not in VC, and Harris, Jenkinson, Kaplan, Stucke (2013) did not find the relationship at all.

While the PE performance is a challenging topic with many potential biases, the value creation topic is probably the most elaborated. PE industry, especially LBO, are negatively well-known for its cost-cutting, staff-reduction programmes, which do not bring any real value to the company. Despite this belief, the research suggests that PE’s are able to create operational value in many cases. Even though Desbrieres and Schatt (2002), Vinten (2008) did not find significant improvement in investing cash flow management and EBITDA level indicator, Cressy, Munari, Malipiero (2007) found that staff-reduction programmes lead to improved efficiency and increase in revenue per employee in the long-term. Kaplan and Stromberg (2008) then confirmed the operational value creation at the EBITDA level, while suggesting as the explanation being the ease to implement business strategy. Similar

conclusion was provided by Achya, Gottschalg, Haha, Kehoe (2011), who found that the background of a GP's partner carrying the investment matters, when partners with financial background outperform those with operating background in the implementation of non-organic growth strategy and vice versa.

The superiority of the PE governance model was initiated by Jensen (1989) who argued that the high ownership concentration would lead to more efficient decision making and replace the inefficient corporate governance model with disperse ownership. As mentioned in Vinten (2008), it would also explain the outperformance of US focused over Europe focused funds, as in the USA, the ownership base is more dispersed and so the benefit would be bigger. However, later papers such as Vinten (2008), Kaplan and Stromberg (2008) as well as the historical development did not confirm this hypothesis of superiority of PE governance model.

Although the governance concentration does not create value statistically in the portfolio company, Barger et al (2007) found that both, buyer and seller, benefit from a stronger position in deal negotiations with increased ownership stake. They also suggest that PE buyers pay lower premium compared to strategic buyers, which was later supported by Kaplan and Stromberg (2008), who argued that GP's are better in determining the true intrinsic value of the target. With reference to their aforementioned notions, they further claim that PEF's can benefit from the great timing of investments, when cheap debt can increase the deal premium, which they can afford. The argument by Axelson, Jenkinson, Stromberg, Weisbach (2008) further increases the importance of debt financing availability, while finding the invert relationship between interest rates and the percentage portion of debt in any kind of deal capital structure. While their argument implies that the leverage level in the target does not reflect the company's needs and the target could perform worse than its peers [Badunenko, Baum, Schafer (2010)], papers by Demiroglu, James (2007), Ivashina and Kovner (2008, 2010) Achya, Gottschalg, Haha, Kehoe (2011) found that PEF create value with this excess leverage, when acquiring cheaper debt financing for the target similar concept to Jensen (1989) and Japanese Keiretsu. Recent paper by Bernstein, Lerner, Mezanotti (2017) then concluded that PE-backed companies performed better than its peers during the Great Recession period.

While reading about the PE related researches, we can notice that there are several categories of arguments and topic frequently covered. Those include fundraising and investment activities of PEFs, value creation topics and performance. Nevertheless, even though several papers concluded that PE fundraising abilities are subject to interest rates, in a performance related literature none of papers provide a quantified finding, which we could verified or denied. Moreover, the performance related papers are relatively old, as many of them was published prior to the Liquidity crisis. In our work, we will attempt to narrow these gaps and suggest areas for further research.

5. Sample overview

As the access to any data for the PE performance is strictly limited, the author has decided to collect two datasets with a different range of information provided. The motivation for choosing two datasets was to increase the potential inference of our finding. Both datasets provide different level of detail and allow us to study our area of interest in various ways. Moreover, we will attempt to create a logical link between both datasets, so that we can determine their mutual relationship.

5.1 Data origination

5.1.1 Data provider selection

(See appendix 5) Our macroeconomic data come from publicly available databases Federal Reserve Economic Data, while our data on PE come from publicly available reports on PE performance benchmarks published by Cambridge Associates and a private database on financial industry Bloomberg.

Cambridge Associates (“CA”) is a private database, launched in early 1980s, with information about 2000 GPs and their 7500 PEFs, which represents roughly 82% of all committed capital until nowadays. It collects data about PEFs’ investments at the cash-flow level and publishes its own benchmark statistics of PEF performance by quarters at an aggregated level, which we will use for our time-series analysis. Even though the cash-flow level information is exclusively private, the aggregated benchmarks are publicly accessible. The data are gathered directly from GPs’ financial statements and dynamically evaluated when some PEF cease reporting to the database. When this happens, the PEF is then excluded from the database completely and the historical benchmarks are adjusted accordingly. This approach is more efficient compared to other databases approach, which perceive the anytime last reported value of the PEF as the current one and artificially lowers the reported PEF performance. However, there still might be present a survivorship bias in the database as low performing PEFs will be less likely reported to the database, and the prevailing sample will be upward biased.

Our data are extrapolated from the latest Q1 2019 reports and the respective variables are as following: USPE, USVC, Global.RE, Global.LBO.

Bloomberg (“BL”) is a private database on all kind of financial information, PEF performance included. It collects the data at the PEF level and reports key metrics as well as fund’s specifications such as strategy, lifecycle stage and fund’s size. Unfortunately, the PEF origination country is not provided, which prevents us from choosing country-specific macroeconomic indicators. It provides us with relevant data for our cross-sectional analysis, where we will combine the macroeconomic and fund specific variables.

Federal Reserve Economic Data is a US publicly available database, gathering majority of macroeconomic indicators, not exclusively US only. It gathers data directly from its research and from specialize national agencies, so the reliability is indisputable. The motivation for choosing primarily US macroeconomic data was the fact that US market share of PE industry exceeds 50% in many indicators and also that my time-series data provider, CA, is mainly focused on US PE industry. The US macroeconomic data thus should be the most convenient for our analysis.

5.1.2 Convenience and limitation of data

Our choice of CA as a data provider seems wisely, as we look at the Demaria (2014). While he discussed in his paper the problem with potential biased conclusions from previous research, resulting from biased databases, he finally worked with the dataset from CA, so our analysis should be in compliance with his findings. Moreover, the CA publish in reports historical PEF performance from the year 1994 up to date by quarters. This means that we reached a 100 observations sample in a current year, and so this effectively enable us to conduct newly a time-series analysis with mitigated risk of violating errors normality assumption in our model.

On contrary, in our covered PE related literature, none of the datasets originated directly from Bloomberg. We could find this surprising given the fact that Bloomberg belongs to the most widely used financial database in the world. Our

cross-sectional analysis can therefore provide a new awareness about the quality of Bloomberg's data and its connection to the real world.

5.2 Statistics and variables

5.2.1 Statistics

We include here also the supportive dataset, used for testing the connection between both main ones. The dataset 1 includes the time-series data (see appendix 1), while the dataset 2 includes the cross-sectional data (see appendix 2). The dataset 3 includes the aggregated performance by vintage years on 4 main strategies (see appendix 3).

5.2.2 Variables identification and choice

- Time series model variables [all variables represent the growth]

USPE, USVC, Global RE, Global LBO – pooled return indexes, which track the performance of 5000 US and international PEFs with various strategies. We choose as the most representative the USPE index, which covers all the main strategies and should be exposed the most to our variables of interest.

Us.nom.gdp.g – US nominal gross domestic product indicates the current stage of US economy.

Hy.bbb.bond.spread – index provided by Bank of America Merrill Lynch, captures the difference between safe investment grade bonds, and riskier speculative grade bonds. The risk of PE investments is often high, so the high yield bonds are more relevant. Ballek (2016) used this variable in his model.

Corp.aaa.bond – yield of the safest bonds at the market, ranked as AAA.

S.p500.index – main US equity index, representing 75% of US stock market capitalization.

recession – dummy variable, implying whether the US economy experienced recession. Dotcom crisis 01Q2-01Q4, Liquidity crisis 08Q1-09Q1.

Q1, Q2, Q3 – supporting quarters variables, used for seasonality detrending.

Dpost.crisis – we define the dummy variable for two mutually exclusive periods. The pre-crisis period last from 01Q4 to 09Q1, while the latter period from 09Q2 are included in the post-crisis.

Dexp.m.p – this dummy variable is created by taking the long term, 1999-2017 average of Fed fund rates and corporate AAA bonds yields, and equals to 1, if the current Fed fund rate is below this threshold. This approach should reflect the prevailing situation at the bond market.

- Cross-sectional model variables [in the case that the variables are used in both models, we do not cover them again, but notice that the time frame has changed from quarter to years. For years, we take the values of Q4]

Quantile – we are provided with relative performance metric, which reflects the quantile ranking of the fund in the same vintage year and with the same strategy

Fundsize, fundsize² – the fundsize reflects the value of committed capital to the fund. The committed capital is not called at once, but through many years. We include also the fund size squared in order to test the finding of Kaplan and Schoar (2005) about the concave relationship and PEF performance.

Netirr – annual return of the fund since its inception in vintage year. In our model, the netirr variable is the dependent one.

DPI, PIC, RVPI, MOIC – our initial dataset included also Multiple variables, however, after careful inspection of the data for potential outliers, we rest with too small observations

Investing, fundraising, harvesting – life stage dummy variables, allowing us to control for the mature of the fund. The omitted variable is liquidated stage.

Venture, growth, debt, secondary, fof, real estate – intuitive dummy variables, allowing us to control for each strategy variation. Omitted strategy is LBO.

Early.stage – dummy variable, which should capture the partly the J-curve effect in the recent years 2016 and 2017.

5.3 Outliers

5.3.1 Motivation of outliers' presence

When analysing the datasets, we should take care about the present outliers in them. The careful inspection of time-series dataset is not required as our observations either results from large samples, are based on macroeconomic data or are defined by ourselves. But unfortunately, we lack the data of high yield bonds spread for years 1994-1996. As a result, we deleted our observations for those years.

When looking at the cross-sectional dataset, we can explain the outlier's presence in several variables by several factors. The bankruptcy of the fund or a great timing and good luck are the factors explaining outliers in Net IRR, while some institutional agreement might result in the mega fund by the fund's size. None of this is convenient for us, so we introduce a method for outliers' detection and treatment.

5.3.2 Detection and treatment

We build our method for outliers' detection based on the z-score mechanism as following:

Figure 6: Z-score formula

$$z_i = \frac{x_i - \bar{x}}{s}$$

Source: [Statistics](#)

Firstly, we would focus on the Net IRR variable, as we choose it as the most convenient for the hypotheses testing. Starting with 3892 observations, we computed the all-time z-score and year specific z-score for each observation and then deleting it, in a case that at least one absolute value z-score would be above 3. This gave us 3805 observations, not reducing the sample much.

Secondly, we adjusted our dataset for fund size outliers. We repeated the method conducted on Net IRR variable, which sets a ceiling at \$10bn per fund. We also deleted all observations with missing information about the fund size. This makes it possible to estimate the final inference based on our sample. After all, we rest with 3310 observations in our dataset, which allow us to assume asymptotical normality, if needed, in our cross-sectional analysis. The model then reduces the observations to 3092.

5.3.3 Link between dataset and simple regression model

So far, we had two separate datasets from two data providers. For our further analysis, however, it would be appropriate if we make a link between them. We will do so by conducting simple linear regression (“SLR”) models on vintage years and main strategies averaged Net IRR. We take as our dependent variable the CA data, more specifically the averages by strategies in each vintage year. As our independent variable we then take computed averages by strategies in each vintage year from Bloomberg cross-sectional dataset. Main strategies include global LBO, global Real Estate, US VC and US overall PE. We conduct a SLR time-series model on each strategy, while trying to prove that the dataset’s performance statistics matches on average.

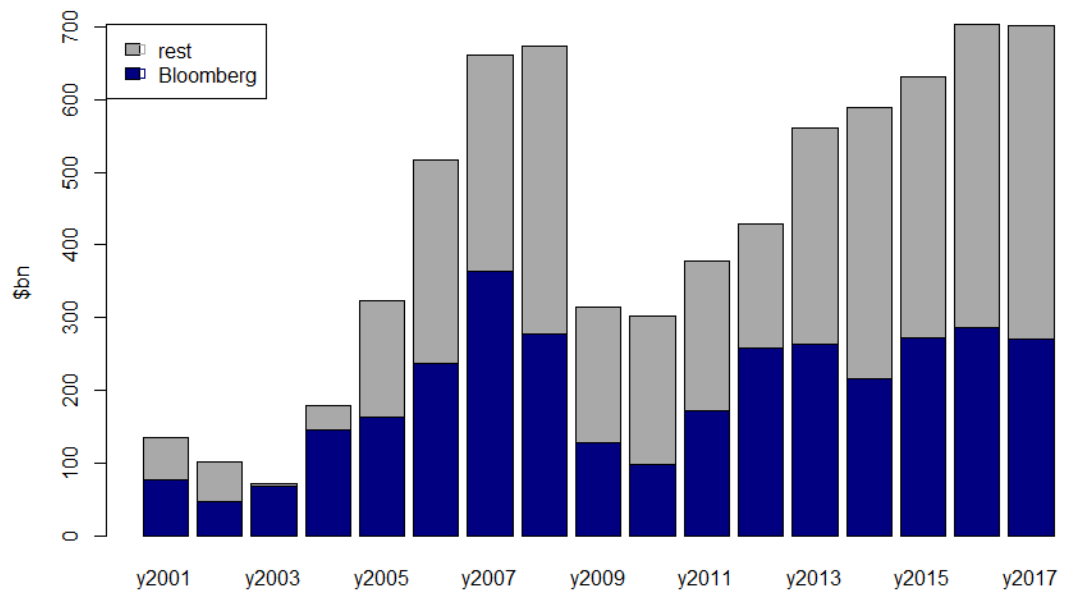
The results (see appendix 8) suggest that there is a significant correlation in each strategy between CA observations and BL observations, although the beta estimates do not always equal to 1 but are statistically significant. Further, through graphical inspection (see appendix 4), we can confirm the similar development in both variables. The R-squared ranges from 48% for US PE to 82% for global LBO,

which enable us to believe that the datasets are highly linked and track the performance similarly.

5.3.4 Global statistics and samples' inference

Knowing that the datasets track the performance similarly, we can take a step back and make an inference about our datasets. Recall that the CA time-series dataset represent approximately 82% of global capital committed since year 1981. The BL cross-sectional dataset then represent approximately 48% of global capital committed since year 1999 to 2017 (see figure 7). Since both datasets represent nearly 50% of the global committed capital their respective years, and follow the same performance pattern, it seems reasonable to assume that we can make a generalized inference about the PE industry from our models.

Figure 7: Bloomberg sample inference potential



Source: Preqin, Bain Capital, Bloomberg

6. Hypotheses and models

6.1 Hypothesis I: Has prevailing low interest rate environment a positive impact on PEF performance growth?

6.1.1 Definition, motivation and consensus

After the Liquidity crisis, Fed continued to execute the expansionary monetary policy QE. This affected the Debt Capital Market's yields, holding them at historical minimums, and created an appetite for Equity Capital Market and PE. In the recent years, we observed shift in Fed's policy and several increases of interest rates. This might worry investors, as the effect of interest rates change on PEF performance has not been covered by current literature and can be ambiguous. Our goal therefore is to quantify this effect, providing investors with an answer for this shortcoming.

Recall that the current literature implied both, a positive effect of low interest rate on the PE fundraising activity as well as boosting of leverage in LBO deal types. Further several papers suggest that PEFs are exposed to general credit market conditions. All of this implies a potential positive effect of low interest rates. On contrary, the high stock valuations and excess liquidity in the funds lead to lower PE activity and performance. The expected effect's sign is unclear, but we will stick to the idea of superior performance of PEF in post-crisis years thanks to the credit market conditions and expect a positive sign of the effect.

6.2 Hypothesis II: Was the PEF performance growth in post-crisis period superior to the pre-crisis period growth?

6.2.1 Definition, motivation and consensus

The second useful information provided by the time-series model would be the quantification of the post-crisis years. The prior hypothesis assumes that the excess returns in post-crisis years should be provided by the prevailing low interest rates environment. However, if we reject this hypothesis, we still can capture the excessive return resulting from other factors in the post-crisis period. Our variable

of interest will be the *Dpost.crisis* dummy, for which we will quantify from beta coefficient the overall effect.

We would expect the coefficient to be positive, which would mean that in the post-crisis period, the PEF growth has improved.

6.2.2 Methodology

$$\begin{aligned}
 USPE_t = & \beta_0 + \beta_1 * Dexp.m.p_t + \beta_2 * Dpost.crisis_t + \beta_3 * corp.aaa.bond_d_t + \\
 & \beta_4 * us.nom.gdp_d_t + \beta_5 * hy.bbb.bond.spread_d_t + \beta_6 * s.p500.index_d_t \\
 & + \beta_7 * s.p500.index_d_1_t + \beta_8 * s.p500.index_d_2_t + \beta_9 \\
 & * s.p500.index_d_3_t + u_t
 \end{aligned}$$

Model 1: Time-series model

To test this hypothesis properly, we create a time-series level-level model with dependent variable US PE, provided by CA, and independent variables capturing the stock market, GDP and bond market development. We further include three dummy variables to control for recessions, pre and post crisis periods *Dpost.crisis* and general credit market conditions *Dexp.m.p* at which we will test the hypothesis. We included both recession and US nominal GDP growth variables because their correlation is after the data transformation truly negligible with value of 0.00619 and they are important for the adjusted R2, as described later. The US PE is a superior variable of other PEF performance indicators, so it should be exposed to general macroeconomic indicators. As a stock indicator, we choose S&P500 index growth with up to three lags, to test for high persistence effect as suggested by Anson (2007). Our GDP variable is the growth of US nominal GDP which should match with the calculation of Net IRR. For the bond market, we add a corporate AAA bond yield growth, where we benefit from its low variance and stability over time, and the high yield BBB bond spread growth, which reflects the difference between investment grade bonds and speculative bonds, used for LBO deals.

After the variable's selection, we should take care of the potential violations of necessary conditions for our test's statistics validity. Firstly, we tested the data for the presence of unit root, and time and seasonality trends. For a vast majority of our data, the time variable was significant while few of them reported seasonality. After detrended the data for both, we conducted the Augmented Dickey Fuller ("ADF") test for 2, 5, 8, 12 lags and Kwiatkowski–Phillips–Schmidt–Shin ("KPSS") test for stationarity and trend-stationarity. The advantage of this approach is that we test the data for null hypothesis of non-stationarity in ADF, while in the KPSS test the null hypothesis is trend-stationarity. We found that majority of our data were not stationary at some level, so we conducted a first differencing transformation for all of them. Afterwards, we tested the data again on time trends and seasonality and finally conclude a stationarity, while rejecting the null hypothesis in ADF test with each p-value being under 0.01 at all lags levels and not rejecting the null hypothesis in KPSS test at 0.05 significance level.

After the stationarity is met for our data, we can run the model, but we should be cautious about the heteroskedasticity and serial correlation. We applied the Breusch-Pagan test for heteroskedasticity, and we failed to reject the null hypothesis of homoskedasticity at the 0.05 level, with our p-value being 0.1869. This implies that our errors are constantly distributed around the fitted values in our model and we do not have to adjust for them. For the presence of serial correlation in our errors, we applied the Breusch-Godfrey test, which allow us to test more than 1 lag as in Durbin-Watson test and give as LM-statistic. Under the null hypothesis, there is no serial correlation of any power in specified lags. Unfortunately, we accepted the alternative hypothesis of serial correlation presence at 0.05 significance level, while our p-value showed 0.01673. This finding was confirmed by the analysis of autocorrelation function and partial autocorrelation function (see appendix 6).

With the serially correlated errors, our test statistics are invalid as the standard errors are likely to be underestimated. We can use either new model with FGLS estimators or stick to the same one with, but with heteroskedastic and serially correlated robust standard errors. We eventually denied using FGLS estimators, as they require strict exogeneity assumption, correctly identified autocorrelation form and larger sample than we have for their consistency. So, we choose the

heteroskedastic and serially correlated robust standard errors method, even though we do not have heteroskedasticity in our model, which can cause slight overestimation of standard errors.

The last issue we should take care of is the normality distribution of residual errors. This is a crucial assumption for our model, because we do not have enough observations to rely on the asymptotical normal distribution. We applied the two formal tests, Jarque-Bera and Shapiro-Wilk test, and a visual check for our normality. The Jarque-Bera test uses the skewness and kurtosis statistics to conclude, whether to reject the null hypothesis of normally distributed errors or not. In our sample, the test gives a p-value of 0.2658, which results to not rejecting the null hypothesis. However, Jarque-Bera test is more convenient for samples larger than ours, so we will further study our finding with Shapiro-Wilk test, which should work properly without the bias from the sample size. The resulting p-value from Shapiro-Wilk test is 0.4267, which does not allow us to reject the null hypothesis, that the sample comes from the normally distributed population. Afterwards, we further made a visual check of Q-Q plots (see appendix 6) and finally concluded, that our residuals follow a normal distribution. All test statistics and results should be valid therefore, and we can make an inference from our results.

6.2.3 Results discussion and inference

The model's results (see table 1) suggest that our model tracks quite well the data, with F-statistic far below 0.01 level, R2 of 0.6490 and adjusted R2 of 0.5885. The difference might be caused by the insignificant variables of high yield BBB bond spread growth and pre and post crisis dummy, which have negligible estimate as well as t statistics. Even though the beta coefficient for pre and post crisis dummy is in compliance with our consensus, its impact is extremely in a real world. Furthermore, we are not able to reject the null hypothesis that the impact of dummy equals zero and thus we cannot make any conclusion about it.

Prior to the interpretations itself, we should explain the meaning of our coefficients. We interpret the level-level model; however, our data are initially growths expressed in %. On top of that, our stationarity transformation required us to make a difference between consecutive growth periods, therefore the final beta

coefficients are expressed in percentage points (“pp”) and reflects the effect of 1pp increase in variable growth.

Table 1: Time-series results

t test of coefficients:

	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	0.0190891	0.0079382	2.4047	0.019399	*
Dexp.m.p[5:89]	-0.0266601	0.0130476	-2.0433	0.045575	*
Dpost.crisis[5:89]	0.0057584	0.0156041	0.3690	0.713449	
corp.aaa.bond_d[4:88]	0.0683153	0.0273721	2.4958	0.015433	*
us.nom.gdp.g_d[4:88]	0.2857100	0.0881032	3.2429	0.001964	**
hy.bbb.bond.spread_d[4:88]	0.0256624	0.0173056	1.4829	0.143516	
S.P500.index_d[4:88]	0.1440672	0.0800223	1.8003	0.077008	.
S.P500.index_d_1[4:88]	0.1140144	0.0526678	2.1648	0.034532	*
S.P500.index_d_2[4:88]	0.1265901	0.0491838	2.5738	0.012636	*
S.P500.index_d_3[4:88]	0.0879912	0.0487613	1.8045	0.076341	.
recession[5:89]	-0.0658351	0.0214285	-3.0723	0.003233	**

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.02833 on 58 degrees of freedom
 (16 observations deleted due to missingness)
 Multiple R-squared: 0.649, Adjusted R-squared: 0.5885
 F-statistic: 10.73 on 10 and 58 DF, p-value: 5.072e-10

Source: Author’s computations

The variables significant at 0.01 level are the recession dummy, which implied a negative relationship of -0.066pp and the US nominal GDP growth with a positive effect of 0.286pp. Both coefficients behave as expected, as in the recession period we can expect that the fair value of NAV will decrease, thus lowers the growth rate or magnify the degrowth. On contrary, when the economy improves and the nominal GDP growth increases, portfolio companies usually became more valuable and increase their NAVs, so the PEF performs better.

The variables significant at 0.05 level are corporate AAA bond yield growth, first and second lag of S&P500 index growth and the dummy variable reflecting the credit market conditions. While the S&P500 index growth lags are intuitive with a positive sign as expected, the positive effect of corporate AAA bond yield growth requires deeper explanation. The corporate bond yield rises, when corporate bond price goes down, and the latter can be caused by increase in riskiness of the AAA companies e.g. AAA companies are usually global, and they must become riskier than smaller companies, probably local one. Based on this logic, the true implied relationship can be interpreted as following. In a global political uncertainty, when

market punishes companies for being global, the PEFs will perform better as it either invest in smaller companies or their portfolio companies are perceived more safely.

The variable of our interest, *Dexp.m.p* which represents the credit market conditions, is significant at 0.05 level. However, its sign is opposite of what we expected in our hypothesis. Even though the beta coefficient is the smallest significant effect with almost no applicability in the real world, the negative sign means that PEF performance growth increases rather in years with prevailing higher interest rates.

To complete the list, variables significant at 0.10 level are S&P500 index growth and its third lag. The effect is similar as in the first and second lag and implies a positive relationship between stock market growth and PEF performance growth. The long-term propensity effect of S&P500 index is then 0.471pp after 4 quarters, which is the slightly less than double of the second biggest effect of US nominal GDP growth. Moreover, by this finding, we found a similar relationship as proposed by Anson (2007), who declared that the high persistence effect, reported by Kaplan and Schoar (2005) and others, is only the market noise and can be captured by adding 3 lags of stock market variable.

The model provides us with finding that we can reject the null hypothesis about the positive effect of low interest rate on PEF performance growth. However, our second hypothesis of excessive PEF performance in cannot be rejected and will stay as a subject for further research. Moreover, what we found is the change in growth indication, not the growth itself. To answer this question, we must look at different dataset.

6.3 Hypothesis III: Has the effect of low interest rate environment changed from pre-crisis to post-crisis years?

6.3.1 Definition, motivation and consensus

With the advantage of cross-sectional data, we will attempt to further clarify the role of low interest rates environment in the PE industry. We can control for fund

characteristics, while still observing the macroeconomic development. The variable of our interest stays the same as in the time-series model, however, the captured effect should provide us with different information. We try to quantify the effect of prevailing low interest rates environment in two periods, separated by a Liquidity crisis in the year 2008. Our notion is that the effect could have changed during the years, since central banks such as Fed invented new tools of monetary policy, allowing them to stimulate the market through different channels with various efficiency. Academic literature directly focusing on the effects of interest rates on PE environment ceased to exist after Vinten (2008). Notice, that every paper covering this topic was published prior to the Liquidity crisis, and therefore cannot capture the potential shift from new monetary policy tools.

We set our consensus in *Dexp.m.p* variable to be positive, in the meaning that the prevailing low interest rates environment provide greater positive effect on the PEF performance.

6.3.2 Methodology

$$\begin{aligned}
 netirr_{it} = & \beta_0 + \beta_1 * early.stage_{it} + \beta_2 * recession_{it} + \beta_3 * s.p500.index_{it} + \\
 & \beta_4 * us.real.gdp.g_{it} + \beta_5 * Dpost.crisis_{it} + \beta_6 * Dexp.m.p_{it} + \beta_7 \\
 & * hy.bbb.bond.spread_{it} + \beta_8 * \dots + \beta_{19} * Dpost.crisis_{it} \\
 & * Dexp.m.p_{it} + \beta_{20} * \dots + u_{it}
 \end{aligned}$$

Model 2: Cross-sectional model

In our model, we are interested in the interaction variable $Dpost.crisis * Dexp.m.p$, which captures the average effect of low interest rate environment and in both periods separately and compares them while looking for significant difference. This method is called difference-in-difference and is widely used for cross-sectional data analysis. Moreover, we let interact the post-crisis dummy with all PEF strategy dummies to capture their development.

As the cross-sectional model can suffer from similar biases as the time-series model, we will conduct the same tests as for our time-series data. Firstly, we need our time varying data to be stationary. After the detrended procedure for time, since seasonality does not make much sense in years case, we conducted ADF and KPSS tests for autocorrelation detection and concluded that our data meets this criterion. As we included only the variables from our time-series model, that meets this condition, we could potentially presume this result. (See appendix 7)

Then we applied the Breusch-Pagan test for heteroskedasticity and must concluded that our model suffers seriously from heteroskedasticity, as we were able to reject the null hypothesis far below 0.01 significance level. After that, we conducted also the normality Jarque-Bera and visual tests, and we rejected the null hypothesis of normally distributed errors in our model. We could not use Shapiro-Wilk test because of the large sample, which would lead to biased conclusion. However, our large sample finally rescue us, as we can assume the asymptotical normal distribution of errors, if the previous conditions are not violated. Even though our model violates the homoscedastic assumption, we can still obtain valid statistics when using the heteroskedasticity robust standard errors.

6.3.3 Results discussion and inference

The overall fit of our model (See table 2 for results and appendix 7 for tests) is enough to make a conclusion from it. Our R^2 is 0.1332 while the adjusted R^2 is 0.1262. This is a comparable fit to many papers, which make conclusions even with halved the value of R^2 such as Phalippou, Gottschalg and Lopez (2014). Also, the null hypothesis of joint insignificance hypothesis is strongly rejected by our F-statistic. When looking into the results, we notice 6 variables to be significant at the 0.01 level. However, by the nature, we are talking only about the 3 tangible effects, since the variables are related to venture capital, real estate and fund's size. The iteration variables describe similar positive development in the post-crisis years for both, venture capital and real estate. The no iteration strategy dummies then suggest that both venture capital and real estate specialized PEFs underperformed the LBO strategy, used as a benchmark. However, after the crisis, the gap narrows as the current effect is the sum of both coefficients. While the real estate pre-crisis

underperformance can be caused by the housing market plummet, the VC underperformance is less intuitive and might be further tested. Then, we found a significance of both fund size variables. We included them to verify the finding of Kaplan and Schoar (2005) about the concave relationship in the fund size and we found exactly the same effect as they did. Another important variable is the early stage dummy, which captures the effect of newly created funds, which underperform the rest. The recession effect is positive here, significance at 0.1 level, which can be ambiguous until we realize that the fund raised during the recession period can benefit from cheap stock market. The positive and biggest coefficient is present in S&P500 index variable, which is in compliance with our time-series findings. Furthermore, we can conclude that all strategies underperform the LBO funds significantly in the pre-crisis period. Also, the life cycle dummies are ordered as expected, with the fund's performance increase in each later stage. Unfortunately, they are insignificant so we cannot make any conclusion about them from our model. Finally, we can discuss the variable of our interest and the suggested relationship between the low interest rates environment and PEF performance. The pre-crisis *Dexp.m.p* variable has a positive sign and is significant at 0.05 level, which should imply a effect of low interest rates environment on the Net IRR of funds raised in that year. Moreover, as the iteration variable of our interest is also significant at 0.05 level, we can conclude that the effect magnifies over time, which can be explain by the extremely long negligible interest period or by the bigger efficiency of new monetary policy tools.

Table 2: Cross-sectional results

t test of coefficients:

	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	7.5647e-02	1.6121e-02	4.6923	2.819e-06	***
early.stage	-4.3648e-02	1.3845e-02	-3.1526	0.001634	**
recession	3.9493e-02	2.2645e-02	1.7440	0.081253	.
S.P500.index	1.4215e-01	5.3627e-02	2.6508	0.008072	**
us.real.gdp.g	-2.5631e-02	1.3797e-01	-0.1858	0.852636	
Dpost.crisis	-2.8479e-02	2.1783e-02	-1.3074	0.191172	
Dexp.m.p	2.3425e-02	7.8215e-03	2.9950	0.002767	**
venture	-4.8858e-02	9.3295e-03	-5.2370	1.742e-07	***
growth	-1.6300e-02	1.9114e-02	-0.8528	0.393849	
debt	-3.1549e-02	1.2283e-02	-2.5686	0.010259	*
secondary	-3.7697e-02	1.8490e-02	-2.0388	0.041555	*
fof	-1.6594e-02	6.9716e-03	-2.3803	0.017360	*
real.estate	-7.5596e-02	8.7151e-03	-8.6741	< 2.2e-16	***
fundraising	-1.4733e-02	1.3867e-02	-1.0625	0.288104	
investing	-9.5456e-03	1.3984e-02	-0.6826	0.494896	
harvesting	-7.5465e-03	1.1951e-02	-0.6315	0.527773	
fundsize	1.7859e-05	3.7885e-06	4.7139	2.538e-06	***
fundsizeSq	-2.2204e-09	5.6795e-10	-3.9094	9.450e-05	***
hy.bbb.bond.spread	-2.8104e-02	3.1351e-02	-0.8964	0.370095	
Dpost.crisis:Dexp.m.p	4.6474e-02	1.8323e-02	2.5364	0.011249	*
Dpost.crisis:venture	6.2771e-02	1.3845e-02	4.5338	6.014e-06	***
Dpost.crisis:growth	1.7724e-03	5.7703e-02	0.0307	0.975499	
Dpost.crisis:debt	1.0825e-02	1.4220e-02	0.7613	0.446531	
Dpost.crisis:secondary	2.5257e-02	3.5486e-02	0.7117	0.476682	
Dpost.crisis:fof	2.5664e-02	1.1519e-02	2.2280	0.025953	*
Dpost.crisis:real.estate	6.8465e-02	1.1327e-02	6.0446	1.677e-09	***

 Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1105 on 3092 degrees of freedom
 (192 observations deleted due to missingness)
 Multiple R-squared: 0.1332, Adjusted R-squared: 0.1262
 F-statistic: 19.01 on 25 and 3092 DF, p-value: < 2.2e-16

Source: Author's computations

Conclusion

The aim of our work was to answer some of the main questions, which private equity investors experienced today. By using the datasets provided by Cambridge Associates and Bloomberg, we conducted a time-series and cross-sectional models to clarify the impact of prevailing macroeconomic conditions in the post-crisis period on the private equity funds performance. Our datasets values represent 82% and 48% of total capital committed during the years 1981-2018 and 1999-2017 respectively, and our conclusions should provide a solid information about the private equity industry and its performance. We tested three hypotheses in our models and concluded two significant findings, while the third hypothesis remains opened. We assumed that the low interest rate environment maintained by Federal Reserve bank after the Liquidity crisis in 2008 would has a positive impact on the private equity funds performance. However, we rejected the hypothesis as the model reported the negative effect, suggesting that the private equity funds maintain greater growth rate in high interest rates environment. Our second hypothesis of superior performance in post-crisis years showed negligible impact in the real world, and we further could not reject its null hypothesis of neutral effect. Our third hypothesis suggested that the effect of low interest rates has changed positively from pre-crisis to post-crisis period. It was tested by the cross-sectional model, and we accepted the hypothesis of positive change between the periods. Our key findings would be that the effect of low interest rates environment on the private equity funds performance is ambiguous, as it provides an increase in private equity funds performance while at the same time weaken its growth. The suggestion for further research would be the topic of better private equity funds performance in the post-crisis years, since we were not able to provide a clear answer for it.

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Appendix 1: Time series data sample statistics

Variable / statistics	standard		min	median	max
	average	deviation			
USPE	3,37%	5,22%	-16,00%	3,90%	17,90%
USVC	3,72%	12,23%	-20,00%	2,50%	84,40%
Global RE	2,44%	4,66%	-23,20%	2,50%	15,90%
Global LBO	3,46%	5,44%	-19,40%	3,80%	17,30%
us.nom.gdp.g	4,34%	2,72%	-7,20%	4,70%	10,20%
hy.bbb.bond.spread	1,99%	19,88%	-27,91%	-2,38%	110,71%
corp.aaa.bond	-0,55%	5,31%	-13,33%	-1,52%	15,15%
S&P500 index	1,79%	6,36%	-28,41%	2,45%	11,89%
recession	0,09	0,29	0,00	0,00	1,00
Q1	0,25	0,43	0,00	0,00	1,00
Q2	0,25	0,43	0,00	0,00	1,00
Q3	0,25	0,43	0,00	0,00	1,00
Dpost.crisis	0,57	0,50	0,00	1,00	1,00
Dexp.m.p	0,55	0,50	0,00	1,00	1,00

*Grey colour indicates CA data

**Bottom line separates the ourself defined variables

Source: CA and FRED

Appendix 2: Cross sectional data sample statistics

Variable / statistics	standard				
	average	deviation	min	median	max
quantile	2,47	1,09	1	2	4
year	2009,36	4,97	1999	2009	2017
fundsize	1057	1444	50	523	9700
fundsizesq	3204036	9881191	2500	273007	94090000
netirr	8,82%	11,90%	-38,00%	9,00%	53,00%
dpi	1,11	0,90	0,02	1,11	3,63
pic	40,29	38,71	0	26,27	125,23
rvpi	2,25	2,59	0,42	2,25	4,08
moic	1,59	1,04	0,12	1,32	9,3
investing	0,41	0,49	0	0	1
fundraising	0,03	0,17	0	0	1
harvesting	0,51	0,50	0	1	1
venture	0,21	0,41	0	0	1
growth	0,02	0,14	0	0	1
debt	0,13	0,34	0	0	1
secondary	0,02	0,14	0	0	1
fof	0,12	0,33	0	0	1
real estate	0,21	0,41	0	0	1
us.nom.gdp.g	3,45%	2,98%	-4,50%	4,20%	8,40%
us.real.gdp.g	1,52%	2,43%	-4,40%	2,00%	5,40%
hy.bbb.bond.spread	-2,52%	17,65%	-18,18%	-8,82%	48,00%
us.housing.price	-0,40%	1,95%	-5,00%	0,00%	2,00%
fed.fund.rate	9,89%	40,80%	-74,00%	0,00%	100,00%
corp.aaa.bond	-0,71%	6,21%	-13,00%	-2,00%	15,00%
S&P500 index	2,33%	7,00%	-28,00%	2,00%	10,00%
recession	0,14	0,35	0	0	1
early.stage	0,13	0,33	0	0	1
Dpost.crisis	0,56	0,50	0	1	1
Dexp.m.p	0,69	0,46	0	1	1

*Grey colour indicates the dependent variable

**To avoid dummy variable trap, base variable for life stage is Liquidated

***To avoid dummy variable trap, base variable for life stage is LBO

****Bottom line separates th eourself defined variables

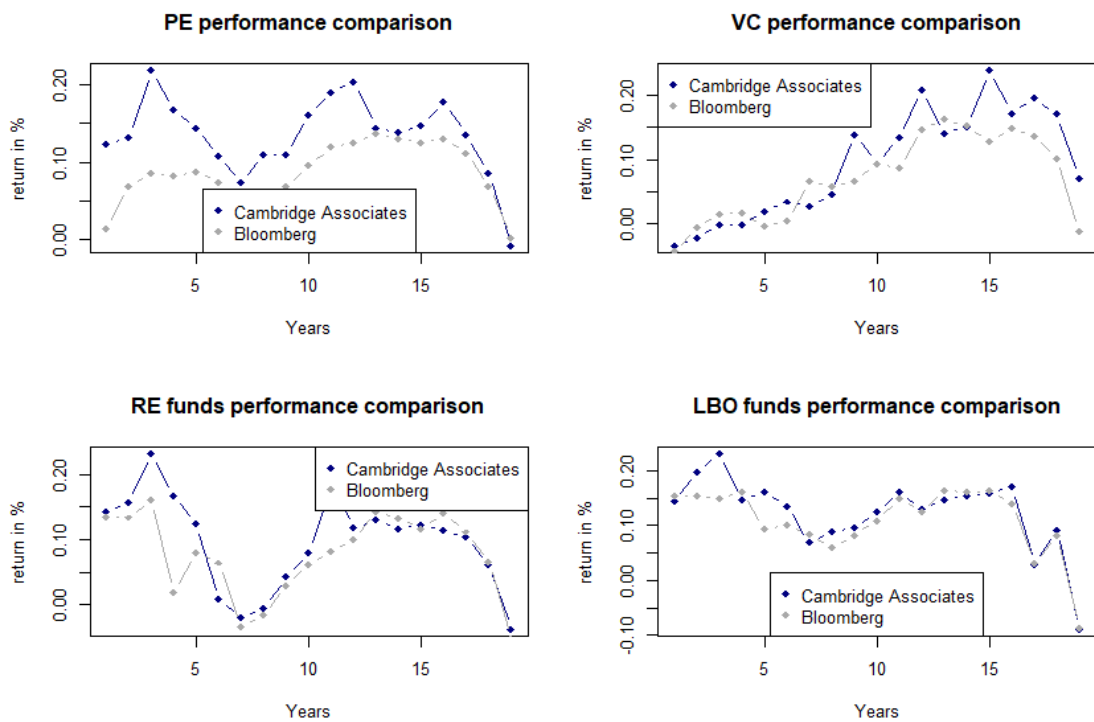
Source: Bloomberg and FRED

Appendix 3: Time series – cross sectional data comparison

Variable / statistics	average	standard deviation	min	median	max
ca.mean.pe	13,49%	5,16%	-0,84%	13,81%	21,89%
ca.mean.vc	9,38%	8,46%	-3,40%	9,36%	23,82%
ca.mean.re	9,70%	7,23%	-3,74%	11,68%	23,11%
bl.mean.pe	8,57%	3,89%	0,24%	8,61%	13,64%
bl.mean.vc	6,95%	6,55%	-4,33%	6,68%	16,17%
bl.mean.re	7,75%	6,30%	-5,12%	8,19%	16,00%
bl.capital.rasied	184221	95045	46037	171627	363879
ex.bl.capital.raised	216306	139005	4927	204527	431440
ca.mean.lbo	12,35%	6,91%	-8,92%	14,38%	23,07%
bl.mean.lbo	10,91%	6,18%	-8,64%	12,39%	16,43%

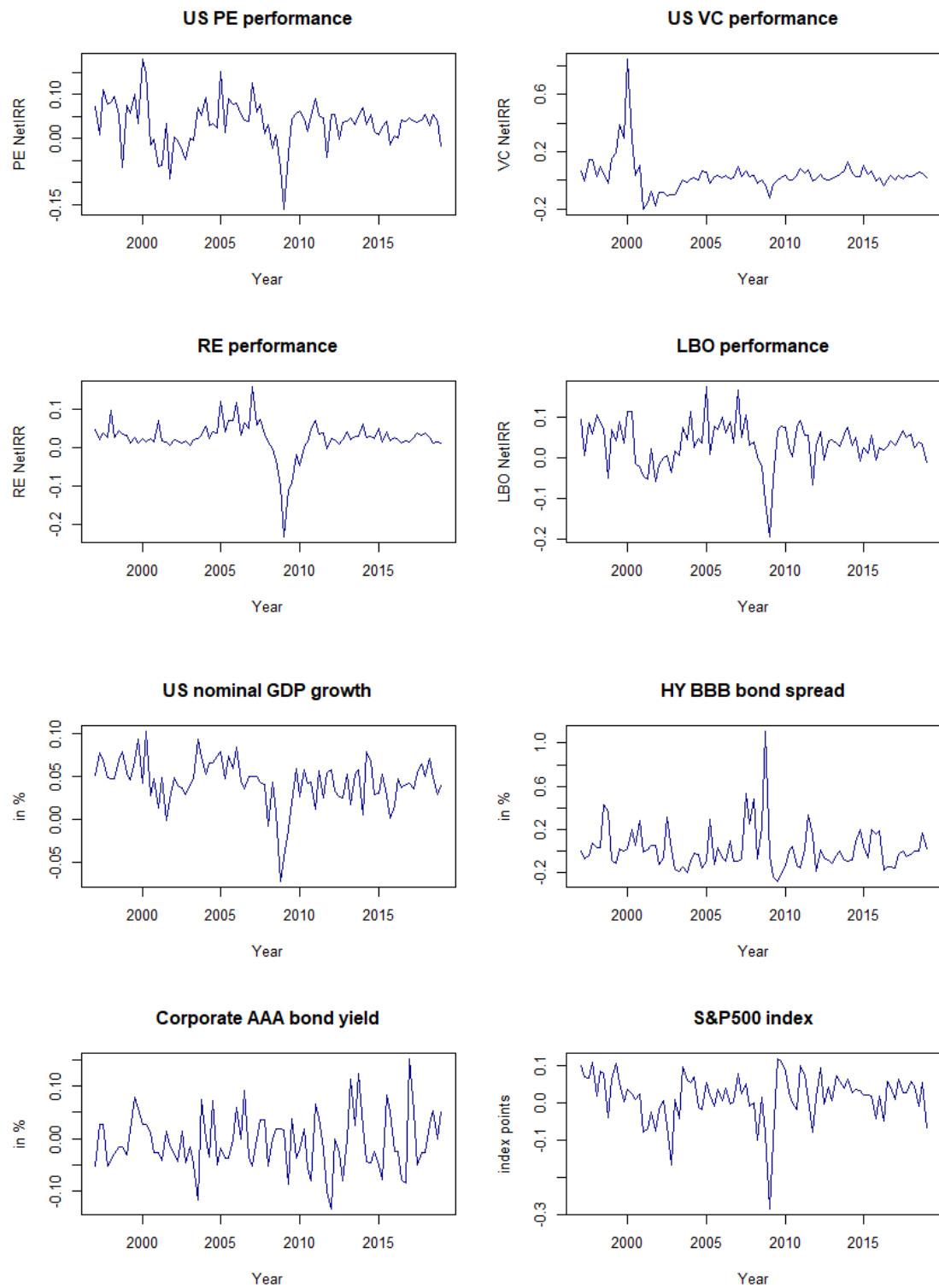
Source: CA and Bloomberg

Appendix 4: Time series – cross sectional visual data comparison



Source: CA and Bloomberg

Appendix 5: Time series – initial data charts by time



Source: CA

Appendix 6: Time-series testing results

Breusch-Godfrey test for serial correlation of order up to 8

data: model_1
LM test = 18.67, df = 8, p-value = 0.01673

Shapiro-wilk normality test

data: residuals_model_1
W = 0.97711, p-value = 0.236

studentized Breusch-Pagan test

data: model_1
BP = 13.705, df = 10, p-value = 0.1869

Jarque Bera Test

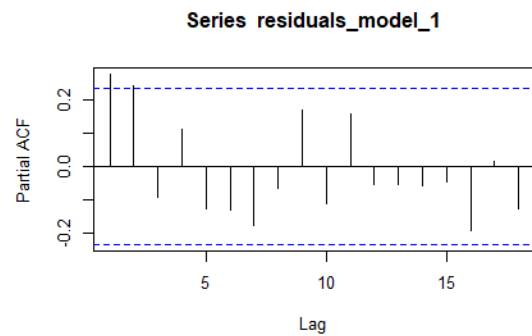
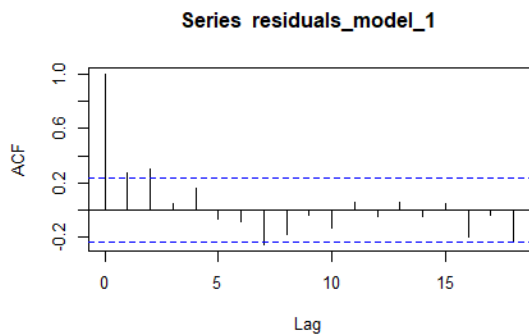
data: residuals_model_1
X-squared = 3.8122, df = 2, p-value = 0.1487

Augmented Dickey-Fuller Test

data: S.P500.index_d
Dickey-Fuller = -4.357, Lag order = 8, p-value = 0.01
alternative hypothesis: stationary

KPSS Test for Level Stationarity

data: S.P500.index_d
KPSS Level = 0.035943, Truncation lag parameter = 3, p-value = 0.1



Appendix 7: Cross-sectional testing results

studentized Breusch-Pagan test

data: model_3
BP = 233.37, df = 25, p-value < 2.2e-16

Jarque Bera Test

data: residuals_model_3
X-squared = 585.89, df = 2, p-value < 2.2e-16

Appendix 8: SLR models results

```
Call:
lm(formula = ca.mean.pe ~ bl.mean.pe, data = mydata3)

Residuals:
    Min       1Q   Median       3Q      Max
-0.065881 -0.026354  0.000763  0.021161  0.083660

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.05525    0.02150   2.570 0.019889 *
bl.mean.pe   0.92902    0.22946   4.049 0.000834 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03785 on 17 degrees of freedom
Multiple R-squared:  0.4909,    Adjusted R-squared:  0.4609
F-statistic: 16.39 on 1 and 17 DF,  p-value: 0.0008345

Call:
lm(formula = ca.mean.vc ~ bl.mean.vc, data = mydata3)

Residuals:
    Min       1Q   Median       3Q      Max
-0.063528 -0.034845 -0.000781  0.026092  0.078300

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.01551    0.01444   1.074  0.298
bl.mean.vc   1.12644    0.15308   7.359 1.12e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04256 on 17 degrees of freedom
Multiple R-squared:  0.7611,    Adjusted R-squared:  0.747
F-statistic: 54.15 on 1 and 17 DF,  p-value: 1.117e-06
```

Call:
lm(formula = ca.mean.re ~ bl.mean.re, data = mydata3)

Residuals:
 Min 1Q Median 3Q Max
-0.076866 -0.023786 -0.011092 0.005296 0.121405

Coefficients:
 Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.02811 0.01740 1.616 0.125
bl.mean.re 0.88862 0.17608 5.047 9.94e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04705 on 17 degrees of freedom
Multiple R-squared: 0.5997, Adjusted R-squared: 0.5762
F-statistic: 25.47 on 1 and 17 DF, p-value: 9.937e-05

Call:
lm(formula = ca.mean.lbo ~ bl.mean.lbo, data = mydata3)

Residuals:
 Min 1Q Median 3Q Max
-0.032634 -0.021274 -0.005114 0.016709 0.066827

Coefficients:
 Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.01189 0.01359 0.875 0.394
bl.mean.lbo 1.02324 0.10912 9.377 3.94e-08 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0286 on 17 degrees of freedom
Multiple R-squared: 0.838, Adjusted R-squared: 0.8285
F-statistic: 87.93 on 1 and 17 DF, p-value: 3.94e-08