KEY ECONOMIC FACTORS AFFECTING RETURNS OF PUBLICLY LISTED PRIVATE EQUITY FIRMS IN THE UNITED STATES OF AMERICA

A Thesis

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Summary

The aim of this thesis is to assess to what extent the selected economic factors (inflation, interest rate, unemployment rate, GDP growth) are affecting publicly listed private equity firms' returns in the US. First of all, this thesis analyses trends of the listed private equity market globally and in the US as well as the specifics of publicly listed private equity firms. In the second part of this thesis, literature review, academic literature on publicly listed private equity firms' returns dependency on economic factors is analysed. Finally, empirical research is performed on the key economic factors (inflation, interest rate, unemployment rate, GDP growth) that affect returns of US publicly listed private equity firms. Time series OLS model has been constructed using monthly data of US big four listed private equity firms' stock prices from May of 2012 until July of 2020. It has been concluded that if monthly US unemployment rate's change increases by 1 %, monthly US LPE big four companies' average stock return increases by 0.043. Moreover, if monthly US interest rate's change increases by 1%, monthly US LPE big four companies' average stock return increases by 0.072. Furthermore, if monthly US GDP's change increases by 1 trillion USD, monthly US LPE big four companies' average stock return increases by 0.135. Finally, for the inflation factor, results were not statistically significant. Hence, three of four tested economic factors – GDP, unemployment, and interest rate – were proved to have a significant impact on the United States listed private equity stock returns.

Keywords: listed private equity, private equity, economic factors, returns

Word count: 11,948

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Introduction

Private equity (PE) market has expanded dramatically over the past decade. According to McKinsey's annual 2020-year review of private markets, globally, private assets under management (AuM) grew 10 % in 2019 and 4 trillion USD in the last decade which shows an increase of 170 %. Also, over the last thirteen years, many private equity firms went public, including the industry leaders Blackstone in 2007 and KKR in 2010 (Veloso, 2018). From PE companies' point of view, more of them are going public due to easier funds raising, improved brand image, accessibility of deals in a greater number of countries and more types of assets (Veloso, 2018). While not-listed private equity is quite an illiquid asset which usually requires a high minimum size of the investment, and the investment has to be made into a wide range of funds to diversify, listed private equity (LPE) has lower barriers to entry, is more liquid, and diversification can be realized with a smaller amount of holdings (Brown & Kraeussl, 2010). Hence, these are main reasons LPE is becoming more and more popular among investors (Brown & Kraeussl, 2010). Moreover, according to Statista, the PE leader region is North America as the value of capital raised by private equity firms in the latter region was 240 billion US dollars in 2018, while in Asia and Europe it was 90 and 80 billion (n.d). It is worth mentioning that similar differences have been observed since 2010 (Statista, n.d.). Hence, the fact that the top four private equity firms – Blackstone, The Carlyle Group, KKR, Apollo – are headquartered in the United States and listed in NYSE or Nasdaq is not surprising (Private Equity International, 2020). As in the US both PE and LPE markets are developed, they create tremendous economic benefits for the US economy. For instance, in 2018, the US PE sector employed 8.8 million workers which earned 600 billion US dollars in wages (Ernst & Young, 2019). Also, in 2018, 5 % of US GDP was created by the US PE sector, and in total, 174 billion US dollars of taxes were paid by PE firms (Ernst & Young, 2019). Considering the fact that the largest PE players in the US are publicly listed, LPE firms' contribution to the economy is large, and, as the trend of PE companies going public is increasing, the contributions should only increase (Private Equity International, 2020). Therefore, it is worth analysing economically beneficial US LPE firms as, for regions like Baltics where the PE market is in the "rapid development stage" (Deloitte a, 2020, p. 2), it could give valuable insights. However, as any other industry, listed private equity is responsive to economic fluctuations such as inflation, interest rate, unemployment rate, and GDP growth. For instance, in 2020, during the COVID-19 pandemic, S&P Listed Private Equity index decreased from 176.10 points in February to 86.79 points in March, LPE share prices were sharply falling (S&P Global, n.d.; Bucak & Saigol, 2020). Moreover, it has been observed that among other research papers analysed in this work, the most discussed economic factors affecting listed and unlisted private equity stock returns and activity was GDP growth as it is a general indicator of overall economy of a country, including possible trends for PE returns and fundraising. Also, it has been noticed that research papers analysed in this work also took inflation, interest rate and unemployment rate into consideration. This could be explained by the fact that usually private equity investments are highly leveraged, hence, news of changing interest rates are very important for private equity investors. Moreover, as interest rates controlled by governments are much dependent on unemployment and inflation rates, these two measures are also analysed in the empirical part of this work. From theoretical perspective factors such as tax rate, R&D expenditure, legal environment could also be analysed, however, they were not included due to relatively small data sample. Hence, in this thesis, it has been decided to analyse to what extent the main economic factors are impacting big four publicly listed private equity firms' returns in the US. The conclusions which will be made in this analysis should be beneficial for LPE firms, investors investing in LPE as well as for markets like Baltics, where PE industry is rapidly expanding and increase of listed private equity firms is very probable.

Research Problem

To what extent are the key economic factors affecting returns of publicly listed private equity firms in the US?

Thesis Purpose

The aim of this thesis is to assess to what extent the selected economic factors are affecting publicly listed private equity firms' returns in the US.

Thesis Objectives

1. To analyse trends of listed private equity market globally and in the US as well as the specifics of publicly listed private equity firms, reasons for being listed.
2. To overview the key industries private equity firms are investing in and analyse those industries' possible dependency on economic factors such as inflation, interest rate, unemployment rate, GDP growth.
3. To examine academic literature on publicly listed private equity firms' returns dependency on economic factors such as inflation, interest rate, unemployment rate, GDP growth.
4. To analyse academic literature on private equity activity's dependency on economic factors.
5. To perform empirical research on the key economic factors that affect returns of US publicly listed private equity firms.

Methodology

To examine to what extent selected economic factors – GDP growth, rate of unemployment, interest rate, and inflation – affect stock returns of the big four LPE firms in the US, a time series model is used. The data was compiled for the analysis, calculations and tests were performed in Gretl statistical software. The period which is analysed is from May of 2012 until July of 2020.

Practical value

This thesis creates a practical value for listed private equity companies, existing and potential LPE investors, governments of countries where the private equity market is new or mature with many listed players. Moreover, as in general LPE market is quite new, more analyses and insights are needed in this field considering the fact how much the fundraising of LPE megafunds increases. As for investors, this work explains the specifics of LPE as s sub-asset class of private equity, analyses the main trends in the market, presents listed private equity stocks as an investment opportunity, and gives insights into how LPE reacts to the changes in the economy. For governments of countries such as the Unites States where both private equity and listed private equity markets are mature, this thesis explains how key economic factors are affecting the returns of the largest LPE companies which contribute a lot to the economy. Moreover, for governments, it has been shown how changes in their policies might affect these returns. For governments where PE and LPE markets are new, this thesis presents PE and LPE as potential beneficial businesses for the economy, explains how PE houses which someday in the future could be listed in a country like Lithuania might react to the changes in the economy. Finally, for LPE companies themselves, this study gives insights into how their stock returns might fluctuate because of the changes in the economy.

1. Situation Analysis

The chapter of Situation Analysis introduces United States private equity industry, including its largest publicly listed PE houses, fundraising trends in the industry, current private equity market cycle, PE returns and PE houses values, historical impact of economic fluctuations on PE industry, and analysis of main sectors PE companies are investing in.

1.1. Fundraising

Differently than other kinds of funds, PE houses do not usually have “permanent source” of capital, hence, and every 4-5 years, the houses have to come back to fund raising market and raise new capital for their investments (PwC, n.d.). The activity of raising finance has been increasing in North America PE industry during post-crisis period, and during 2014-2019 average growth rate was 14.8 % indicating increasing amounts of PE investments (McKinsey, 2020). As it could be observed from Figure 1, the rise has been largely influenced by buyout segment. It is worth noting that decrease in the buyout segment in 2018, according to McKinsey report, probably just reflect “lumpiness” in the timing of huge raises (2020, p. 7).

North American PE fundraising reached an all-time high in 2019.

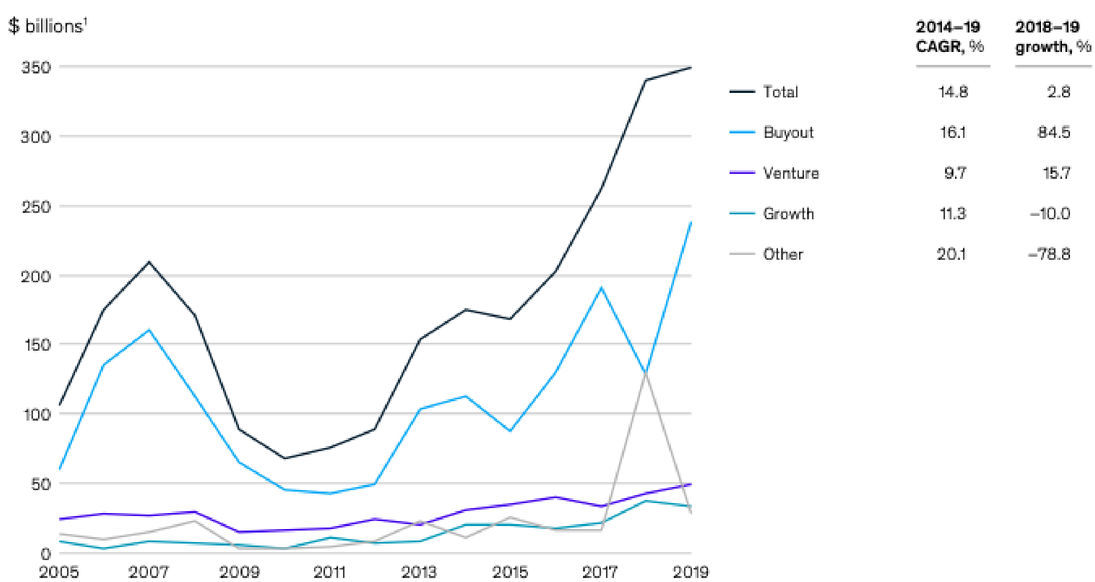

Figure 1. North American PE fundraising.

Source: McKinsey Private Equity Report 2020

In the McKinsey report it is also emphasized that more than a half of total fundraising in 2019 was caused by PE “megafunds” which each counted for 5 billion USD or more of total industry fundraising (2020, p. 9). Furthermore, it is worth pointing out that number of the buyout “megafunds” in US which fundraised 10 billion USD or more in 2015 was just 1, while in 2019 there were already 6 (Table 1). Furthermore, as it could be discovered in Figure 2, the part of large funds (>10 billion USD) fundraising in the buyout, largest PE segment, is increasing globally, not only in US, through the last decade. Actually, the funds greater than 10 billion USD dollars were responsible for 35 % fundraising (McKinsey, 2020). Hence, analysis of the largest

Table 1. North American Buyout Megafunds

North American buyout funds greater than $10 billion by year of close

	2015	2016	2017	2018	2019
Number of funds	1	1	4	2	6
Collective fundraising, $ billion	18.0	10.5	63.0	34.5	95.3

[1]Excludes secondaries and funds-of-funds.
Data source: Preqin

Source: McKinsey Private Equity Report 2020

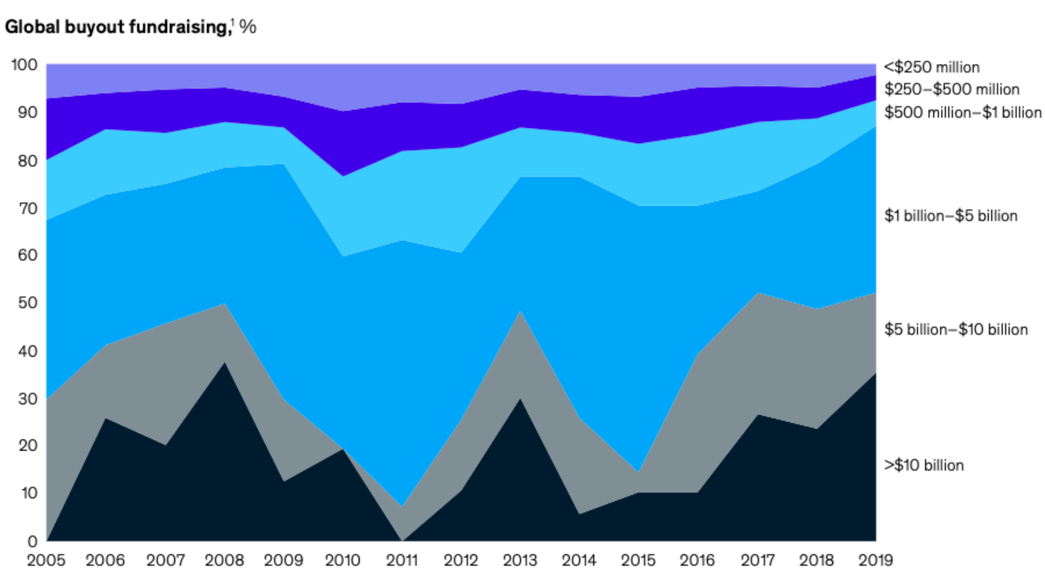

Figure 2. The Largest Buyout Funds’ Growing Share of PE Capital

Source: McKinsey Private Equity Report 2020

PE houses, which will be done in the empirical analysis part of this work, seems meaningful and necessary as these PE houses are shaping this expanding industry.

1.2. Current Private Equity Market Cycle

Even though increasing fundraising activity indicates expansion of the PE industry, due to uncertain macroeconomic conditions caused by trade wars, uncertainty due to Brexit, COVID-19 in the recent years, roughly 14 % general partners (GPs) of PE buyout funds think that current PE market cycle is already in recession while 57 % think that the cycle has reached its peak and the recession will follow in nearest future (Bain & Company a, 2020, p. 3; Figure 3). Moreover, according to Preqin data, GPs have reacted to the cycle by changing their investment strategies, completing more explicit due diligence for investments, "building more balanced portfolios to emphasize countercyclicality", increasing exits, or "getting more wary of overpaying" (Bain & Company a, 2020, p. 3-4; Figure 3). Therefore, it could be stated that PE general partners are responsive to the fluctuations in the economy, and hypothesis that changed PE houses' portfolios

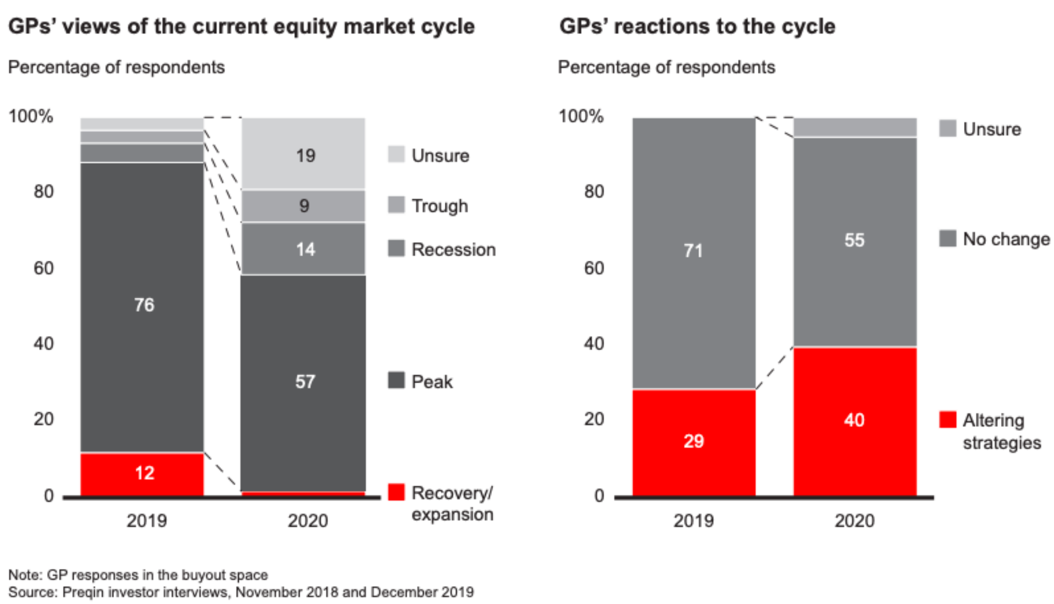

Figure 3. Private Equity Firms Preparation for Downturn

Source: Bain & Company Global Private Equity Report 2020

and investments caused by those economic fluctuations have an impact on PE houses returns could be raised, the latter will be analyzed in the empirical part of this work.

1.3. Returns and Value

As the increasing amounts of money are coming to the PE industry from investors, returns, however, at the moment in US PE industry are lower than in public US stock market (Figure 4). Actually, it is not a usual situation as in the last 10 years, it is the first time US PE market underperformed S&P 500 (Figure 4). According to Global Bain and Company Private Equity Report calculations, 10-year annualized IRR is 15.3 % for US PE buyouts and 15.5 % for S&P 500 (2020, p. 82-82; Figure 4). After financial crisis of 2008, pension funds, insurers were "pouring" money into PE funds, however, not sufficient amount of "alpha" was generated (Wiggins, 2020). Nevertheless, the amount of "dry powder" – funds collected but not yet invested by PE firms – reached a record of 2.5 trillion USD (Wiggins, 2020). However, Ludovic Phalippou, professor at Oxford University, in his recent study emphasizes that big four PE firms

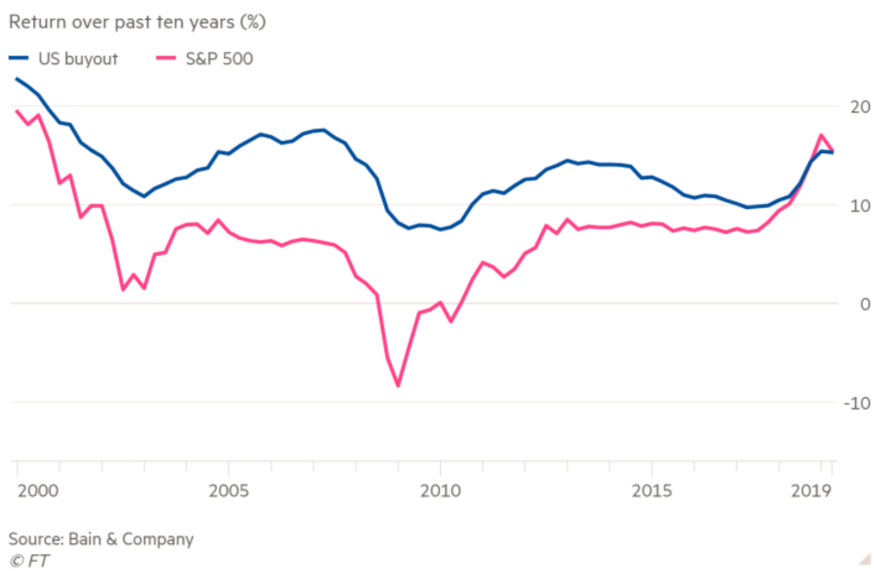

Figure 4. Returns of US Buyout Versus S&P 500 Index

Source: Bain & Company Global Private Equity Report 2020

(all publicly listed in the US) – KKR, Blackstone, Apollo, and Carlyle – showed higher IRR figures than PE average, hence, increasing number of investors are choosing these companies and most of these returns are coming there (2020). Actually, 11of 22 Private Equity industry multibillionaires are employees of one of the four largest PE firms (Phalippou, 2020). Moreover, differently than unlisted PE, publicly traded PE firms are easier to analyze because their stock prices are always available together with benchmarks such as S&P Listed Private Equity Index (Oakley, 2007). From Figure 5, which illustrates stock prices of largest PE companies, the steep prices increase of the stocks in 2019 can be observed, however, before the trend was not so drastic. However, Forbes journalist Antoine Gara notes that even though stock prices were very low until 2017, the largest PE firms were paying generous dividends to their investors (2017). For example, in 2016, Apollo earned 638 million USD net profits and 92 % of them were paid

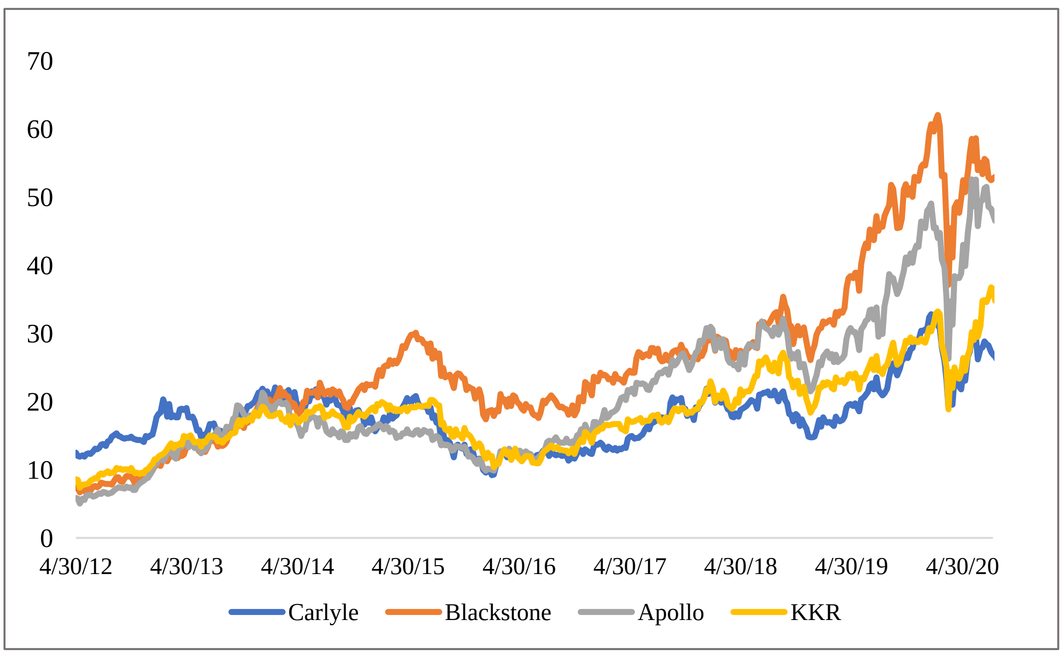

Figure 5. Weekly Adjusted Close Stock Prices of Big Four PE Firms

Source: prepared by author, data retrieved from Yahoo Finance out to investors representing 1.56 USD earnings per share (Gara, 2017). It is worth mentioning that all these big four PE companies were first time listed relatively recently – in the period 2007-2012: Blackstone – 2007, KKR – 2010, Apollo – 2011, Carlyle – 2012 (Veloso, 2018). The possible reasons for underperforming IPOs are the business structure of PE houses which does not ensure predictability of performance fees, the fact that private equity stocks are comparatively new in the stock market, the fact that shares are not included in the main market indices as S&P 500 and are largely taxed (Veloso, 2018). When comparing the stock prices since IPO day to the end of 2018, Blackstone and Carlyle share prices were even lower than IPOs which still, despite the dividends, should indicate some “red flags” to investors (Table 2). Hence, regardless of the increasing revenues and size of these firms, market values of the big four did not reflect this until 2016-2018, later the upward trend was steeper and share prices were more in line with the market (Veloso, 2018; Figure 5). Also, is observed that since 2018 until COVID-19, the stock prices were mainly increasing, however, the COVID-19-led crisis shook that stability

Table 2. Big Four PE Firms IPO Prices

	IPO date	**IPO price**	**Price 03/12/2018**
Blackstone Group	22/7/2007	36.45	32.71
KKR	15/07/2010	10.50	22.20
Apollo Global	30/03/2011	18.70	26.25
The Carlyle Group	03/05/2012	22.00	17.57

Source: prepared by author, data retrieved from Yahoo Finance

(Figure 5). The stocks, same as S&P 500 experienced the most significant drop at the end of March of 2020 and since then were recovering (Figure 5; MarketWatch, n.d.). Finally, it could be concluded that even though overall US PE buyout IRR were outperforming the market until

2019, the main listed PE firms market values do not reflect that regardless of increasing size and revenues of the firms. However, as in a last few years US PE returns are more in line with the market, it raises a question how much dependent listed PE houses really are on the overall market and economy.

1.4. Historical Impact of Economic Fluctuations on Private Equity

As nowadays market is very volatile it is important to analyze how private equity historically performed at the time of economic distresses. Recent study by Neuberger Berman investment management firm analyzed historical private equity performance during crises of the 2000s and the 2008 to obtain outlook "on current conditions with the understanding that the dynamics behind COVID-19-related volatility may be quite different from the past" (2020, p. 1). It has been observed that during the financial crisis of 2007-2009 the U.S. Buyout segment's peak-to-though net asset value decreased 28 % while S&P 500 index – 55 % (Neuberger Berman, 2020, p. 2-3). In addition, US Buyout and S&P 500 NAVs started recovering almost in the same period, however, diversified US Buyout portfolio fully recovered in the third quarter of

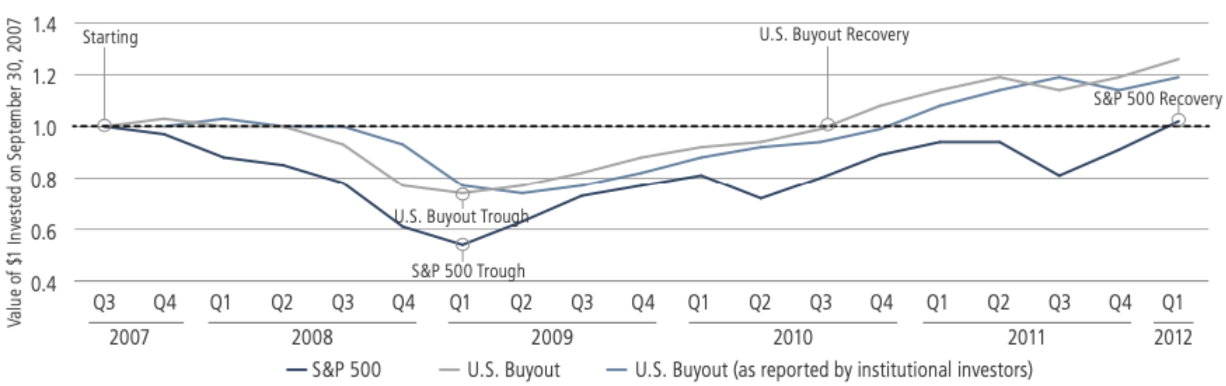

Figure 6. NAV Comparison of US Buyout Segment And S&P 500 Index 2007-2012

Source: Neuberger Berman, 2020

2010 while S&P 500 in the first quarter of 2012 (Figure 6). Moreover, quite similar full recovery results have been noticed during 2000s crisis where US Buyout portfolio has recovered 9 quarters earlier than S&P 500, even though the latter's recovery period started one quarter earlier (Figure 7). The author suggests that private equity returns experienced better performance

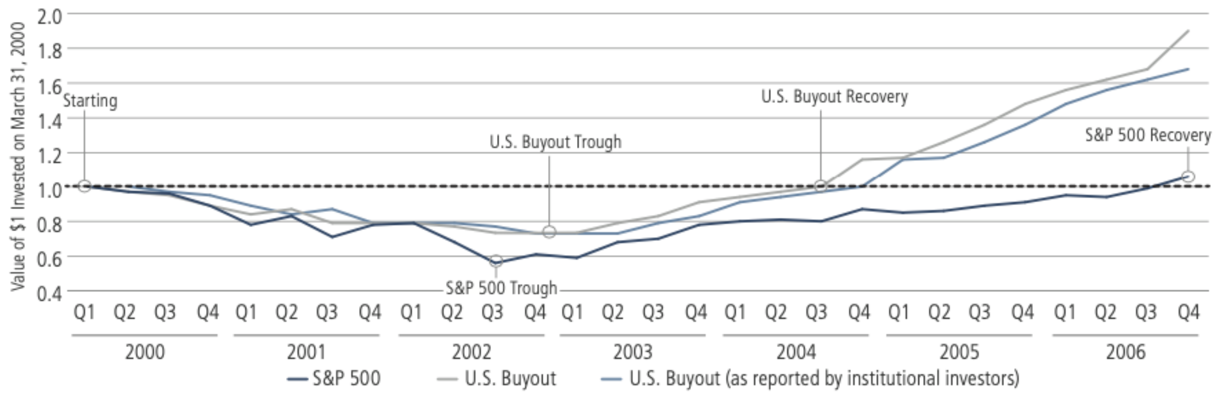

Figure 7. NAV Comparison of US Buyout Segment And S&P 500 index 2000-2006

Source: Neuberger Berman, 2020

during times of economic recessions because of the extent of control PE investors have over portfolio companies which is often exercised with ability to implement changes during times of recession (Neuberger Berman, 2020). Also, the author emphasized that unlisted PE companies might have been performing better due to greater protection from public markets (Neuberger Berman, 2020). Hence, this raises concern about listed private equity firms which both, have similar business structure as regular unlisted PE houses, however, are listed on stock exchanges and, because of this, probably are more sensitive to economic fluctuations.

As three of four current big four listed PE companies were not publicly traded on stock exchanges during financial crises of 2000s and 2008, stock price's recovery of the only listed – Blackstone – has been compared to S&P 500 (Table 2, Figure 8). It has been noticed that company's stock reached its lowest price and started recovering at the very similar time as S&P 500 index (Figure 7). Furthermore, Blackstone stock price reached the full recovery – 0.0% point

– at almost identical time as S&P 500 (Figure 7). Even though conclusions about all listed PE houses cannot not be made, it could be stated that today's PE leader's stocks were not recovering better than the overall stock market during the post-crisis period, and key economic factors affecting largest US listed PE houses returns will be analyzed in empirical part of this work.

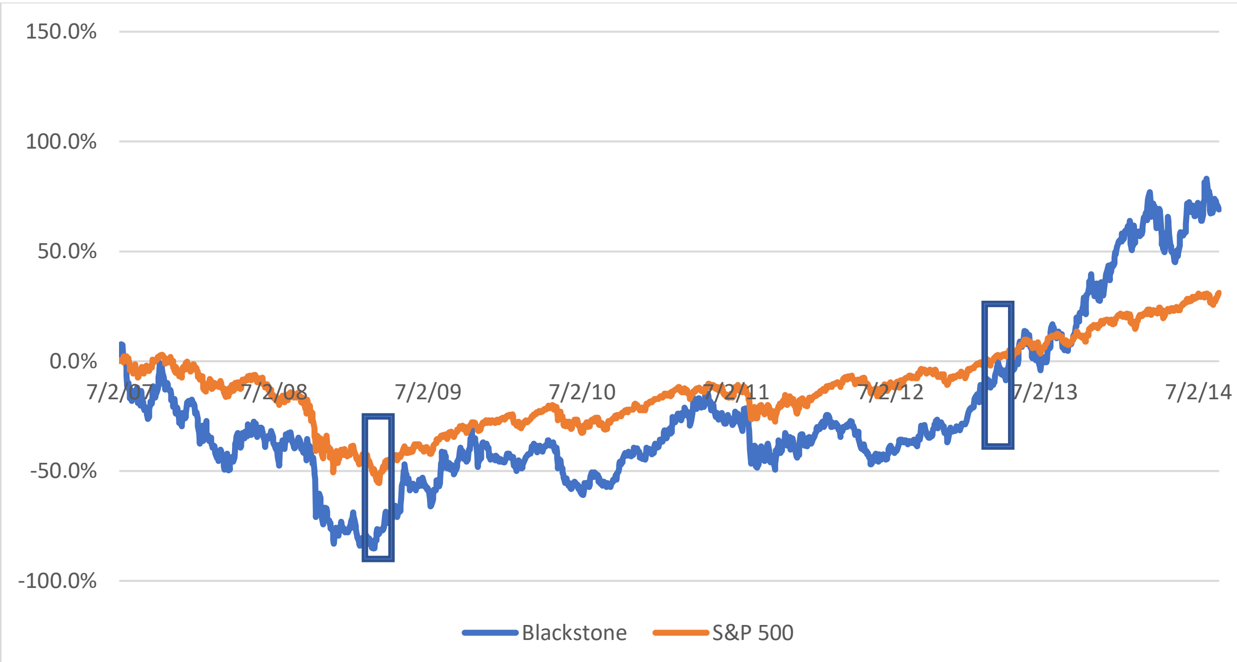

Figure 7. Stock Price Comparison of Blackstone and S&P 500 index 2007-2014, percentage

Source: prepared by author, daily stock price data retrieved from Yahoo Finance

1.5. Main Sectors US PE Firms Are Investing in

Furthermore, the sectors US PE houses are investing in are analyzed to examine the possible impact of economic fluctuations on those industries, as well as PE houses returns.

1.5.1. Technology. According to Bain & Company Private Equity Report, the main industries PE firms invest in are Financial Services, Industrials, Consumer, Healthcare, and Technology (2020). Also, it emphasized that the latest growth of PE houses EBITDA is mostly explained by increased value creation in Technology more than in other segments (Bain &

Company a, 2020). Calculated gross multiple of invested PE Capital (MOIC) in 2010-2018 shows that for every dollar invested in technology, revenues, on average, are 2.3 times greater (Figure 8). This multiple explains why the number of deals of US PE buyouts "outpaced those of nontech deals" (Bain & Company a, 2020, p. 33). Moreover, more extensively analyzing PE buyouts' investments in technology, it has been observed that investments in software are leading in generating returns with MOIC of 2.8x (Figure 8). However, the authors states

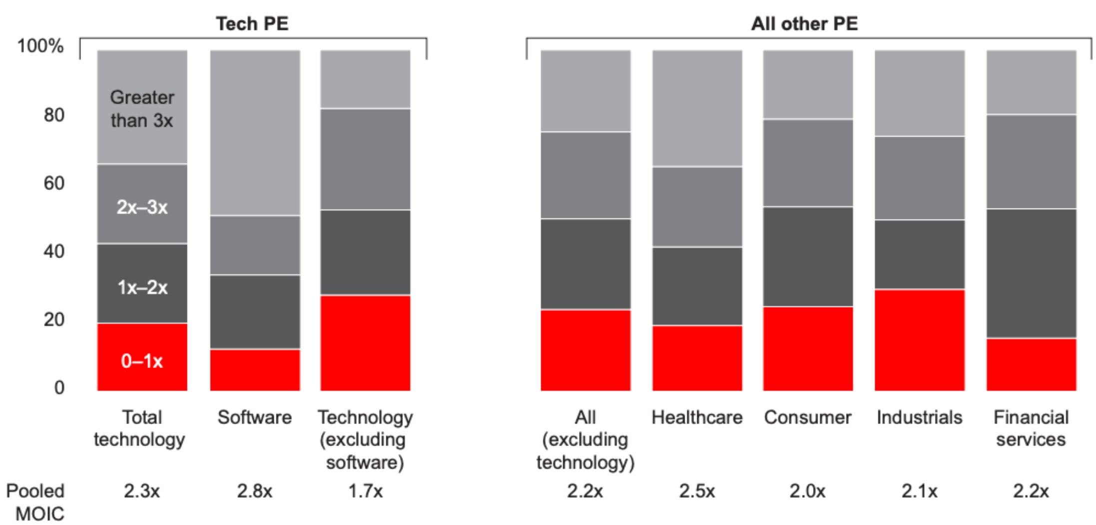

Figure 8. Global Gross Multiple of Invested PE Capital, 2010-2018

Source: Bain & Company Private Equity Report, 2020

that technology sector is booming itself as pooled market value of just four main companies – Apple, Facebook, Google and Netflix – had market capitalization of almost 4 trillion USD dollars in 2019 which was 25 % more than total Nasdaq market cap of 2018 (Bain & Company a, 2020). Moreover, risk that market will correct itself "among the most inflated tech assets is significant", however, in general PE houses avoid the most popular and inflated tech segments and are investing more in software firms which are not so sensitive to economic fluctuations (Bain & Company a, 2020, p. 30).

1.5.2. Healthcare. Furthermore, global PE healthcare sector has been expanding in the last decade, both in number of healthcare deals and as share of total PE deals (Figure 9). Moreover, healthcare's share of total PE deals is now very close to the healthcare sector share of GDP in many countries (Bain & Company b, 2020). North America continues to retain its position as largest healthcare PE market as roughly half of all PE deals were made there (Bain & Company b, 2020). Analyzing healthcare PE's responsiveness to economic fluctuations during years 2008 and 2009, the number of PE deals globally decreased, however, the share of healthcare PE deals among all PE deals significantly increased suggesting that this sector is not very sensitive to the fluctuations (Figure 9). According to Harvard University professor dr. Cutler, historically, healthcare has been "relatively immune from recessions" as people cannot choose time to get sick, hence, demand for medical care is comparatively constant across different stages business cycle (2020). However, COVID-19 recession is different as US

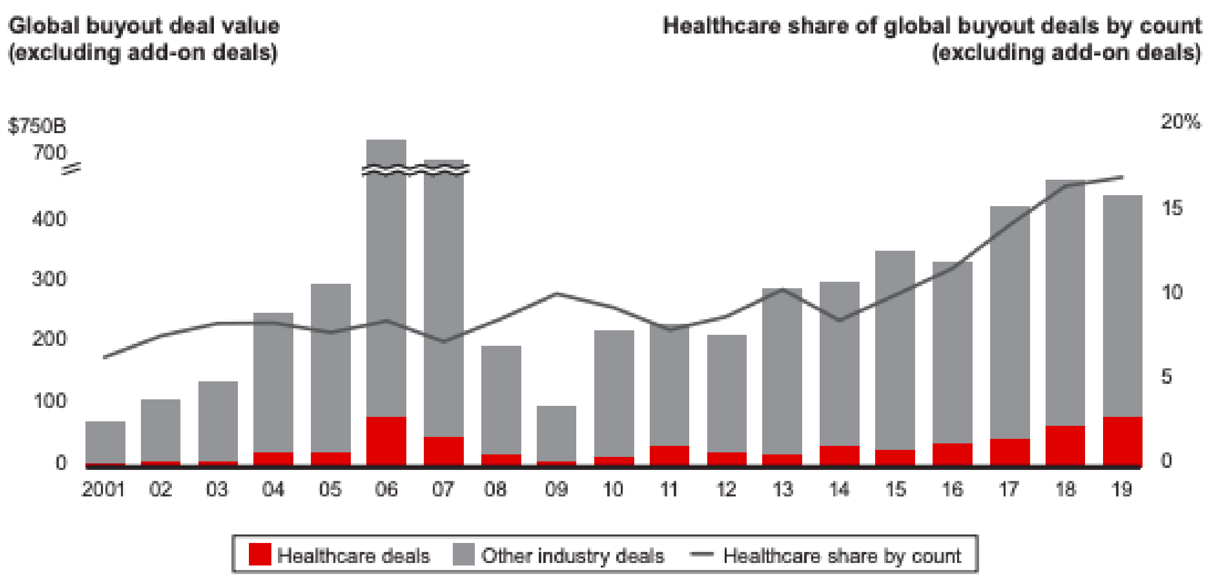

Figure 9. Global Healthcare Buyout Deal Share

Source: Global Healthcare Private Equity and Corporate M&A Report 2020 by Bain & Company insurance companies are not so generous in comparison to last recession, hence, more people in US cannot afford visits, also, people with a high risk of being infected by COVID-19 are being asked to stay at home, and these are the people who usually needs healthcare the most (Cutler, 2020).

1.5.3. Financial Services. Moreover, historically, Financial Services PE "took a harder hit than many other industries" during the latest two recessions (Cashman, Cochrane, Miller & Smith, 2019). Even though financial services PE had a great performance over the past few years with increasing deal values globally and in US, strong returns, however, now investors are adjusting for the recession risks (Cashman, Cochrane, Miller & Smith, 2019). The authors emphasize that nowadays PE houses use financial opportunities created by demographic trends like aging populations which lead to "restructuring of pensions and life insurance schemes, greater demand for wealth management, and more lending opportunities such as reverse mortgages" (Cashman, Cochrane, Miller & Smith, 2019). Figure 10 shows that the largest PE

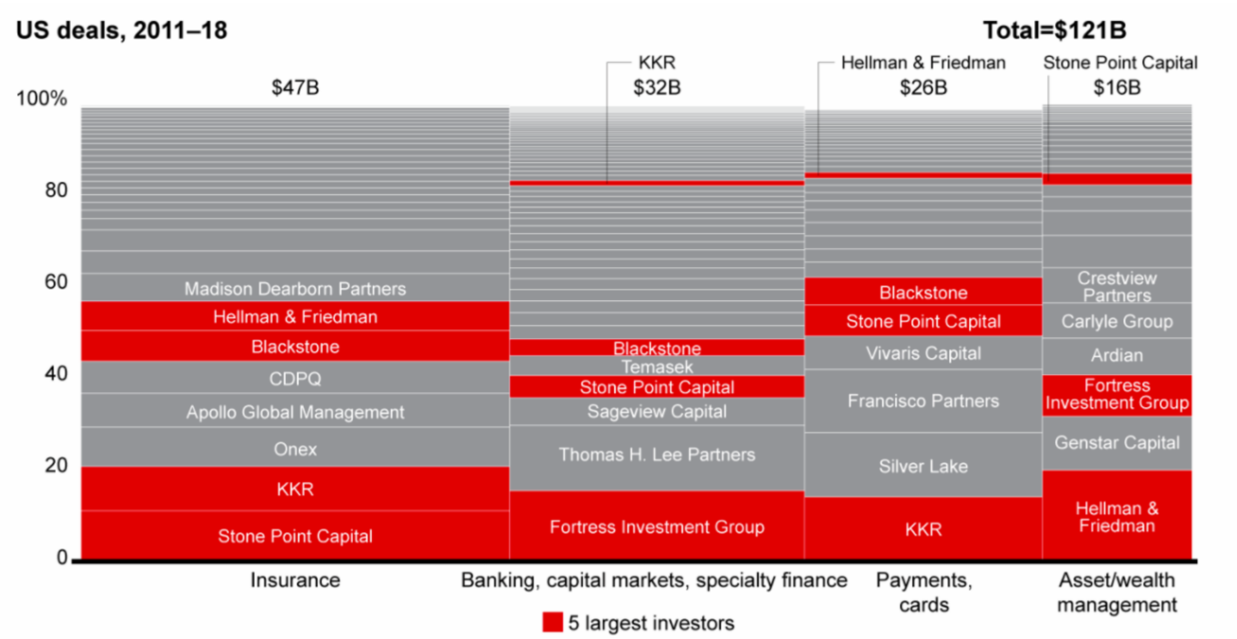

Figure 10. US PE Deals by Subsector

Source: Bain & Company, 2019

financial sector subsector is insurance with 47 billion USD in deals. It is worth emphasizing that big four listed PE companies (KKR, Blackstone, Apollo, Carlyle) together with other megafunds are responsible for a significant part of these deals, therefore, they might be sensitive to fluctuations in the industry which may be caused by economic instability (Figure 10).

1.5.4. Industrials. Another important PE segment is industrials, or manufacturing and construction, which generated, on average, 2.1x MOIC for PE houses during the period 2010-2018 (Figure 8). However, in times of recession this sector is very sensitive, for instance, during Great Recession, US manufacturing lost 20 % of its production and 15 % of workforce (Putre, 2017; Figure 11). Actually, before the Great Recession, the industry still had not been recovered from the crisis in 2001 when terrorist attacks on World Trade Center happened (Putre, 2017; Figure 11). Moreover, during the Great Depression in the 1930s, it lost about 50 % of its output (Putre, 2017). US manufacturing production has also decreased about 20 % in 2020, during COVID-19 pandemic (Figure 11). Even though in 2020 industry seems recovering faster, recent US National Association of Manufacturers survey reveals that 35.5 % of respondents state that they are experiencing supply chain problems, 53 % of companies are going to implement

Figure 11. US Manufacturing Production, Percentage

Source: Trading Economics

changes in their operations in the nearest future, 78 % believe COVID-19 will negatively affect their businesses (Figure 11; The National Association of Manufacturers, 2020). Hence, knowing the manufacturing industry's sensitivity to economic fluctuations and the fact that it is one of the largest industries PE firms are investing in, the fluctuations in economy might have significant results on PE houses, which are investing in manufacturing, returns.

1.5.5. Consumer. Finally, one more important PE segment is consumer, which generated, on average, 2.0x MOIC for PE houses during the period 2010-2018 (Figure 8). Even though US consuming trend is mainly positive in the recent two decades, "both revenue and ROA experienced notable declines during the recessions of 2000 and 2009" (Deloitte b, 2020, p. 3; Figure 12). One of the most important factors which affects consumer spending during recessions is unemployment. For instance, 2016-year study conducted by Ganong, P. and Noel, P. which analyzed anonymized data on 210,000 bank accounts of people that received

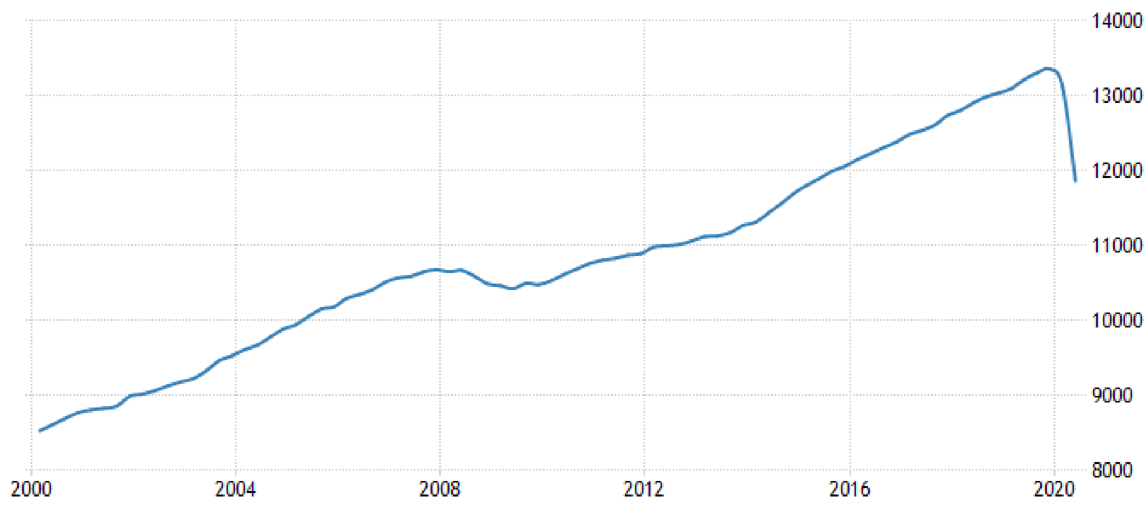

Figure 12. US Consumer Spending, USD Billion, Current Prices

Source: Trading Economics

unemployment insurance (UI) showed that UI recipients' spending decreases by 6 % at the beginning of unemployment and continues to decrease 1 % more every month UI is received. Moreover, for people who "exhaust" their UI benefits, additional 11 % decrease of spending has been observed (Ganong & Noel, 2016, p. 39). Hence, economic fluctuations are significantly affecting consumer segment activity which might cause instability of returns for PE houses investing in the sector's companies.

1.6. Big Four PE Firms Stock Prices and Economic Factors

Like many other industries, listed private equity is responsive to economic fluctuations such as inflation, interest rate, unemployment rate, and GDP growth. For instance, Gatauwa M. J. and Mwithiga A. S. state that economic "growth causes PE investments" which increase the fundraising and overall returns (2014, p. 7). Analysing US GDP, it could be noticed that from 2012 to 2020 US GDP grew quite steadily until the COVID-19 pandemic, after this event,

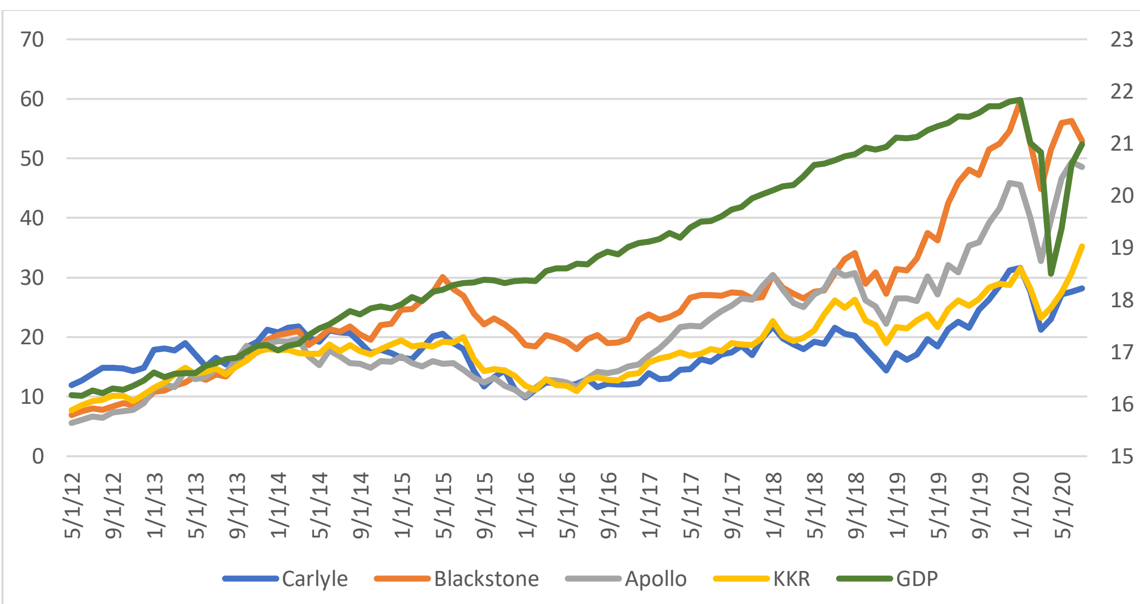

Figure 13. Monthly US GDP, trillion USD, (Right Axis), Monthly LPE Stock Prices, USD (Left Axis)

Source: prepared by author, data retrieved from YCharts

GDP sharply decreased (Figure 13). A similar fall could also be noticed in the PE big four stock prices which shows that PE stocks were responsive to the general economic slowdown (Figure 13). Big four LPE stock prices were quite steady from 2012 to 2015, however, later started fluctuating more, therefore, it is interesting to analyse to what extent these fluctuations are determined by the economic growth (Figure 13).

Moreover, the general trend of a decreasing unemployment and increasing stock prices could be noticed (Figure 14). However, when analysing the fluctuations themselves, in many cases an increase in unemployment goes together with increase of stock prices (Figure 14). Some would state that higher unemployment is beneficial for private equity mainly because at the times of high employment it is hard for private equity portfolio companies, especially industrial, to recruit competent employees without causing wage inflation (Alvarez & Marsal, 2018). Also, it is a general knowledge that an increase of unemployment is expected to cause decrease in interest rate which is beneficial for stock market.

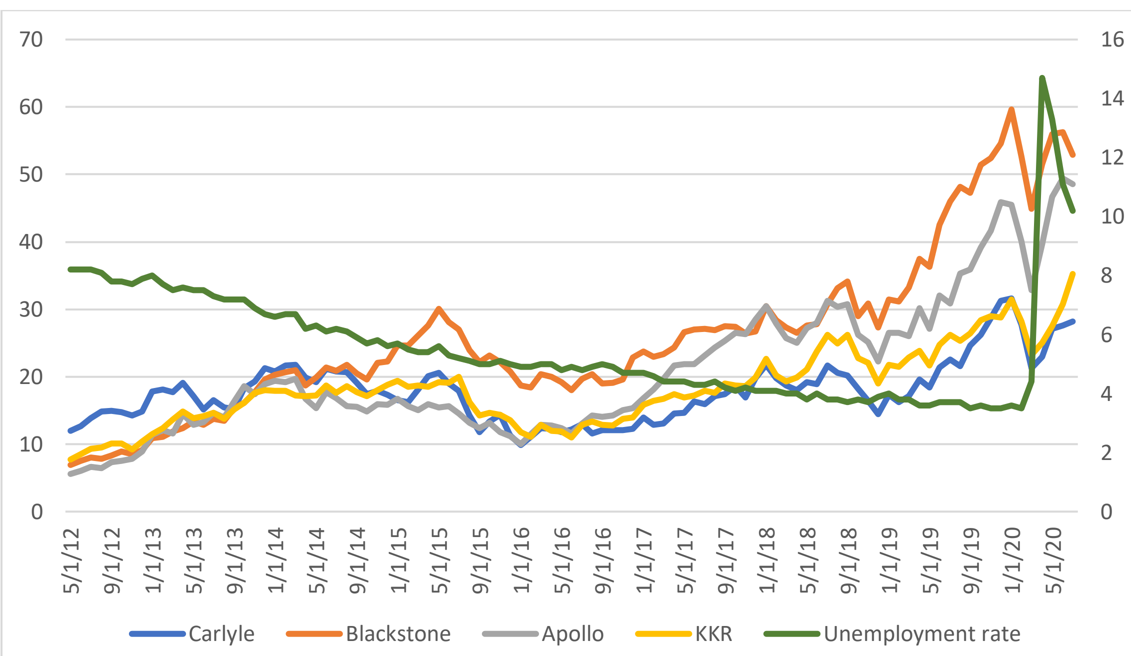

Figure 14. Monthly US Unemployment, Percentage (Right Axis), Monthly LPE Stock Prices, USD (Left Axis)

Source: prepared by author, data retrieved from FRED, Yahoo Finance

Furthermore, the inverse relationship between an increase of the US Fed interest rate and the big four stock prices could be expected as PE firms usually use leveraged capital for the buyouts, and the increased cost of debt could strongly affect the firm's returns (Breiten, 2015). Through the period of this analysis, the first increase of the Fed rate happened in January of 2016, and it could be noticed that the stock prices were not increasing the whole year (Figure 15). From 2017 to the beginning of 2019, the further increase of interest rates could be noticed, and it has been observed that stock prices, even though had a mainly upward trend, were highly fluctuating which may be partially caused by the interest rates (Figure 15). Moreover, the Fed interest rate stabilized for half a year from January to July of 2019, and it has been observed

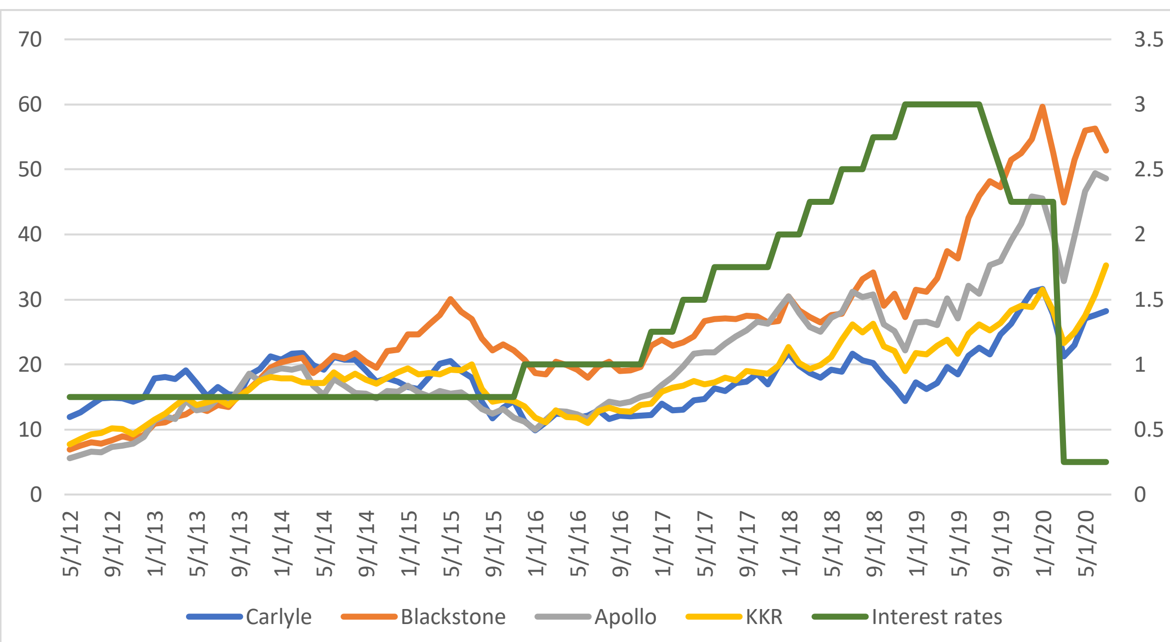

Figure 15. Monthly US Discount Rate, Percentage (Right Axis), Monthly LPE Stock Prices, USD (Left Axis)

Source: prepared by author, data retrieved from FRED, Yahoo Finance

that stock returns were mostly increasing during this period (Figure 15). After July, the Fed interest rate has been decreasing and stock prices were booming until the middle of February which supports the hypothesis that listed PE stock prices and Fed interest rate to some extent may be inversely related (Figure 15). The sharp decrease in stock prices from the end of February until the end of April of 2020 could be explained by the COVID-19-led chaos in the country, however, stocks started recovering in the last months (Figure 15; McIntyre, Pickert & Qiu, 2020).

Finally, in general, stocks "seem to be more volatile during highly inflationary periods" (Zucchi, 2020). Even though the consumer price index increase rate was quite stable and controlled by the interest rate through the period of 2016-2020, some more drastic fluctuations

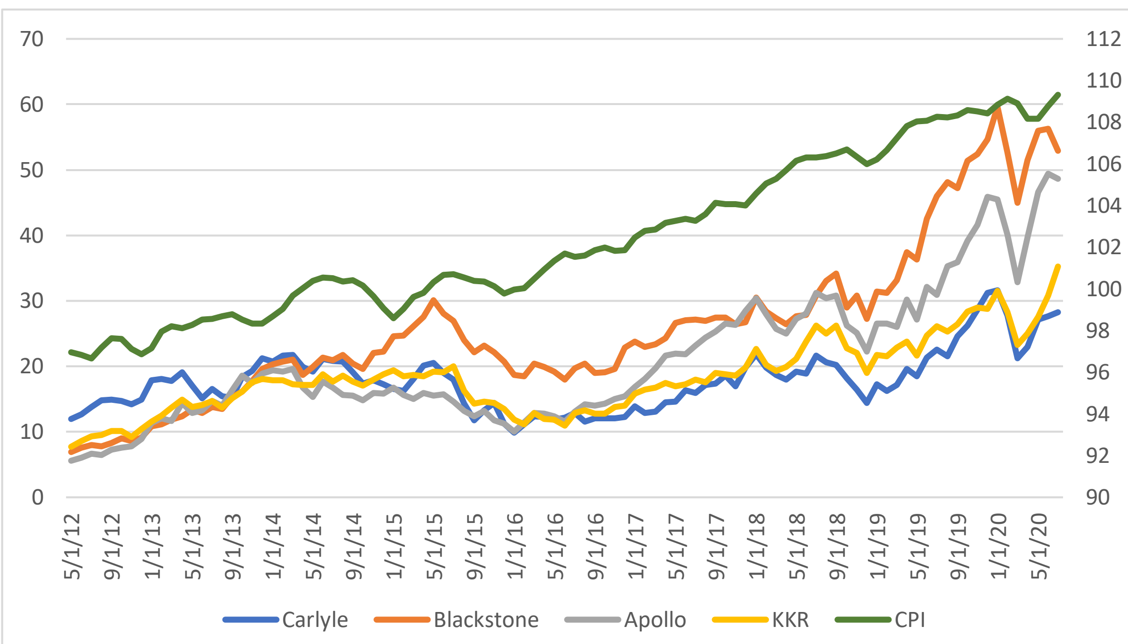

Figure 16. Monthly US CPI, 2015=100 (Right Axis), Monthly LPE Stock Prices, USD (Left Axis)

Source: prepared by author, data retrieved from OECD, Yahoo Finance could be noticed until 2016 when the interest rate was mainly constant and low (Figures 15,16). During that period, except for Blackstone’s temporary peak, stock prices were performing quite poorly, therefore it is interesting whether this performance was influenced by drastic inflation peaks in 2014 and 2015 (Figure 16). Finally, some not so sharp CPI fluctuations are noticeable from 2016 as well, hence, it is interesting to analyse to what extent stock prices’ fluctuations are determined by this inflation.

2. Literature Overview and Research Methodology

Listed private equity returns dependency on economic factors has been discussed and examined in other authors' research papers, however, not widely. It has been observed that authors whose works have been discussed in this section, analysed listed private equity stock indices returns' dependency on economic factors rather than examined big four LPE or other specific firms.

2.1. Macroeconomic Factors Affecting Listed Private Equity Returns

First of all, Dopke and Tegtmeier studied "macroeconomic risk factors driving the expected stock returns of listed private equity" (2018, p. 340). The authors used a data set of LPE indices of the period from 2004 until 2016 and analysed them by different regions to evaluate countries' macroeconomic risks and risk premiums of the indices which drive the returns (Dopke & Tegtmeier, 2018). The authors' findings show that listed private equity "exhibit a significantly higher (covariance) risk than the overall stock market" measured by betas (Dopke & Tegtmeier, 2018, p. 355). However, it has been discovered that coefficients differ depending on "organizational form, regional country focus and style of the respective index" (Dopke & Tegtmeier, 2018, p. 355). Moreover, the authors emphasize that world market risk is insufficient to evaluate listed private equity stocks, additional macroeconomic factors have to be taken into account (Dopke & Tegtmeier, 2018). The authors emphasize that "economic policy uncertainty" proves to be the most important of all macroeconomic factors (Dopke & Tegtmeier, 2018, p. 355). It is explained that governmental policy is ubique and it is tremendously hard to diversify this risk (Dopke & Tegtmeier, 2018). Also, the authors draw attention to the fact that this systematic risk factor drives the expected shares returns during weak economic conditions of the economy the strongest (Dopke & Tegtmeier, 2018). Dopke & Tegtmeier have discovered that listed privacy indices risk and returns profile differs from the country indices, hence, LPE could be used for greater diversification of investor portfolio (2018). Moreover, considering all the factors analysed by the authors, inflation and global economic policy instability were statistically significant (Dopke & Tegtmeier, 2018). The inflation coefficient has a positive sign as well as global economic policy instability for the vast majority of indices analysed (Dopke & Tegtmeier, 2018). However, the authors agree that the results of the latter are quite surprising as many other researches showed the opposite results related to economic instability and stock returns (Dopke & Tegtmeier, 2018). Hence, inflation and economic growth factors will be analysed in the empirical part of this work.

Furthermore, other authors Jegadeesh, Kraussl & Pollet have also analysed the risk-return profile of listed private equity, and the same as Dopke & Tegtmeier's, the authors analysed LPE indices, however, additionally they analysed listed private equity funds of funds (FoF) indices (2009). Jegadeesh, Kraussl & Pollet discovered that "one standard deviation change in GDP growth leads to 2.04 % and 1.29 % increase in excess returns for FoFs and LPEs respectively" (Jegadeesh, Kraussl & Pollet, 2009, p. 27).

Moreover, the authors summarize the main similarities between listed and unlisted private equity which could be affecting the returns as follows:

> The managers of LPEs are compensated through management fees and performance fees similar to unlisted PE funds. The LPEs also invest in private equity. These LPEs have the same opportunity sets as PE funds, to the extent that excess returns may be available to skilled investors who specialize in PE investments (Jegadeesh, Kraussl & Pollet, 2009, p. 4-5).

However, there are differences as well which lead to analysing listed private equity as a separate asset class:

> <…> PE funds' partnership structure may contribute to their value since they are not exposed to agency costs associated with diffusely owned publicly traded firms. Also, since PE funds have finite lives, they are committed to returning to their investors when they float funds in the future. Therefore, their reputational concerns provide them with an added incentive to perform. Since LPEs have an indefinite life, they are relatively insulated from such concerns (Jegadeesh, Kraussl & Pollet, 2009, p. 5).

Moreover, Boyd, Jagannathan & Hu analysed how increasing unemployment affects stock returns (2001). It has been discovered that unemployment positively affects stock returns during times of economic expansion and negatively during times of economic contractions (Boyd, Jagannathan & Hu, 2001). This phenomenon was explained by the fact that increasing unemployment signals two main things for investors: information about declining interest rates which is a positive effect for stocks as market premium increases, and information about decreasing corporate earnings and dividends due to economic contraction (Boyd, Jagannathan & Hu, 2001). In the times of economic expansion, "good news" about declining interest rates, increasing earnings and dividends cancel out "bad news" because of economic stability, consequently, in times of economic contraction "bad news" are more important because an unstable economy signals lower firms' earnings and declining interest rates usually do not sufficiently cancel the latter during economic slowdowns (Boyd, Jagannathan & Hu, 2001).

2.2. Cyclicality of Listed Private Equity

Furthermore, a recent 2019-year study that analysed the "Sell in May" effect on listed private equity indices' returns showed that this phenomenon is typical for listed private equity and, hence, could be considered when investing in this asset class (Bachmann, Gebhardt, Tegtmeier & Steinborn, 2019). Even though calendar effects will not be analysed in the empirical part of this work, “Sell in May” research gives some valuable information for asset managers and investors who are going to invest in listed private equity. The results show that a simple trading strategy with just two trades a year should be more profitable than a “buy and hold portfolio” (Bachmann, Gebhardt, Tegtmeier & Steinborn, 2019, p. 805). The existence of this phenomenon means that typically LPE stock indices returns are drastically lower during summer than during winter (Bachmann, Gebhardt, Tegtmeier & Steinborn, 2019). However, it is worth emphasizing that even though the effect was statistically significant, the “Sell in May” investment strategy should be used carefully on LPE, because the statistical significance is not very high (Bachmann, Gebhardt, Tegtmeier & Steinborn, 2019).

2.3. Are Investments Affecting Economy?

It is interesting to mention that some researchers do not only investigate how stock returns are affected by economic factors but also the inverse relationship is analysed. In a recent study, Ahmed, Elgammal & McMilan have analysed whether stock prices and some stock factors changes could predict GDP growth (2020). The authors used a tremendous dataset of United States stock portfolios from 1964 to 2019 (Ahmed, Elgammal & McMilan, 2020). Finally, the results showed that “stock prices reflect expectations regarding future movements in economic conditions” (Ahmed, Elgammal & McMilan, 2020, p. 343). Moreover, some stock factors such as Q-ratio (fair value of the stock) also had “predictive power across all time horizons considered” (Ahmed, Elgammal & McMilan, 2020, p. 343). For other investigated stock factors, there was not a lot of evidence to have predictive power, however, it has been noticed that during contraction periods predictability improves (Ahmed, Elgammal & McMilan, 2020). Differently than Dopke & Tegtmeier (2018) and Jegadeesh, Kraussl & Pollet (2009), Ahmed, Elgammal & McMilan (2020) analysed the stock market in general, not listed private equity separately, however, the insights of the authors are beneficial for this research as the selected country of analysis is the United States, same as the geographical area of this work.

Moreover, Bernstein, Lerner, Sorensen & Stromberg in 2010 analysed whether private equity investments are improving the performance of the industry the investment is made to. Bernstein, Lerner, Sorensen & Stromberg found that:

> <…> industries with PE deals have significantly higher growth rates of production and value added. <…> the coefficient of 0.906 implies that the total production of an average PE industry grows at an annual rate that is 0.906% higher than a non-PE industry. Value added for an industry appears to be increasing in the amount of PE activity, with the differences between high and low PE industries being statistically and economically significant (Bernstein, Lerner, Sorensen & Stromberg 2010).

However, even though results seem very promising and Bernstein, Lerner, Sorensen & Stromberg (2010) same as Ahmed, Elgammal & McMilan (2020) employed large data set with more than 8500 observations, the authors are still concerned about the causality of these results. It could have been that PE investors only choose industries that are starting to grow, hence, for this reason, researchers later used twice-lagged data for the test (Bernstein, Lerner, Sorensen & Stromberg, 2010). The results were very similar, therefore, authors indicated the effect of the better industry performance “is unlikely to be driven by PE investors entering countries and industries where they expect stronger immediate growth” (Bernstein, Lerner, Sorensen & Stromberg, 2010, p.15).

Even though there are researches which analyse the stock market's, private equity market's contributions to the economy, particular industries, their growth, this research will only empirically analyse listed private equity's dependency on economic factors. The main reason for this is the limitation of the small data sample, however, it has been shown that from a theoretical perspective the inverse relationship could also be considered.

2.4. Macroeconomic Factors Affecting Private Equity Activity

Another comprehensive study which analysed macroeconomic factors affecting private equity activity suggests that "economic activity, the inflation rate, equity market capitalization, unit labour costs, the unemployment rate as well the institutional and legal environment are significant determinants of PE activity" (Bernoth & Colavecchio, 2014). Even though this research analyses private equity asset class and not the sub-class of listed private equity, it provides reasonable insights which might be also valid for listed private equity. The data of this research covered the period from 2001 until 2011, and 13 European countries. Moreover, the economic factors taken into consideration were the annual real GDP growth rate, inflation (annual change of CPI), total unemployment rate (Bernoth & Colavecchio, 2014). Furthermore, as for the financial environment, short-term interest rate, corporate tax rate, and some other factors were considered (Bernoth & Colavecchio, 2014). Also, the researchers included factors such as labour productivity, labour costs, and regulations of employment (Bernoth & Colavecchio, 2014). Finally, political, legal and social environment factors' influence on PE activity has been analysed making this research even more comprehensive and holistic (Bernoth & Colavecchio, 2014). The findings of this research show that out of 42 factors that were considered affecting PE activity "only 9 appear to be 'robustly' correlated to PE investments" (Bernoth & Colavecchio, 2014, p. 1181). Firstly, "the faster a country is growing in terms of

GDP, the more PE investment is attracted" (Bernoth & Colavecchio, 2014, p. 1181). Also, differently than the research which analysed LPE returns, the authors found "negative coefficients of the inflation rates, a general indicator of macroeconomic stability" (Bernoth & Colavecchio, 2014, p. 1181; Dopke & Tegtmeier, 2018). Moreover, the results showed that the "unemployment rate in Western Europe appears to play a positive and strong role in PE investment decision" (Bernoth & Colavecchio, 2014, p. 1181). As for inflation, results are not straightforward:

> The coefficient on the inflation rate shows the expected negative sign for both country groups <…>. However, inflation appears to have a significant impact only on the Western European PE markets while the decision to invest in firms located in CEE countries is unaffected by the respective inflation rates (Bernoth & Colavecchio, 2014, p. 1180).

As before mentioned, authors found a positive relationship between listed private equity returns and inflation, these authors present a negative relationship between inflation and PE activity which is quite contradicting, however, as this negative relationship was not noticed in both regions analysed, it could depend on a country (Bernoth & Colavecchio, 2014; Dopke & Tegtmeier, 2018). Furthermore, another research examining macroeconomic determinants' effects on private equity activity analysed factors such as level of transparency in a country, level of tax, expected GDP growth rate, and even type of law system in the country (Aarekol, 2016). The hypotheses were saying that transparency level and expected GDP growth rate should be positively correlated with the PE activity in the country while higher tax level should be negatively correlated, and, finally, it was guessed that there is a significant difference in private equity activity between civil law and common law countries (Aarekol, 2016). Even though only two factors proved to be statistically significant – a level of corruption and legal system, the author suggests that for further analysis it would be worth to look whether higher PE activity means higher returns:

> It would be interesting to see if the independent variables in this study actually have an effect on PE investors outcome, hence if investors have a higher return in common law countries and countries with little or no corruption (Aarekol, 2016, p. 54).

As for expected GDP growth which did not prove to be a statistically significant factor on PE activity in a country, the author admits that expected GDP growth rate is just a prediction and “it is no way of knowing if what the actual growth in GDP will be for the coming years” (Aarekol, 2016, p. 53). Therefore, in the empirical part of this work simple GDP growth, not expected, will be used. It could be noticed that before discussed author used simple GDP growth and found a significant positive correlation between the factor and PE activity in a country (Bernoth & Colavecchio, 2014). It is worth emphasising that GDP growth (simple or expected) is one of the most important factors which was analysed in all the researches examined, and it could be explained by below:

> <…> markets will be more attractive to invest in if there is growth in it. Businesses can grow with the expanding market and there will be less fight for resources, compared to a market with no growth, or a declining economy (Aarekol, 2016, p. 32).

Moreover, Dias & Macedo analysed what drives the supply and demand for private equity and venture capital (2016). The authors found out that “a positive relationship between the levels of financing generated by PE/VC funds and the depth of the capital market” (Dias & Macedo, 2016, p. 17). It has been observed that PE/VC supply and demand increase when the number of IPOs, mergers and acquisitions, stock volume increase in that particular market (Dias & Macedo, 2016). The author states this explains the reason why the United States is the largest PE/CV market (Dias & Macedo, 2016). Of course, it is not the only factor, but it is a very important, as there is very clear relationship between “the depth of the capital market and the amount of funds raised” (Dias & Macedo, 2016, p. 17). Furthermore, Dias & Macedo, as many other researchers discussed in the literature review, analysed how economic activity in a country (GDP per capita and GDP growth in percentage) have impacted the fundraising (2016). It has been confirmed that economic activity in the country and fundraising are positively related, however, as the results were significant only at 10 %, the authors suggest that a longer period and larger sample probably should be analysed (Dias & Macedo, 2016). Hence, summarizing all the factors discussed, it could be assumed that PE investments are attracted to the countries due to opportunities and probably high expected returns, macroeconomic factors affecting PE investment activity might be also affecting (L)PE returns.

2.5. Macroeconomic Factors Affecting Firm’s Financial Performance

Egbunike & Okerekeoti (2018) analysed macroeconomic factors’ influence on manufacturing firms’ returns on assets (ROA) in Nigeria. Most of the economic factors analysed by Egbunike & Okerekeoti (GDP growth rate, interest rate, and inflation) are the same as analysed in this work (2018). The research found no significant effect on ROA for interest rate, however, there was a significant effect on GDP growth and inflation (Egbunike & Okerekeoti, 2018). Even though this study might seem quite unrelated to listed private equity, however, its results are worth analysing because, first of all, the manufacturing industry is a very popular choice for private equity investments (Figure 8), consequently, economic factors affecting firms financial performance are also affecting PE portfolio returns the firm belongs to, and finally, a significant effect for GDP growth and inflation also partly supports the selection of economic factors chosen in this work. Moreover, Egbunike & Okerekeoti indicated "(CPI), unemployment, gross domestic product (GDP), stock market index, corporate tax rateand interest rates" as key economic factors affecting firm's returns (2018, p. 142). Egbunike & Okerekeoti study showed that GDP had a positive effect on firms' ROA which confirmed authors' which accepted alternative hypothesis. As for inflation, it had a negative effect on ROA, therefore the effect is different than for stock returns analysed by Dopke & Tegtmeier in 2018 but the same as for PE activity analysed by Bernoth & Colavecchio in 2014.

2.6. Research Methodology

In this research, to examine to what extent GDP growth, rate of unemployment, interest rate, and inflation affect stock returns of the big four LPE firms in the US, a time-series model is used. These variables of economic factors have been chosen because they were most comprehensively discussed in the works of other researchers and due to the fluctuations and possible relations discussed in the situation analysis. Listed private equity firms – Blackstone, The Carlyle Group, KKR, Apollo – have been chosen because they are the largest US LPE firms at the time of research according to Private Equity International (2020). Moreover, as mentioned in the situation analysis, the geographical area of research – the US – has been chosen because it is the largest private equity market globally.

2.6.1. Hypotheses of the Thesis. After examination of academic literature and completion of situation analysis, the following four hypotheses have been derived:

H1: GDP growth in the US has a positive impact on the big four US LPE stock returns

H2: Increasing unemployment rate in the US has a positive impact on the big four US LPE stock returns

H3: Increasing interest rate in the US has a negative impact on the big four US LPE stock returns

H4: Increasing inflation in the US has a negative impact on the big four US LPE stock returns

Hence, these four hypotheses are tested in the empirical part of this thesis.

2.6.2. Data Types. For any empirical research, it is very important to select relevant and convenient statistical data. Three of the most common statistical data types are cross-sectional, panel data, and time series (Buteikis, 2020). The first one, cross-sectional data, is "collected in a single time period and is characterized by individual units" such as firms, people, cities, or countries (Buteikis, 2020). With this type of data, the order of data is not important (Buteikis, 2020). Another type, time series data, is collected "at a number of specific points in time" (Buteikis, 2020). The examples of this data could be stock prices, exchange rate, GDP (Buteikis, 2020). Besides, this type of data could be collected "hourly, daily, weekly, monthly, quarterly, annually, etc." (Buteikis, 2020). Moreover, differently than for cross-sectional data, the ordering of time series data matters as every point "represents the values at specific points in time" (Buteikis, 2020). Finally, the panel data type is a combination of above mentioned two types.

The original dataset of this thesis has a panel structure, however, it was reconstructed to a time-series dataset. In the initial data set, there are four cross-sectional units, four firms, however, it has been decided to compile the returns data of four firms into one returns variable using averages. The first reason is that this thesis focuses not on separate returns of each firm but on the big four LPE returns in general. The second reason is that as this thesis focus on one geographical area – the US – independent variables which are economic factors of the country have the same values for all four firms, hence, Gretl cannot fully interpret this data as panel data.

2.6.3. Dependent Variable. The dependent variable of this thesis, monthly LPE stocks' return, in general, should be calculated by the formula below.

$$Total\ Stock\ Return = \frac{(P1 - P0) + D}{P0}$$

Where:

P0 = Initial Stock Price

P1 = Ending Stock Price

D = Dividends

However, as adjusted stock prices were used, the below formula is sufficient.

$$Total\ Stock\ Return = \frac{(P1 - P0)}{P0}$$

Where:

P0 = Adjusted Initial Stock Price

P1 = Adjusted Ending Stock Price

Finally, stock returns of the big four LPE firms are summed and divided by four to get the average. In this formula, all four firms have equal weight as not actual prices, but the returns are calculated. This step could be explained by the fact that all four firms belong to the same LPE "megafunds" category.

$$LPE\ Stocks\ Return = \frac{Total\ Stock\ Return1 + Total\ Stock\ Return2 + Total\ Stock\ Return3 + Total\ Stock\ Return4}{4}$$

2.6.4. Time Series Analysis. Time series models are composed quite similarly to other regression models as they can indicate a positive or negative correlation (Seber & Wild, n.d.; Gerbing, 2016). Moreover, time series models have two main parts in the equation: a fixed component which is a trend and a random error (Seber & Wild, n.d). Furthermore, observed time series data are often non-stationary, have a trend or cyclical variations that need to be eliminated for time series analysis' unbiased results (Gerbing, 2016; Plaza, 2009; Seber & Wild, n.d.). Hence, smoothing, differencing, indexing, or deseasonalizing are often applied (Seber & Wild, n.d.). Also, it is very important that tests of stationarity "precede" tests of causality to prevent invalid regressions (Plaza, 2009, p. 477). One of the most popular tests to examine the stationarity of variables is the Dickey-Fuller test (Plaza, 2009). Other tests that could be applied are Augmented Dickey-Fuller and KPSS. Besides, in time series analysis it is important to check for autocorrelation which is a correlation between variable and lag of itself, and partial autocorrelation which is the same as autocorrelation except that it controls for a correlation of shorter lags. Finally, after the regression model is created, normality of residuals, heteroscedasticity of residuals, multicollinearity, and autocorrelation of residuals should be tested to check if the model is valid. The simplest linear trend model might be expressed as below:

$$Yt = b_0 + b_1X(t) + \varepsilon(t)$$

Where:

Y_t = value of dependent variable at time t

b_0 = intercept, where t = 0

b_1 = slope of the coefficient of the time trend

X_t= independent variable

t = time period

ε_t = error term

3. Empirical Research

The final objective of this thesis – to perform empirical research on the key economic factors that affect the returns of US publicly listed private equity firms – is completed in this part of the thesis. The time series regression is constructed, and tests are applied to check the validity of the model. Moreover, the hypotheses are being tested and results are analysed, interpreted, and presented. Besides, Gretl statistical software is used to perform all the calculations. Moreover, the limitations of this research and recommendations for future investigation are provided. Finally, the main goal of this part is to solve the main problem of the thesis and answer the question to what extent the key economic factors are affecting returns of publicly listed private equity firms in the US.

3.1. Data Sample

The data sample of this research covers the period from 2012 May to 2020 July. This start of the observation is selected because the last of the big four LPE companies (Blackstone, The Carlyle Group, KKR, Apollo) got listed at that time while this end date of the observations is selected due to availability of the latest information of economic factors data used in this research. Besides, the data are observed monthly, hence, totally there are 99 periods observed. All selected economic factors observations are focused on one geographical area – the United States. Moreover, the data sample is constructed as a typical time-series data set. Finally, calculations mentioned in research methodology have been applied to construct the dependent variable.

3.2. Variables

The regression model constructed in this empirical research has one dependent (LPE return), four independent variables (GDP growth rate, inflation, unemployment rate, and interest rate), and one categorical variable (COVID; with categories “NO COVID” and “COVID”).

Table 3. Definition of variables

Variable	Type	Definition	Measure unit	Source	Expected effect
RETURN	Dependent variable	Monthly US LPE big four companies’ average stock return	Return units (not percentage)	Yahoo finance	Not applicable
GDP	Independent variable	Monthly US GDP change	Trillion USD	YCharts	Positive
INFLATION	Independent variable	Monthly US inflation calculated (CPI(t)-CPI(t-1))/ CPI(t-1). CPI 2015=100	Inflation rate units (not percentage)	OECD	Negative
UNEMPLOYMENT	Independent variable	Monthly US unemployment	Percentage points	Federal Reserve Bank	Positive
INTRATE	Independent variable	Monthly US interest rate	Percentage points	Federal Reserve Bank	Negative
COVID	Categorical variable	Category “COVID” – months when there were Covid-19 cases in US plus one previous month, category “NO COVID” – months when there were not Covid-19	Not applicable	Health Data.gov	Negative for category “COVID”

	cases in the US minus one last month when Covid-19 was not present.	

3.3. Regression Equation

After the literature review and selection of dependent and independent variables, a regression model is constructed to test if the raised hypotheses are valid. General linear trend model has been adjusted to the research problem and empirical objective of this thesis. Finally, the regression model could be presented as below:

$$RETURNS_t = \beta_0 + \beta_1 x\ INFLATION_t + \beta_2 x\ UNEMPLOYMENT_t + \beta_3 x\ GDP_t + \beta_4 x\ INTRATE_t + \beta_5 x\ COVID_t + \varepsilon_t$$

3.4. Descriptive Statistics

Before the regression equation is built, descriptive statistics of the variables used in this research are summarized. It has been observed that values of dependent variable “returns” and independent variables “inflation” and “GDP” are negatively skewed meaning that their frequency distribution from minimal and maximum values are more concentrated on the right (Appendix A). Meanwhile, remaining values unemployment and interest rate are positively skewed meaning that values in the distribution are concentrated on the left (Appendix A). Besides, there were more observations of months when Covid-19 was not present (Appendix A). Hence, frequency distributions of all variables are not completely symmetrical.

Table 4 shows that unemployment in the United States during the research period ranged from 3.5 % to 14.7 % with an average of 5.6 % unemployment and a standard deviation from the mean of 2.0 %. Moreover, interest rate in the US during the period fluctuated from 0.3 % to 3.0 % with an average of 1.4 % and a standard deviation of 0.8 %. Furthermore, returns fluctuated a lot from -18.4 % to 19.4 % with a standard deviation of 7.3 %. On average, monthly big four LPE stock returns were 2.0 %. Moreover, monthly US inflation during the research period ranged from -0.7 % to 0.8 % with an average of 0.1 % monthly inflation and a standard deviation of 0.3 %. Monthly change of GDP ranged from -2.3 trillion USD to 1.2 trillion USD with a much smaller average of 0.04 trillion USD change. Finally, it could be concluded that differences from mean to median in all variables are low comparing to high amplitudes between minimum and maximum values, hence, it indicates the existence of a small number of drastic outliers. As discussed in situation analysis, the highest fluctuations appeared when Covid-19 pandemic started, hence, the categorical Covid-19-related variable was included in the research.

Table 4. Descriptive Statistics (Appendix A)

Variable	Mean	Median	S.D.	Min	Max
UNRATE	5.57	5.00	2.02	3.50	14.7
INTRATE	1.35	1.00	0.825	0.250	3.00
RETURNS	0.0204	0.0269	0.0729	-0.184	0.194
INFLATION	0.00123	0.00118	0.00299	-0.00669	0.00819
GDP	0.0492	0.0700	0.307	-2.33	1.23

Moreover, correlations between variables are presented in the correlation matrix in Table 5. A strong negative correlation is considered from 0.5 to 1.0 or from -0.5 to -1.0, hence, it is only observed between the interest rate and unemployment rate (Table 5). It could be explained by the fact that the period analysed in this research is mostly economic expansion, hence, the interest rate was increasing to control inflation while unemployment was decreasing because of the improving economic situation after the crisis of 2008. Of course, it changed after Covid-19-led slowdown, however, the period when Covid-19 is present is comparatively small in the research period. Finally, in other cases, the correlation between observed variables is weak (Table 5).

Table 5. Correlation Matrix. Note: Using the observations 2012:06 - 2020:07, 5% critical value (two-tailed) = 0.1986 for n = 98

UNRATE	INTRATE	RETURNS	INFLATION	GDP	
1.0000	-0.7005	0.2442	-0.1185	-0.1095	UNRATE
	1.0000	0.0234	0.1247	0.0088	INTRATE
		1.0000	0.0385	0.0379	RETURNS
			1.0000	0.2726	INFLATION
				1.0000	GDP

3.5. Time Series Model and Tests

In this sub-section of empirical research, stationarity of numerical variables, one of the most common assumptions in time series techniques, is examined to make sure the model does not create misleading correlations. Finally, the OLS model is built. Also, normality of residuals, heteroscedasticity of residuals, multicollinearity, and autocorrelation of residuals are checked.

3.5.1. Stationarity of Numeric Variables. The stationarity of all numerical variables was tested using the Dickey-Fuller, Augmented Dickey-Fuller, and KPSS tests. The null hypotheses of these tests are different:

- KPSS has a null hypothesis that data is stationary
- Dickey-Fuller has a null hypothesis that data are not stationary
- Augmented Dickey-Fuller that data are not stationary

Results of all three tests for all numeric variables are presented in Appendix B. The test showed that “Returns”, “GDP” and “Inflation” variables are stationary, hence, no further adjustments for these variables were required (Appendix B). Meanwhile test results of variables “Unemployment” and “Interest Rate” showed that variables are not stationary, hence, differencing was applied (Appendix B). The first difference of these variables was applied in Gretl and stationarity was tested again. Differencing solved the non-stationarity problem, hence, it was decided to use variables “Returns”, “GDP”, “Inflation”, the first difference of “Unemployment”, and first difference of “Interest Rate” in the final model (Appendix B).

3.5.2. Regression and Interpretation of Results. Before interpretation of regression coefficients and significance, normality of residuals, heteroscedasticity of residuals, multicollinearity, and autocorrelation of residuals are checked (Table 6). White’s test failed to reject the null hypothesis that heteroskedasticity is not present, hence, errors of regression are not heteroscedastic which does not identify a problem with the regression (Table 6). Moreover, the test for normality of residuals failed to reject the null hypothesis that error is normally distributed, hence, a problem is also not identified. Furthermore, the test for autocorrelation failed to reject the null hypothesis of no autocorrelation (Table 6). Also, the Durbin-Watson test value near two (1.93) indicated no autocorrelation (Table 6).

Table 6. Summary of Final Regression Tests (Appendix C)

White's test for heteroskedasticity - Null hypothesis: heteroskedasticity not present Test statistic: LM = 21.6212 with p-value = P (Chi-square (19) > 21.6212) = 0.30351	Test for normality of residual - Null hypothesis: error is normally distributed Test statistic: Chi-square (2) = 0.99049 with p-value = 0.609422	LM test for autocorrelation up to order 12 - Null hypothesis: no autocorrelation Test statistic: LMF = 0.447837 with p-value = P (F(12, 80) > 0.447837) = 0.938319

Moreover, lower than 10 variance inflation factors do not indicate a collinearity problem between independent variables in the model (Table 7).

Table 7. Variance Inflation Factors. Note: Values > 10.0 may show a collinearity problem (Appendic C)

d_UNRATE	**d_INTRATE**	**GDP**	**DCOVID_2**	**INFLATION**
4.757	1.131	4.478	1.203	1.116

Finally, the regression model presented in Table 8 is build indicating that two variables – the first difference of “Unemployment” and “GDP” – are significant at 0.01 threshold. Moreover, the first difference of “Interest Rate” is significant at 0.05 threshold. Meanwhile “Covid” and “Inflation” are not significant, hence, their coefficients are not interpreted. The significant coefficients could be interpreted as follows:

- If monthly US unemployment rate’s change increases by 1 % monthly US LPE big four companies’ average stock return increases by 0.043.
- If monthly US interest rate’s change increases by 1%, monthly US LPE big four companies’ average stock return increases by 0.072.
- If monthly US GDP’s change increases by 1 trillion USD, monthly US LPE big four companies’ average stock return increases by 0.135.

Table 8. OLS Model. Note: Using observations 2012:06-2020:07 (T = 98), dependent variable: RETURNS.

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0112372	0.00827921	1.357	0.1780	
d_UNRATE	0.0428692	0.0140423	3.053	0.0030	***
d_INTRATE	0.0723064	0.0338935	2.133	0.0356	**
GDP	0.134916	0.0486088	2.776	0.0067	***
DCOVID_2	−0.00080865	0.0280979	−0.02878	0.9771	
INFLATION	1.73812	2.48865	0.6984	0.4867	

Mean dependent var	0.020449	S.D. dependent var	0.072887
Sum squared resid	0.443665	S.E. of regression	0.069444
R-squared	0.139032	Adjusted R-squared	0.092240
F(5, 92)	2.971296	P-value(F)	0.015657
Log-likelihood	125.4290	Akaike criterion	−238.8580
Schwarz criterion	−223.3482	Hannan-Quinn	−232.5846
rho	0.027905	Durbin-Watson	1.929301

However, comparatively low adjusted R-squared showed that only 9.2 % of the dependent variable's variance is explained by independent variables (Table 8).

3.6. Causality Between Dependent and Independent Variables

Classical Granger's causality estimation was performed between dependent and significant independent variables of the model to test whether time series of the dependent variable are useful in forecasting independent variables and vice versa. As G-cause is not the same as a true cause-and-effect relationship, it allows not only to check whether independent variables G-cause dependent variable but also if the dependent variable G-causes independent variables (Leamer, 1985).

As for classical Granger causality testing each variable needs to be stationary, all the variables were used in the same form as in the OLS model. Moreover, the optimal number of lags was chosen using the VAR lag selection function in Gretl. For GDP and unemployment one lag was selected according to the Akaike criterion, Schwarz Bayesian criterion, and Hannan-Quinn criterion (Appendix D). For interest rate further investigation of autocorrelation, ARCH effect, and normality of residuals was performed as AIC indicated 7 lags while BIC and HQC indicated 1 lag as an optimal number of lags (Appendix D). It has been observed that VAR (1) performed better in autocorrelation and ARCH effect tests while for both VAR (1) and VAR (7) normality of residuals was lacking, hence, it was decided to use VAR (1) (Appendix D).

Finally, vector autoregression models were run to check Granger causality. It has been observed that GDP does not G-cause returns, however, the null hypothesis that returns does not G-cause GDP is rejected (Table 9). Therefore, according to this method, past values of returns should have information that is helpful to forecast GDP.

Table 9. Returns and GDP Granger Causality (Appendix D)

Equation 1: RETURNS
All lags of GDP F(1, 95) = 0.026510 [0.8710]
H0: *GDP does not G-cause RETURNS*
Equation 2: GDP
All lags of RETURNS F(1, 95) = 14.158 [0.0003]
H0: *RETURNS does not G-cause GDP*

Moreover, it has been observed that unemployment does not G-cause returns, however, the null hypothesis that returns does not G-cause unemployment is rejected (Table10). Hence, according to this method, past values of returns should have information that is helpful to forecast unemployment.

Table 10. Returns and Unemployment Granger Causality (Appendix D)

Equation 1: RETURNS
All lags of d_UNRATE F(1, 95) = 2.6888 [0.1044]
H0: d_UNRATE *does not G-cause* RETURNS
Equation 2: d_UNRATE
All lags of RETURNS F(1, 95) = 11.769 [0.0009]
H0: RETURNS *does not G-cause* d_UNRATE

Furthermore, it has been observed that returns do not G-cause interest rate, however, the null hypothesis that interest rates do not G-cause returns is rejected at 10 % threshold (Table 11). Therefore, according to this method, past values of interest rates should have information that is helpful to forecast returns.

Table 11. Returns and Interest Rate Granger Causality (Appendix D)

Equation 1: RETURNS
All lags of d_INTRATE F(1, 95) = 2.8540 [0.0944]
H0: d_INTRATE *does not G-cause* RETURNS
Equation 2: d_INTRATE
All lags of RETURNS F(1, 95) = 1.2584 [0.2648]
H0: All lags of RETURNS *does not G-cause* d_INTRATE

3.7. Limitations and Recommendations for Future Research

First of all, it could be concluded that differences from the mean to the median in all variables are low comparing to high amplitudes between the minimum and maximum values, hence, it indicates the existence of a small number of drastic outliers which could mislead the results of regression and increase values of errors. It could be explained by the Covid-19-led economic slowdown and increased volatility in stock markets, hence, in order to have fewer outliers, periods of drastic fluctuations could be excluded. Another option would be to account for these significant events. Even though the categorical variable "Covid" in this research is used, it is not significant, hence, further investigation of how to account for Covid-19-led fluctuations could be made. Secondly, as most of the initial variables were not stationary, they had to be differenced which slightly complicated the interpretation of results, hence, the regression is not so convenient to use as in its initial form. However, as the existence of a trend or seasonality is a common problem for time series, the possible options to the problem are to adjust the existing data or select stationary data where attainable. One more limitation of this research is that average big four LPE returns could not be compared to LPE stock indices as the latter data are not available at free sources at the time of this research, hence, if indices data are acquired, more comprehensive investigation could be made. Besides, the scope of this thesis could be broadened in the future including more geographical regions in the analysis. The geographical region of the thesis – the US – is selected because it is the largest private equity and listed private equity market in the world, however, regions like Europe or Asia could be also analyzed as private equity market there is expanding, and valuable insights could be made from these regions as well. Moreover, as mentioned in the literature review, from a theoretical perspective, not only economic factors effects stock returns but also companies' effects and contributions to the country's economy could be analyzed. However, for this type of research, a much larger pool of companies should be gathered. Moreover, a period of 99 months (after adjustment of variables – 98) could not be expanded in this research as the big four LPE companies got listed comparatively late, hence, in the future, this period could increase improving the validity of the insights. Also, relatively low R-squared might be a consequence of important variables that were not included in the regression. Hence, an even deeper theoretical investigation could be made about possible significant factors that are affecting LPE returns. Obtaining LPE firms' investment portfolio data which is not provided in free sources might help to raise new hypotheses. Also, the interest rate has a positive coefficient sign in the final OLS model which is different than expected. This probably may be explained by the fact that during the selected research period economy mainly increased together with the interest rate to control the inflation, however, further investigation about differences in how economic factors affect LPE returns at times of expansions and at times of contractions could be performed. Moreover, as private equity firms for their portfolio companies are a source of financing, increasing interest rates could lead the companies to choose private equity financing instead of debt. Therefore, this could also partly explain the positive interest rate coefficient sign, however, further investigation is needed to confirm.

Conclusions

1. US private equity's fundraising has been increasing during the post-crisis period. The rise has been largely influenced by the buyout segment. It was emphasized that more than half of total fundraising in 2019 was caused by PE "megafunds", mostly LPEs. Moreover, according to GPs, L(PE) market cycle has reached its peak. Also, the big four LPE firms showed higher IRR figures than the PE average. From an investor's point of view, the main difference between PE and LPE firms is the liquidity of the asset. From the company's point of view, more PE houses are going public due to easier fundraising, improved brand image, accessibility of deals in a greater number of countries, and more types of assets.
2. The main segments US private equity firms are investing in are technology, healthcare, financial services, industrial, and consumer. The technology sector was mainly booming in the past decade despite economic fluctuations. Historically, the healthcare segment has been relatively immune from recessions, however, the situation is not certain at the time of Covid-19-led economic slowdown. Moreover, financial services has been one of the most sensitive segments to economic slowdowns. In times of recessions, the industrials segment has also been very sensitive. One of the most important factors that affect the consumer segment is unemployment.
3. Most of the researchers indicated GDP, unemployment, interest rate, and inflation as key economic factors affecting (L)PE returns. In all analysed cases GDP had a positive impact on (L)PE returns. Furthermore, unemployment in a lot of cases also had a positive impact on the returns. Meanwhile, for increasing interest rate and inflation, the effect was usually negative.

4. Private equity activity's dependency on economic factors exists. The main economic factors affecting private equity activity are GDP, unemployment, inflation, and interest rate. The more economically attractive the country looks, the more fundraising is attracted. However, non-economic factors such as the legal system, corruption level in the country, political and social environments are also important for PE activity.
5. The final objective of this thesis – to perform empirical research on the key economic factors that affect returns of US publicly listed private equity firms – was completed in the empirical part of the thesis. The time series OLS regression using observations from 2012 May to 2020 July was constructed, and tests were applied to check the validity of the model. Variables of returns, Covid-19, inflation, unemployment, GDP, and interest rate were used in Gretl statistical software for calculations. Moreover, the hypotheses were tested and results were analysed, interpreted, and presented:
   5.1. **GDP**. Hypothesis that GDP growth in the US has a positive impact on the big four US LPE stock returns was not rejected. GDP is statistically significant at the 95 % threshold. Hence, during the research period, increasing US GDP increases the big four US LPE stock returns.
   5.2. **Unemployment.** The hypothesis that increasing unemployment rate in the US has a positive impact on the big four US LPE stock returns was not rejected. Unemployment is statistically significant at the 99 % threshold. Hence, during the research period, increasing US unemployment increases big four US LPE stock returns.
   5.3. **Interest rate.** Hypothesis that increasing interest rate in the US has a negative impact on the big four US LPE stock returns was rejected. Interest rate is statistically

significant at the 99 % threshold, however, correlation is positive. Hence, during the research period, increasing US interest rate increases big four US LPE stock returns.

5.4. **Inflation.** Hypothesis that increasing inflation in the US has a negative impact on the big four US LPE stock returns was rejected as the results were not statistically significant.

Hence, three of four tested economic factors – GDP, unemployment, and interest rate – were proved to have a significant impact on the United States listed private equity stock returns.

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Appendices

Appendix A

Descriptive Statistics

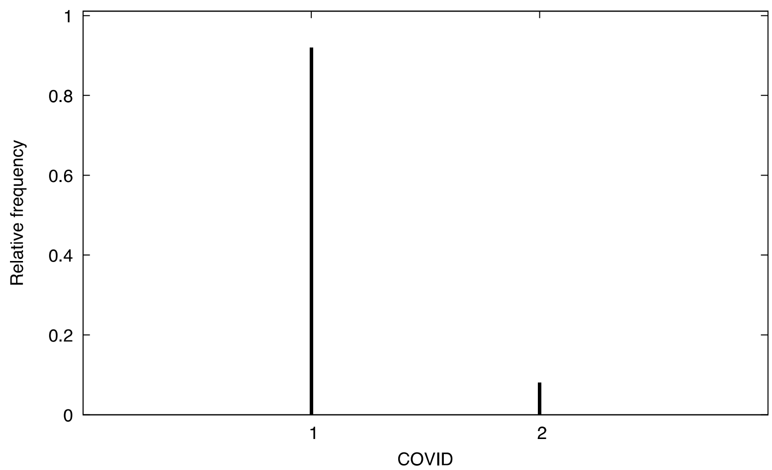
Summary Statistics, using the observations 2012:05 - 2020:07
(missing values were skipped)

Variable	Mean	Median	Minimum	Maximum
UNRATE	5.5707	5.0000	3.5000	14.700
INTRATE	1.3460	1.0000	0.25000	3.0000
RETURNS	0.020449	0.026927	-0.18393	0.19450
INFLATION	0.0012291	0.0011830	-0.0066868	0.0081900
GDP	0.049184	0.070000	-2.3300	1.2300

Variable	Std. Dev.	C.V.	Skewness	Ex. kurtosis
UNRATE	2.0228	0.36312	1.8561	4.8056
INTRATE	0.82508	0.61300	0.81064	-0.74487
RETURNS	0.072887	3.5643	-0.29313	0.087045
INFLATION	0.0029924	2.4346	-0.26381	-0.27331
GDP	0.30694	6.2407	-4.2673	38.141

Variable	5% Perc.	95% Perc.	IQ range	Missing obs.
UNRATE	3.6000	8.2000	2.6000	0
INTRATE	0.25000	3.0000	1.2500	0
RETURNS	-0.11665	0.12836	0.096466	1
INFLATION	-0.0047075	0.0056503	0.0041983	1
GDP	-0.090500	0.19150	0.11000	1

Frequency Distribution of Categorical Variable



Appendix B

Stationarity of Numerical Variables

```
KPSS test for UNRATE (including trend)

T = 99
Lag truncation parameter = 3
Test statistic = 0.266986

                   10%      5%      1%
Critical values: 0.120   0.148   0.215
P-value < .01

Augmented Dickey-Fuller test for UNRATE
testing down from 11 lags, criterion AIC
sample size 98
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)UNRATE
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.134009
  test statistic: tau_c(1) = -2.44361
  p-value 0.1327
  1st-order autocorrelation coeff. for e: 0.070

  with constant and trend
  including 0 lags of (1-L)UNRATE
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.131709
  test statistic: tau_ct(1) = -2.11847
  p-value 0.5289
  1st-order autocorrelation coeff. for e: 0.067

  with constant, linear and quadratic trend
  including 0 lags of (1-L)UNRATE
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.238169
  test statistic: tau_ctt(1) = -3.31252
  p-value 0.1749
  1st-order autocorrelation coeff. for e: 0.094

Dickey-Fuller test for UNRATE
sample size 98
unit-root null hypothesis: a = 1

  test with constant
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.134009
  test statistic: tau_c(1) = -2.44361
  p-value 0.1327
  1st-order autocorrelation coeff. for e: 0.070

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.131709
  test statistic: tau_ct(1) = -2.11847
  p-value 0.5289
  1st-order autocorrelation coeff. for e: 0.067
```

```
  with constant, linear and quadratic trend
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.238169
  test statistic: tau_ctt(1) = -3.31252
  p-value 0.1749
  1st-order autocorrelation coeff. for e: 0.094

KPSS test for d_UNRATE (including trend)

T = 98
Lag truncation parameter = 3
Test statistic = 0.0588105

                   10%      5%      1%
Critical values: 0.120   0.148   0.215
P-value > .10

Augmented Dickey-Fuller test for d_UNRATE
testing down from 11 lags, criterion AIC
sample size 96
unit-root null hypothesis: a = 1

  test with constant
  including one lag of (1-L)d_UNRATE
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.22205
  test statistic: tau_c(1) = -8.30123
  asymptotic p-value 6.417e-14
  1st-order autocorrelation coeff. for e: -0.023

  with constant and trend
  including 2 lags of (1-L)d_UNRATE
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.51346
  test statistic: tau_ct(1) = -7.13094
  asymptotic p-value 1.03e-09
  1st-order autocorrelation coeff. for e: -0.000
  lagged differences: F(2, 90) = 3.974 [0.0222]

  with constant, linear and quadratic trend
  including 2 lags of (1-L)d_UNRATE
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.70828
  test statistic: tau_ctt(1) = -7.56835
  asymptotic p-value 8.075e-14
  1st-order autocorrelation coeff. for e: -0.002
  lagged differences: F(2, 89) = 6.034 [0.0035]

Dickey-Fuller test for d_UNRATE
sample size 97
unit-root null hypothesis: a = 1

  test with constant
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.00355
  test statistic: tau_c(1) = -9.74541
  p-value 3.037e-08
  1st-order autocorrelation coeff. for e: -0.001

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.02043
```

```
  test statistic: tau_ct(1) = -9.83842
  p-value 2.627e-12
  1st-order autocorrelation coeff. for e: -0.005

  with constant, linear and quadratic trend
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.03465
  test statistic: tau_ctt(1) = -9.89059
  p-value 1.274e-11
  1st-order autocorrelation coeff. for e: -0.009

KPSS test for INTRATE (including trend)

T = 99
Lag truncation parameter = 3
Test statistic = 0.185931

                   10%      5%      1%
Critical values: 0.120   0.148   0.215
Interpolated p-value 0.028

Augmented Dickey-Fuller test for INTRATE
testing down from 11 lags, criterion AIC
sample size 91
unit-root null hypothesis: a = 1

  test with constant
  including 7 lags of (1-L)INTRATE
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.103719
  test statistic: tau_c(1) = -4.11793
  asymptotic p-value 0.0009042
  1st-order autocorrelation coeff. for e: -0.016
  lagged differences: F(7, 82) = 9.615 [0.0000]

  with constant and trend
  including 7 lags of (1-L)INTRATE
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.10801
  test statistic: tau_ct(1) = -2.07714
  asymptotic p-value 0.558
  1st-order autocorrelation coeff. for e: -0.017
  lagged differences: F(7, 81) = 9.281 [0.0000]

  with constant, linear and quadratic trend
  including 7 lags of (1-L)INTRATE
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 0.0720281
  test statistic: tau_ctt(1) = 0.621504
  asymptotic p-value 1
  1st-order autocorrelation coeff. for e: 0.008
  lagged differences: F(7, 80) = 8.423 [0.0000]

Dickey-Fuller test for INTRATE
sample size 98
unit-root null hypothesis: a = 1

  test with constant
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.0297165
  test statistic: tau_c(1) = -1.08814
  p-value 0.7181
  1st-order autocorrelation coeff. for e: 0.043
```

```
  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.00753807
  test statistic: tau_ct(1) = -0.196738
  p-value 0.9923
  1st-order autocorrelation coeff. for e: 0.014

  with constant, linear and quadratic trend
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.00321118
  test statistic: tau_ctt(1) = -0.0861007
  p-value 0.9993
  1st-order autocorrelation coeff. for e: -0.063

KPSS test for d_INTRATE (including trend)

T = 98
Lag truncation parameter = 3
Test statistic = 0.207955

                   10%      5%      1%
Critical values: 0.120   0.148   0.215
Interpolated p-value 0.014

Augmented Dickey-Fuller test for d_INTRATE
testing down from 11 lags, criterion AIC
sample size 88
unit-root null hypothesis: a = 1

  test with constant
  including 9 lags of (1-L)d_INTRATE
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 0.470555
  test statistic: tau_c(1) = 1.01542
  asymptotic p-value 0.9969
  1st-order autocorrelation coeff. for e: -0.001
  lagged differences: F(9, 77) = 5.587 [0.0000]

  with constant and trend
  including 6 lags of (1-L)d_INTRATE
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 1.23837
  test statistic: tau_ct(1) = 3.60811
  asymptotic p-value 1
  1st-order autocorrelation coeff. for e: 0.016
  lagged differences: F(6, 82) = 9.719 [0.0000]

  with constant, linear and quadratic trend
  including 6 lags of (1-L)d_INTRATE
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 0.764677
  test statistic: tau_ctt(1) = 2.03433
  asymptotic p-value 1
  1st-order autocorrelation coeff. for e: -0.004
  lagged differences: F(6, 81) = 9.717 [0.0000]

Dickey-Fuller test for d_INTRATE
sample size 97
unit-root null hypothesis: a = 1

  test with constant
```

```
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.974213
  test statistic: tau_c(1) = -9.49861
  p-value 1.576e-08
  1st-order autocorrelation coeff. for e: -0.000

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.993514
  test statistic: tau_ct(1) = -9.63154
  p-value 5.384e-12
  1st-order autocorrelation coeff. for e: -0.000

  with constant, linear and quadratic trend
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.06674
  test statistic: tau_ctt(1) = -10.2763
  p-value 3.396e-12
  1st-order autocorrelation coeff. for e: -0.008

KPSS test for RETURNS (including trend)

T = 98
Lag truncation parameter = 3
Test statistic = 0.147192

                   10%      5%      1%
Critical values: 0.120   0.148   0.215
Interpolated p-value 0.052



Augmented Dickey-Fuller test for RETURNS
testing down from 11 lags, criterion AIC
sample size 97
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)RETURNS
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.912401
  test statistic: tau_c(1) = -8.9677
  p-value 6.351e-09
  1st-order autocorrelation coeff. for e: 0.001

  with constant and trend
  including 0 lags of (1-L)RETURNS
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.912749
  test statistic: tau_ct(1) = -8.92003
  p-value 7.363e-11
  1st-order autocorrelation coeff. for e: 0.001

  with constant, linear and quadratic trend
  including 0 lags of (1-L)RETURNS
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.949943
  test statistic: tau_ctt(1) = -9.17547
  p-value 1.762e-10
  1st-order autocorrelation coeff. for e: 0.005

Dickey-Fuller test for RETURNS
sample size 97
```

```
unit-root null hypothesis: a = 1

  test with constant
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.912401
  test statistic: tau_c(1) = -8.9677
  p-value 6.351e-09
  1st-order autocorrelation coeff. for e: 0.001

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.912749
  test statistic: tau_ct(1) = -8.92003
  p-value 7.363e-11
  1st-order autocorrelation coeff. for e: 0.001

  with constant, linear and quadratic trend
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.949943
  test statistic: tau_ctt(1) = -9.17547
  p-value 1.762e-10
  1st-order autocorrelation coeff. for e: 0.005

KPSS test for INFLATION (including trend)

T = 98
Lag truncation parameter = 3
Test statistic = 0.033352

                   10%      5%      1%
Critical values: 0.120   0.148   0.215
P-value > .10

Augmented Dickey-Fuller test for INFLATION
testing down from 11 lags, criterion AIC
sample size 92
unit-root null hypothesis: a = 1

  test with constant
  including 5 lags of (1-L)INFLATION
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.05318
  test statistic: tau_c(1) = -5.79368
  asymptotic p-value 3.697e-07
  1st-order autocorrelation coeff. for e: -0.028
  lagged differences: F(5, 85) = 4.931 [0.0005]

  with constant and trend
  including 8 lags of (1-L)INFLATION
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.52325
  test statistic: tau_ct(1) = -5.39034
  asymptotic p-value 2.886e-05
  1st-order autocorrelation coeff. for e: 0.022
  lagged differences: F(8, 78) = 3.560 [0.0015]

  with constant, linear and quadratic trend
  including 8 lags of (1-L)INFLATION
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.52773
  test statistic: tau_ctt(1) = -5.38212
  asymptotic p-value 0.0001911
  1st-order autocorrelation coeff. for e: 0.018
```

```
  lagged differences: F(8, 77) = 3.547 [0.0015]

KPSS test for GDP

T = 98
Lag truncation parameter = 3
Test statistic = 0.0437899

                   10%      5%      1%
Critical values: 0.349   0.462   0.734
P-value > .10

Augmented Dickey-Fuller test for GDP
testing down from 11 lags, criterion AIC
sample size 94
unit-root null hypothesis: a = 1

  test with constant
  including 3 lags of (1-L)GDP
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -2.35865
  test statistic: tau_c(1) = -7.59332
  asymptotic p-value 7.475e-12
  1st-order autocorrelation coeff. for e: 0.009
  lagged differences: F(3, 89) = 7.428 [0.0002]

  with constant and trend
  including 3 lags of (1-L)GDP
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -2.39736
  test statistic: tau_ct(1) = -7.63344
  asymptotic p-value 2.995e-11
  1st-order autocorrelation coeff. for e: 0.011
  lagged differences: F(3, 88) = 7.617 [0.0001]

  with constant, linear and quadratic trend
  including 3 lags of (1-L)GDP
  model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -2.60459
  test statistic: tau_ctt(1) = -8.00794
  asymptotic p-value 1.565e-18
  1st-order autocorrelation coeff. for e: 0.007
  lagged differences: F(3, 87) = 9.143 [0.0000]



Dickey-Fuller test for GDP
sample size 97
unit-root null hypothesis: a = 1

  test with constant
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.990454
  test statistic: tau_c(1) = -9.59386
  p-value 1.995e-08
  1st-order autocorrelation coeff. for e: 0.001

  with constant and trend
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.992379
  test statistic: tau_ct(1) = -9.55438
  p-value 7.074e-12
  1st-order autocorrelation coeff. for e: 0.001
```

```
with constant, linear and quadratic trend
model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + e
estimated value of (a - 1): -0.997119
test statistic: tau_ctt(1) = -9.5253
p-value 4.75e-11
1st-order autocorrelation coeff. for e: 0.001
```

Appendix C

Tests of Final Model

White's test for heteroskedasticity
OLS, using observations 2012:06-2020:07 (T = 98)
Dependent variable: uhat^2

	coefficient	std. error	t-ratio	p-value	
const	0.00517188	0.00122266	4.230	6.31e-05	***
d_UNRATE	0.00184554	0.00626834	0.2944	0.7692	
d_INTRATE	0.0164790	0.0139611	1.180	0.2414	
DCOVID_2	−0.00623003	0.00629964	−0.9890	0.3257	
GDP	0.00259779	0.0120288	0.2160	0.8296	
INFLATION	−0.0285089	0.303014	−0.09408	0.9253	
sq_d_UNRATE	0.00906747	0.0100728	0.9002	0.3708	
X2_X3	0.0580328	0.0562840	1.031	0.3057	
X2_X4	0.00730259	0.0226659	0.3222	0.7482	
X2_X5	0.0527182	0.0584499	0.9019	0.3699	
X2_X6	−0.398391	1.30016	−0.3064	0.7601	
sq_d_INTRATE	−0.0463965	0.0364254	−1.274	0.2065	
X3_X4	−0.192499	0.0997593	−1.930	0.0573	*
X3_X5	−0.00766399	0.187777	−0.04081	0.9675	
X3_X6	−13.3264	4.37355	−3.047	0.0032	***
X4_X5	0.0320450	0.0494236	0.6484	0.5186	
X4_X6	−0.109588	1.70206	−0.06439	0.9488	
sq_GDP	0.0447430	0.0553802	0.8079	0.4216	
X5_X6	1.54537	2.82709	0.5466	0.5862	
sq_INFLATION	−101.988	67.1935	−1.518	0.1331	

Unadjusted R-squared = 0.220625

Test statistic: TR^2 = 21.621240,
with p-value = P(Chi-square(19) > 21.621240) = 0.303510

Breusch-Godfrey test for autocorrelation up to order 12
OLS, using observations 2012:06-2020:07 (T = 98)
Dependent variable: uhat

	coefficient	std. error	t-ratio	p-value
const	0.00115429	0.00866712	0.1332	0.8944
d_UNRATE	0.00161012	0.0152002	0.1059	0.9159
d_INTRATE	0.0155241	0.0371537	0.4178	0.6772
DCOVID_2	−0.0104149	0.0316995	−0.3285	0.7434
GDP	−6.88479e-05	0.0525361	−0.001310	0.9990
INFLATION	−0.507860	2.68974	−0.1888	0.8507
uhat_1	0.0361034	0.113518	0.3180	0.7513
uhat_2	0.0360372	0.113052	0.3188	0.7507
uhat_3	0.0524435	0.114483	0.4581	0.6481
uhat_4	−0.00160931	0.111269	−0.01446	0.9885
uhat_5	0.0925421	0.112004	0.8262	0.4111
uhat_6	0.0708147	0.113721	0.6227	0.5352
uhat_7	0.00599041	0.112467	0.05326	0.9577
uhat_8	0.0245994	0.113346	0.2170	0.8287
uhat_9	0.163455	0.113924	1.435	0.1552
uhat_10	−0.0713621	0.118142	−0.6040	0.5475
uhat_11	0.00977105	0.117928	0.08286	0.9342
uhat_12	−0.145261	0.114213	−1.272	0.2071

Unadjusted R-squared = 0.062947

Test statistic: LMF = 0.447837,
with p-value = P(F(12,80) > 0.447837) = 0.938

Alternative statistic: TR^2 = 6.168817,
with p-value = P(Chi-square(12) > 6.16882) = 0.907

Ljung-Box Q' = 6.0797,
with p-value = P(Chi-square(12) > 6.0797) = 0.912

Frequency distribution for uhat10, obs 2-99
number of bins = 9, mean = -2.12415e-19, sd = 0.0694439

interval	midpt	frequency	rel.	cum.	
< -0.14909	-0.16927	3	3.06%	3.06%	*
-0.14909 - -0.10873	-0.12891	4	4.08%	7.14%	*
-0.10873 - -0.068376	-0.088555	7	7.14%	14.29%	**
-0.068376 - -0.028017	-0.048197	16	16.33%	30.61%	*****
-0.028017 - 0.012341	-0.0078384	24	24.49%	55.10%	********
0.012341 - 0.052699	0.032520	21	21.43%	76.53%	*******
0.052699 - 0.093057	0.072878	16	16.33%	92.86%	*****
0.093057 - 0.13342	0.11324	5	5.10%	97.96%	*
>= 0.13342	0.15359	2	2.04%	100.00%	

Test for null hypothesis of normal distribution:
Chi-square(2) = 0.990 with p-value 0.60942

Variance Inflation Factors
Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

d_UNRATE	4.757
d_INTRATE	1.131
GDP	4.478
DCOVID_2	1.203
INFLATION	1.116

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient
between variable j and the other independent variables

Belsley-Kuh-Welsch collinearity diagnostics:

variance proportions

lambda	cond	const	d_UNRATE	d_INTRATE	GDP	DCOVID_2	INFLATION
2.117	1.000	0.010	0.038	0.008	0.041	0.007	0.054
1.563	1.164	0.151	0.003	0.077	0.000	0.187	0.063
1.051	1.419	0.110	0.017	0.450	0.012	0.032	0.085
0.620	1.848	0.040	0.003	0.310	0.024	0.319	0.509
0.537	1.985	0.570	0.000	0.149	0.002	0.412	0.269
0.112	4.353	0.118	0.939	0.005	0.922	0.044	0.019

lambda = eigenvalues of inverse covariance matrix (smallest is 0.111682)
cond = condition index
note: variance proportions columns sum to 1.0

According to BKW, cond >= 30 indicates "strong" near linear dependence, and cond between 10 and 30 "moderately strong". Parameter estimates whose variance is mostly associated with problematic cond values may themselves be considered problematic.

```
Count of condition indices >= 30: 0
Count of condition indices >= 10: 0

No evidence of excessive collinearity
```

Appendix D

Granger Causality

RETURNS and d_UNRATE

```
VAR system, maximum lag order 12

The asterisks below indicate the best (that is, minimized) values
of the respective information criteria, AIC = Akaike criterion,
BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags        loglik    p(LR)       AIC          BIC          HQC

   1     -24.38084             0.660019*    0.774175*    0.705962*
   2     -22.25907  0.37405    0.703699     0.932011     0.795584
   3     -21.39983  0.78736    0.776740     1.119207     0.914567
   4     -20.60018  0.80892    0.851167     1.307790     1.034936
   5     -19.01772  0.53061    0.907389     1.478167     1.137101
   6     -17.13266  0.43801    0.956574     1.641508     1.232228
   7     -14.80888  0.32541    0.995555     1.794645     1.317152
   8     -14.17977  0.86842    1.073948     1.987194     1.441487
   9     -13.46753  0.83993    1.150408     2.177809     1.563889
  10      -9.20952  0.07440    1.144407     2.285964     1.603831
  11      -7.85599  0.60798    1.205953     2.461666     1.711319
  12      -4.62993  0.16783    1.223952     2.593820     1.775260
```

VAR system, lag order 1
OLS estimates, observations 2012:07-2020:07 (T = 97)
Log-likelihood = -23.615866
Determinant of covariance matrix = 0.0055785352
AIC = 0.5694
BIC = 0.6756
HQC = 0.6123
Portmanteau test: LB(24) = 56.3437, df = 92 [0.9988]

Equation 1: RETURNS

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
RETURNS_1	0.133842	0.0999297	1.339	0.1836
d_UNRATE_1	0.0113634	0.00692989	1.640	0.1044

Mean dependent var	0.019753	S.D. dependent var	0.072938
Sum squared resid	0.521030	S.E. of regression	0.074058
R-squared	0.050183	Adjusted R-squared	0.040185
F(2, 95)	2.509625	P-value(F)	0.086676
rho	−0.016741	Durbin-Watson	2.020698

F-tests of zero restrictions:
All lags of RETURNS F(1, 95) = 1.7939 [0.1836]
All lags of d_UNRATE F(1, 95) = 2.6888 [0.1044]

Equation 2: d_UNRATE

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
RETURNS_1	−4.83288	1.40877	−3.431	0.0009	***
d_UNRATE_1	0.0333883	0.0976948	0.3418	0.7333	

Mean dependent var	0.020619	S.D. dependent var	1.100846
Sum squared resid	103.5508	S.E. of regression	1.044035
R-squared	0.110235	Adjusted R-squared	0.100869
F(2, 95)	5.884887	P-value(F)	0.003896
rho	−0.044022	Durbin-Watson	2.082740

F-tests of zero restrictions:
All lags of RETURNS F(1, 95) = 11.769 [0.0009]
All lags of d_UNRATE F(1, 95) = 0.1168 [0.7333]

RETURNS and GDP

```
VAR system, maximum lag order 12

The asterisks below indicate the best (that is, minimized) values
of the respective information criteria, AIC = Akaike criterion,
BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags        loglik    p(LR)       AIC          BIC          HQC

   1      83.20770              -1.842039*   -1.727884*   -1.796097*
   2      84.79389  0.52940   -1.785904    -1.557593    -1.694020
   3      87.53398  0.24148   -1.756604    -1.414137    -1.618777
   4      92.48596  0.04208   -1.778743    -1.322121    -1.594974
   5      94.77646  0.33305   -1.738987    -1.168209    -1.509276
   6      98.30622  0.13278   -1.728052    -1.043117    -1.452397
   7      99.24727  0.75743   -1.656913    -0.857823    -1.335317
   8     101.66988  0.30355   -1.620230    -0.706984    -1.252691
   9     103.08155  0.58781   -1.560036    -0.532635    -1.146555
  10     106.78238  0.11613   -1.553079    -0.411522    -1.093655
  11     107.12168  0.95394   -1.467946    -0.212234    -0.962580
  12     107.89610  0.81796   -1.392933    -0.023064    -0.841624
```

VAR system, lag order 1
OLS estimates, observations 2012:07-2020:07 (T = 97)
Log-likelihood = 97.029895
Determinant of covariance matrix = 0.00046365467
AIC = -1.9181
BIC = -1.8120
HQC = -1.8752
Portmanteau test: LB(24) = 62.8245, df = 92 [0.9914]

Equation 1: RETURNS

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
RETURNS_1	0.150398	0.101012	1.489	0.1398
GDP_1	0.00403721	0.0247958	0.1628	0.8710

Mean dependent var	0.019753	S.D. dependent var	0.072938
Sum squared resid	0.535628	S.E. of regression	0.075088
R-squared	0.023572	Adjusted R-squared	0.013294
F(2, 95)	1.146716	P-value(F)	0.322036
rho	−0.003069	Durbin-Watson	1.997079

F-tests of zero restrictions:

All lags of RETURNS F(1, 95) = 2.2169 [0.1398]

All lags of GDP F(1, 95) = 0.02651 [0.8710]

Equation 2: GDP

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
RETURNS_1	1.48264	0.394036	3.763	0.0003	***
GDP_1	0.00560744	0.0967257	0.05797	0.9539	

Mean dependent var	0.049794	S.D. dependent var	0.308474
Sum squared resid	8.150616	S.E. of regression	0.292909
R-squared	0.130647	Adjusted R-squared	0.121496
F(2, 95)	7.138356	P-value(F)	0.001294
rho	−0.039677	Durbin-Watson	2.066671

F-tests of zero restrictions:

All lags of RETURNS F(1, 95) = 14.158 [0.0003]

All lags of GDP F(1, 95) = 0.0033608 [0.9539]

RETURNS and d_INRATE

```
VAR system, maximum lag order 12

The asterisks below indicate the best (that is, minimized) values
of the respective information criteria, AIC = Akaike criterion,
BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags        loglik    p(LR)       AIC          BIC          HQC

   1     108.86450             -2.438709    -2.324554*   -2.392767*
   2     110.89103  0.39887   -2.392815    -2.164503    -2.300930
   3     111.97149  0.70619   -2.324918    -1.982451    -2.187091
   4     112.96409  0.73848   -2.254979    -1.798356    -2.071209
   5     116.58360  0.12378   -2.246130    -1.675352    -2.016418
   6     125.89571  0.00093   -2.369668    -1.684733    -2.094013
```

7	136.86124	0.00021	-2.531657*	-1.732567	-2.210060
8	139.43935	0.27164	-2.498589	-1.585344	-2.131050
9	142.74773	0.15758	-2.482505	-1.455104	-2.069024
10	146.35002	0.12546	-2.473256	-1.331699	-2.013833
11	146.86864	0.90410	-2.392294	-1.136581	-1.886928
12	147.66391	0.81049	-2.317765	-0.947897	-1.766457

Test for autocorrelation of order up to 7

	Rao F	Approx dist.	p-value
lag 1	3.320	F(4, 146)	0.0123
lag 2	1.726	F(8, 142)	0.0972
lag 3	1.313	F(12, 138)	0.2174
lag 4	1.083	F(16, 134)	0.3768
lag 5	0.971	F(20, 130)	0.5009
lag 6	1.589	F(24, 126)	0.0535
lag 7	1.664	F(28, 122)	0.0312

Test for autocorrelation of order up to 1

	Rao F	Approx dist.	p-value
lag 1	2.578	F(4, 182)	0.0390

Test for ARCH of order up to 7

	LM	df	p-value
lag 1	25.793	9	0.0022
lag 2	31.162	18	0.0276
lag 3	34.100	27	0.1632
lag 4	39.412	36	0.3198
lag 5	53.015	45	0.1925
lag 6	60.266	54	0.2596
lag 7	68.117	63	0.3075

Test for ARCH of order up to 1

	LM	df	p-value
lag 1	7.523	9	0.5828

7 lags
Residual correlation matrix, C (2 x 2)

1.0000	0.029900
0.029900	1.0000

Eigenvalues of C

0.9701
1.0299

Doornik-Hansen test
Chi-square(4) = 100.135 [0.0000]

1 lag
Residual correlation matrix, C (2 x 2)

```
      1.0000      0.19170
     0.19170       1.0000

Eigenvalues of C

   0.808299
     1.1917

Doornik-Hansen test
 Chi-square(4) = 1205.17 [0.0000]
```

VAR system, lag order 1
OLS estimates, observations 2012:07-2020:07 (T = 97)
Log-likelihood = 127.09199
Determinant of covariance matrix = 0.00024946108
AIC = -2.5380
BIC = -2.4318
HQC = -2.4950
Portmanteau test: LB(24) = 68.5003, df = 92 [0.9683]

Equation 1: RETURNS

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
RETURNS_1	0.186141	0.101333	1.837	0.0693	*
d_INTRATE_1	−0.0585575	0.0346622	−1.689	0.0944	*

Mean dependent var	0.019753	S.D. dependent var	0.072938
Sum squared resid	0.520151	S.E. of regression	0.073995
R-squared	0.051786	Adjusted R-squared	0.041805
F(2, 95)	2.594182	P-value(F)	0.079993
rho	−0.036273	Durbin-Watson	2.063881

F-tests of zero restrictions:

All lags of RETURNS	F(1, 95) =	3.3743 [0.0693]
All lags of d_INTRATE	F(1, 95) =	2.854 [0.0944]

Equation 2: d_INTRATE

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
RETURNS_1	0.341143	0.304105	1.122	0.2648
d_INTRATE_1	0.00280283	0.104023	0.02694	0.9786

Mean dependent var	−0.005155	S.D. dependent var	0.222379
Sum squared resid	4.684655	S.E. of regression	0.222063
R-squared	0.013757	Adjusted R-squared	0.003375
F(2, 95)	0.662566	P-value(F)	0.517892
rho	0.006819	Durbin-Watson	1.986107

F-tests of zero restrictions:

All lags of RETURNS F(1, 95) = 1.2584 [0.2648]

All lags of d_INTRATE F(1, 95) = 0.00072599 [0.9786]

Appendix E

Data Used for Empirical Calculations

DATE	UNRATE	GDP	CPI. 2015 100	Int rate	Carlyle Adj Close	Blacksone Adj Close	Adj Close Apollo	Adj Close KKR	COVID
5/1/12	8,2	16,17	969,614	0,75	119,383	691,488	5,584,696	7,722,198	NO
6/1/12	8,2	16,16	9,681,921	0,75	12,678,794	7,566,012	6,066,375	8,566,103	NO
7/1/12	8,2	16,26	9,666,142	0,75	13,809,314	8,017,541	6,638,768	9,297,111	NO
8/1/12	8,1	16,21	9,719,936	0,75	14,821,131	7,809,142	6,487,107	9,469,897	NO
9/1/12	7,8	16,3	9,763,308	0,75	14,898,248	8,327,066	7,298,587	10,134,389	NO
10/1/12	7,8	16,27	9,759,511	0,75	1,475,631	8,956,841	7,562,451	10,094,149	NO
11/1/12	7,7	16,35	971,327	0,75	14,239,636	8,566,149	7,811,379	9,222,225	NO
12/1/12	7,9	16,46	9,687,111	0,75	148,719	9,154,098	8,881,225	1,038,041	NO
1/1/13	8	16,61	9,715,759	0,75	17,848,558	10,862,782	11,393,135	11,505,011	NO
2/1/13	7,7	16,52	9,795,331	0,75	18,099,949	11,097,651	12,027,509	12,418,322	NO
3/1/13	7,5	16,58	9,820,941	0,75	17,740,013	11,882,099	11,618,634	13,700,254	NO
4/1/13	7,6	16,59	9,810,731	0,75	19,047,789	12,344,642	14,453,497	14,891,581	NO
5/1/13	7,5	16,59	9,828,198	0,75	17,100,788	13,344,125	12,912,577	13,813,716	NO
6/1/13	7,5	16,73	9,851,783	0,75	15,110,503	12,838,157	1,324,133	14,125,243	NO
7/1/13	7,3	16,79	9,855,664	0,75	16,501,863	13,746,455	14,680,837	14,692,841	NO
8/1/13	7,2	16,87	986,752	0,75	1,543,476	13,443,834	13,950,095	13,730,079	NO
9/1/13	7,2	16,89	9,878,996	0,75	15,254,395	15,321,293	16,296,612	15,096,289	NO
10/1/13	7,2	17	9,853,555	0,75	18,338,488	16,176,926	18,603,273	16,101,238	NO
11/1/13	6,9	17,12	983,343	0,75	19,275,581	17,740,494	17,409,576	1,758,308	NO
12/1/13	6,7	17,13	9,832,586	0,75	21,236,929	1,955,303	18,862,417	18,035,069	NO
1/1/14	6,6	17,03	9,869,166	0,75	20,754,005	20,328,945	1,936,367	17,864,645	NO
2/1/14	6,7	17,12	9,905,661	0,75	21,624,468	20,701,378	19,208,521	17,886,875	NO
3/1/14	6,7	17,16	9,969,453	0,75	21,758,543	21,023,355	19,642,263	1,726,351	NO
4/1/14	6,2	17,32	1,000,232	0,75	19,863,802	1,867,127	16,757,692	17,165,249	NO
5/1/14	6,3	17,45	1,003,725	0,75	19,176,497	19,865,175	15,337,025	17,180,368	NO
6/1/14	6,1	17,53	1,005,595	0,75	21,135,418	21,373,598	17,710,613	18,741,325	NO
7/1/14	6,2	17,66	1,005,202	0,75	20,774,448	20,887,833	16,777,803	17,655,209	NO
8/1/14	6,1	17,78	1,003,523	0,75	20,699,764	21,763,433	15,589,429	18,607,094	NO
9/1/14	5,9	17,72	1,004,278	0,75	19,055,498	20,432,833	15,528,149	17,664,465	NO
10/1/14	5,7	17,84	1,001,755	0,75	17,366,402	19,550,095	14,818,179	17,078,293	NO
11/1/14	5,8	17,87	9,963,463	0,75	17,910,673	22,072,058	15,918,955	18,012,932	NO
12/1/14	5,6	17,84	9,906,969	0,75	1,730,057	22,276,178	15,850,763	18,764,814	NO
1/1/15	5,7	17,91	9,860,348	0,75	16,545,633	24,587,425	16,717,916	19,411,598	NO
2/1/15	5,5	18,06	9,903,172	0,75	16,262,539	24,666,439	15,675,991	18,473,759	NO
3/1/15	5,4	17,98	9,962,112	0,75	18,071,993	26,156,496	15,058,714	18,710,247	NO
4/1/15	5,4	18,16	9,982,364	0,75	20,132,597	27,548,735	1,593,714	18,464,169	NO
5/1/15	5,6	18,2	1,003,325	0,75	20,559,391	30,100,359	15,477,012	19,205,227	NO
6/1/15	5,3	18,29	1,006,839	0,75	18,982,401	280,868	15,678,732	19,121,538	NO
7/1/15	5,2	18,32	1,006,907	0,75	17,943,933	26,973,495	14,560,338	2,000,021	NO
8/1/15	5,1	18,33	1,005,481	0,75	14,268,833	23,964,701	1,315,173	16,252,548	NO
9/1/15	5	18,39	1,003,915	0,75	11,750,617	22,159,481	12,408,928	14,285,894	NO
10/1/15	5	18,37	1,003,464	0,75	13,317,368	23,132,061	13,196,223	14,600,895	NO
11/1/15	5,1	18,32	1,001,346	0,75	14,373,524	22,174,801	11,794,982	1,439,657	NO

12/1/15	5	18,36	9,979,242	1	11,267,456	20,761,806	11,199,926	13,523,201	NO
1/1/16	4,9	18,37	9,995,739	1	9,868,041	1,865,296	10,019,433	11,823,042	NO
2/1/16	4,9	18,36	1,000,397	1	111,304	18,439,947	11,472,916	11,137,774	NO
3/1/16	5	18,55	1,004,704	1	12,412,868	20,386,656	1,288,682	12,906,404	NO
4/1/16	5	18,61	1,009,468	1	12,309,918	1,994,331	12,728,744	11,948,749	NO
5/1/16	4,8	18,61	1,013,552	1	11,809,873	19,221,434	12,359,905	11,869,676	NO
6/1/16	4,9	18,69	1,016,881	1	12,138,098	1,801,046	115,797	10,972,356	NO
7/1/16	4,8	18,68	1,015,235	1	12,923,373	19,698,481	13,108,373	12,839,612	NO
8/1/16	4,9	18,83	1,016,168	1	11,584,666	20,391,092	14,231,951	13,328,653	NO
9/1/16	5	18,92	101,861	1	12,109,686	18,985,584	14,005,793	12,824,677	NO
10/1/16	4,9	18,87	101,988	1	12,055,243	19,087,114	14,255,342	12,761,723	NO
11/1/16	4,7	19,02	1,018,294	1	12,094,131	19,628,534	15,019,581	13,759,997	NO
12/1/16	4,7	19,09	1,018,627	1,25	12,271,212	22,896,418	15,378,188	14,000,144	NO
1/1/17	4,7	19,12	1,024,564	1,25	13,920,786	23,757,357	16,871,523	15,792,234	NO
2/1/17	4,6	19,17	1,027,787	1,25	12,914,947	22,911,928	18,063,015	16,401,728	NO
3/1/17	4,4	19,28	1,028,622	1,5	13,092,242	23,388,809	19,702,194	16,730,915	NO
4/1/17	4,4	19,19	1,031,673	1,5	14,528,695	24,286,564	21,686,996	17,419,239	NO
5/1/17	4,4	19,38	1,032,555	1,5	14,651,822	26,634,089	21,897,631	16,905,289	NO
6/1/17	4,3	19,5	1,033,491	1,75	16,303,505	27,014,799	21,818,951	17,227,947	NO
7/1/17	4,3	19,51	1,032,778	1,75	15,890,761	2,709,581	23,180,059	17,950,409	NO
8/1/17	4,4	19,6	1,035,871	1,75	17,129,002	26,934,282	24,359,686	17,607,704	NO
9/1/17	4,2	19,73	1,041,356	1,75	17,399,487	27,460,958	25,284,353	18,997,234	NO
10/1/17	4,1	19,78	1,040,697	1,75	18,579,113	27,395,124	26,527,573	18,735,588	NO
11/1/17	4,2	19,95	1,040,723	1,75	16,936,062	26,447,725	26,300,772	18,614,111	NO
12/1/17	4,1	20,02	1,040,111	2	19,811,327	26,697,861	28,494,741	1,984,894	NO
1/1/18	4,1	20,1	1,045,777	2	21,801,113	30,474,915	30,435,818	22,695,272	NO
2/1/18	4,1	20,18	105,052	2	19,768,072	28,348,763	2,792,433	20,225,937	NO
3/1/18	4	20,21	1,052,895	2,25	18,727,896	27,324,633	25,716,082	19,278,433	NO
4/1/18	4	20,37	105,708	2,25	1,798,229	264,694	25,038,887	19,886,227	NO
5/1/18	3,8	20,59	1,061,477	2,25	19,210,346	2,761,425	2,719,202	21,111,309	NO
6/1/18	4	20,62	1,063,168	2,5	18,918,346	27,821,814	28,023,672	23,779,043	NO
7/1/18	3,8	20,68	106,324	2,5	21,627,312	30,799,858	31,215,574	26,200,008	NO
8/1/18	3,8	20,76	1,063,831	2,5	206,059	33,088,154	30,362,642	24,956,039	NO
9/1/18	3,7	20,79	1,065,067	2,75	20,215,443	34,137,005	30,767,178	26,259,295	NO
10/1/18	3,8	20,92	1,066,949	2,75	18,171,488	29,009,281	26,198,854	22,773,462	NO
11/1/18	3,7	20,88	1,063,375	2,75	164,144	3,084,029	25,103,525	2,207,052	NO
12/1/18	3,9	20,94	1,059,979	3	14,406,193	27,256,124	22,216,194	18,999,113	NO
1/1/19	4	21,12	106,2	3	17,278,286	31,453,075	26,507,341	21,728,483	NO
2/1/19	3,8	21,1	1,066,489	3	16,198,961	31,163,744	26,525,444	21,515,553	NO
3/1/19	3,8	21,13	1,072,505	3	17,114,506	33,196,316	26,060,038	2,285,795	NO
4/1/19	3,6	21,25	1,078,184	3	19,614,271	37,458,588	3,015,584	2,379,212	NO
5/1/19	3,6	21,33	1,080,479	3	1,844,397	36,264,523	27,130,112	2,168,051	NO
6/1/19	3,7	21,4	1,080,695	3	2,136,396	42,559,319	32,091,228	24,719,234	NO
7/1/19	3,7	21,52	108,25	3	22,535,625	45,970,192	30,874,945	26,166,977	NO
8/1/19	3,7	21,51	1,082,446	2,75	21,524,593	48,140,377	35,300,358	2,527,681	NO
9/1/19	3,5	21,59	1,083,294	2,5	24,598,825	47,250,324	35,944,092	26,393,217	NO
10/1/19	3,6	21,71	108,577	2,25	26,254,148	51,429,718	39,118,423	28,339,535	NO
11/1/19	3,5	21,72	1,085,188	2,25	28,679,382	52,455,215	41,627,476	28,988,306	NO

12/1/19	3,5	21,81	1,084,201	2,25	31,225,645	54,622,711	45,868,343	287,966	YES
1/1/20	3,6	21,84	1,088,407	2,25	31,614,988	59,631,912	45,493,397	31,491,655	YES
2/1/20	3,5	21,01	109,139	2,25	27,702,049	52,572,163	4,005,188	28,233,898	YES
3/1/20	4,4	20,83	1,089,015	0,25	21,234,575	44,923,683	32,823,696	23,255,852	YES
4/1/20	14,7	18,5	1,081,733	0,25	22,990,231	51,499,088	39,672,581	24,979,975	YES
5/1/20	13,3	19,37	1,081,754	0,25	27,129,255	55,994,411	46,639,042	27,496,799	YES
6/1/20	11,1	20,6	1,087,673	0,25	27,646,179	56,276,531	49,409,012	30,765,377	YES
7/1/20	10,2	20,99	1,093,175	0,25	28,210,993	52,919,407	48,597,408	35,238,708	YES