An additional basket to put your eggs in?

- A study of listed private equity's ability to improve portfolio performance

Sofie Lundström[α] and Leandro Saucedo[β]

ABSTRACT

In this study, we examine whether adding Listed Private Equity ("LPE") to an investment portfolio during the period December 1993 to May 2010 has provided a better risk adjusted return for investors. We also analyse the correlation structure of LPE and MSCI returns and relate them to a number of macroeconomic variables. By using the LPX index family as a proxy for the LPE universe, we show that LPE and stock market returns have been positively correlated for all types of LPE during the period. We also show that this correlation seem to have increased over time and find a historical pattern of higher correlation in volatile periods. However, we show that the correlation has been low enough to provide diversification effects by adding certain types of LPE to an investment portfolio of stocks, hence providing a better risk adjusted return. We also show that GDP growth affected LPE and stock markets differently, while we cannot find evidence for the other chosen macro economic variables to have been affecting LPE and stock markets differently. Consequently, our results suggest that the diversification opportunity from adding LPE to an investment portfolio seem to partly have stemmed from LPE's different exposure to GDP growth.

Keywords: Listed private equity, correlation, risk-return, GDP growth, volatility, credit spread, term spread, TED spread

Thesis Tutor
CLAS BERGSTRÖM

Presentation: 21 December 2010 at 3:15 pm
Location: Room 348 at Stockholm School of Economics
Discussants: Leo Nilsson 20466 and Felipe Gutierrez 20822

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We would like to thank our tutor, Professor Clas Bergström of the Department of Finance of the Stockholm School of Economics, for invaluable comments and guidance.

STOCKHOLM SCHOOL OF ECONOMICS
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SOFIE LUNDSTRÖM[α] and LEANDRO SAUCEDO[β]

December 2010

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TABLE OF CONTENTS

I. INTRODUCTION

Private Equity is a hot topic within the world of finance and a debated subject in the political arena as well as in society in general. During the last decade media has frequently highlighted success stories about private equity funds, their investors' fantastic returns and the private equity managers' enormous wealth. This has obviously increased the interest for private equity and other alternative investments and, fuelled by its opaque nature, increased the mystery surrounding the asset class.

Are these financials players to the benefit of society or just return hungry capitalists? Whether one believes private equity creates value, destroys long-term visions or provides required growth capital to business owners, it still plays a significant role in today's world of finance. Though few know about it, private equity firms are already an integral part of our lives. Just to mention a few Swedish examples; when you go buying the latest fashion at *MQ*, pick your favourite candy from *Karamell Kungen* or maybe get an unnecessary gadget from *Teknikmagasinet* you are interacting with private equity. Your kids might be studying at a private equity owned school, your old mother treated by a private equity owned hospital and when you choose to spend your holiday away from all your worries you just might be travelling with private equity operated travel agencies and staying at private equity owned hotels. In short, private equity surrounds us every day whether we like it or not. Moreover, since many of the major pension funds in Sweden and in the rest of the world invest large amounts in private equity, its performance might affect our pensions in the future.

Despite being such an integral part of society it is still remarkable how difficult it is for academia to study and truly test the private equity industry's performance. This is due to the nature of the asset class. Private equity funds are not obliged, nor motivated, to announce their returns publicly. Most of the studies on private equity returns have been performed on data provided to the researcher by funds themselves which adds a certain level of uncertainty to the results.

During the last 15-20 years a new sub-group of the private equity industry has evolved since quite a few private equity funds have gone public. Companies such as *Ratos*, *3i* and *Blackstone*, just to mention a few, have turned to the capital markets in order to raise capital. This trend towards *Listed Private Equity ("LPE"*) has been more pronounced during the last ten years and has enabled investors and researchers to get a sneak peek of the returns of the private equity industry.

The fairly new LPX® index family consist of investable, tradable and transparent LPE's all around the world. For the first time there is now a publicly traded index which enables deeper studies and research on private equity, or at least the listed sub-group of the asset class.

Obviously, there are many interesting questions and possible angles to broach the topic of the private equity industry and this study is our attempt to contribute with facts to investors and to the academic debate about private equity. By its broadest mean our question formulation is; does it make sense to invest in *listed private equity*?

Purpose of this thesis and contribution

As the LPE sub-group of the private equity asset class emerges investors face the possibility to add LPE to their portfolios and need to understand whether doing so could result in a better risk-adjusted return.

An important clue in answering the investment decision thus lies in understanding LPE's correlation with stock markets and its risk-return profile. Moreover, an analysis of LPE's and stock markets correlation structure vis-à-vis the macro economy could enhance investors understanding of the characteristics of the asset class and where potential diversification effects stem from.

The aim of this paper is to study LPE during the period December 1993 to May 2010 in order to provide investors a good platform for future investment decisions. Consequently, our thesis is a study of; i) LPE's historical ability to provide diversification and increased risk adjusted returns of investment portfolios; and ii) macroeconomic variables' effect on LPE and stock market returns.

Previous research supports the inclusion of alternative asset classes in an investor's total portfolio. Edwards (2001), for instance, argues that the primary motivation for investing in alternative asset classes is the diversification opportunities provided against the risk of poor performance in traditional asset classes, such as stocks. However, little previous research has been performed on LPE alone. Milner and Vos (2003) study the performance effects of including private equity into a portfolio but do not single out LPE. Further, Bauer et al (2001) study and perform a fundamental multi-index model analysis of LPE in order to examine whether the asset class provides a different risk profile. We have used these studies as a starting point for our work and to our knowledge this is the first study focusing on LPE using the LPX-index as a proxy for the industry and applying traditional asset allocation theory to it.[1]

Thesis outline

The paper is organized as follows. Section II provides a brief introduction to the private equity industry, including a description of the difference between unlisted private equity and LPE. In section III, we present the relevant theoretical framework of our study. Our data and samples are presented in section IV while the methodology and model specification is provided in Section V.

[1] Please refer to methodology section for further information

The empirical results are outlined in section VI followed by a discussion of the results and concluding remarks in Section VII.

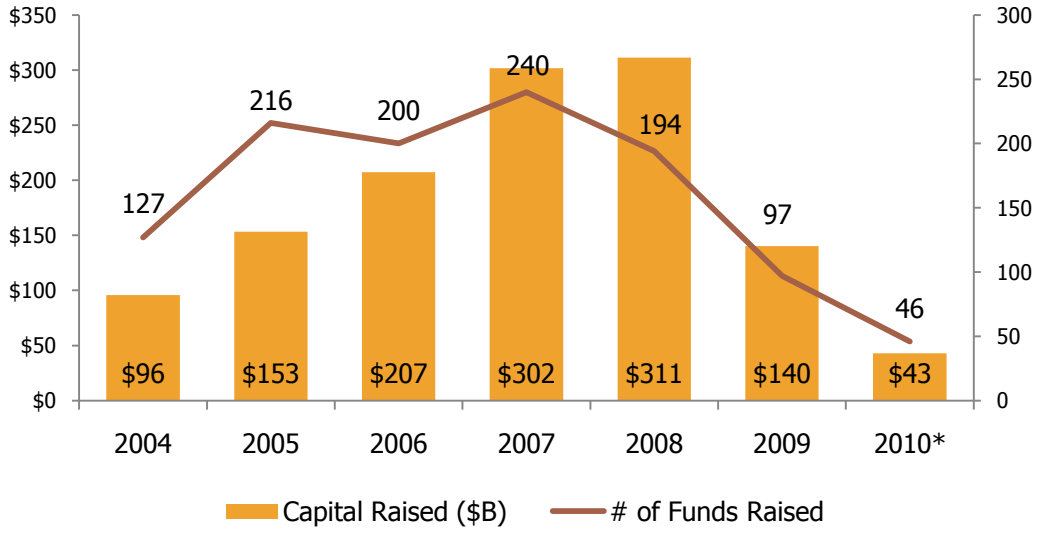
II. BRIEF OVERVIEW OF THE PRIVATE EQUITY INDUSTRY

In this section we provide a short background to the private equity universe, the private equity business model and describe the difference between unlisted and listed private equity.

Private equity companies invest in equity capital of private companies, i.e. companies that are not listed on a public stock exchange, and comprise a wide array of investment styles including leveraged buyouts, venture capital and growth capital. Private equity firms normally have specific investment strategies, as regards to geography, sector, type and size of investments. The typical private equity investment strategy is to acquire large ownership stakes in companies and play an active ownership role. To allow for operational improvements of the business and create long-term value before an exit through a sale or an IPO, the investments demand long holding periods. The most common investors in private equity funds are therefore institutional investors such as pension funds, endowments and insurance companies.

Private equity is today considered a separate asset class, and has grown into a multi billion industry. In 2009, USD 140 billion was committed to private equity funds and funds under management amounted to USD 2.5 trillion. (The Pitchbook, 2010). This can be put into perspective by comparing to world stock market capitalization which amounted to approximately USD 50 trillion in 2009. As a result of the economic turmoil during 2008 and 2009, the amount of new funds has declined considerably and so has capital commitments. However, as of 2010, this negative trend seems to be turning.

Graph 1: Number of Funds Closed and Total Capital Raised by Year



**) as of June 2010.*

Private Equity (unlisted)

The traditional and most common type of private equity is *unlisted* private equity. The majority of investments in this category are carried out by private equity firms raising capital from institutional investors who are able to invest large amounts of money for long periods of time, such as pension funds, insurance companies and mutual funds.

Returns or internal rate of return (IRR) are often expected to be high, 20-30% annually, in order to reflect the fairly high risk involved in the business model. For an institutional investor, it is attractive to invest at least a fraction of its funds in this kind of assets.

However, unlisted private equity possesses certain characteristics that makes the asset class highly illiquid and therefore makes it difficult for individual investors to access the asset class. Typically, investments are restricted to a minimum commitment, often larger than EUR 1 million. Most investments are generally long term, between seven and ten years, early withdrawals are typically not accepted and the stake cannot be sold in a stock market in the case of a need for cash.

The private equity asset class is characterized by a non-transparent nature, with little publicly released information, making investment returns difficult to access and study for others than the investors.

Listed Private Equity

An alternative to unlisted private equity has recently emerged. *Listed private equity* (LPE) refers to public companies listed and traded on a primary stock exchange with the business model of investing in unlisted companies. Globally, there are more than 300 LPE companies with a combined market capitalization of approximately USD 50 billion (LPX.ch).

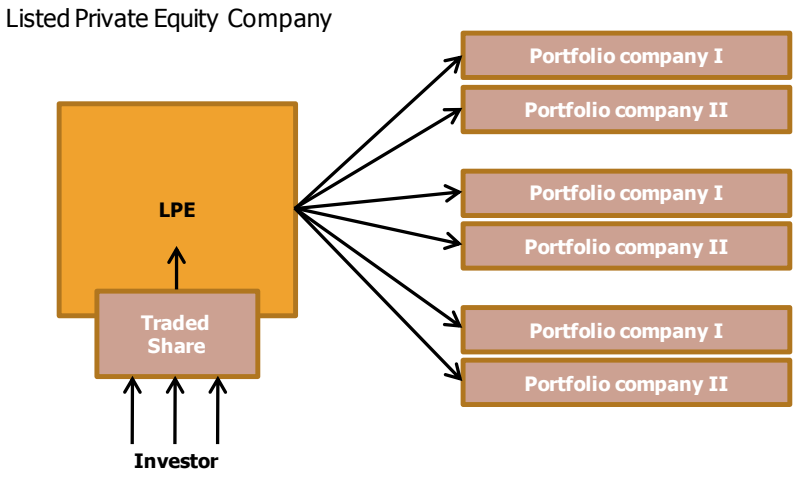
Unlisted private equity and LPE investments show similar or even equivalent characteristics, with regards to investment styles, financing styles and investment strategies. Listed private equity companies follow the same business model and display similar risk and return potential (Huss 2005) as their unlisted counterparts. However, LPEs have different organisational structures and do not have a set lifespan. In contrary they possess the opportunity to continuously invest and reinvest money.

From an investor point of view, LPE investments provide significant benefits compared to unlisted private equity investments and offers solutions to many of the concerns related to the traditional form of the asset class. The primary advantages are related to liquidity and accessibility. As a result of being publicly listed, LPE solves the issue of fixed investment horizons and lock up of invested money for long periods of time. It thus makes investments more liquid than investments in unlisted private equity. Due to lower requirement on investment size LPE also enables all

investors, not only institutional ones, to invest in private equity. The availability of market information and the requirements of providing information to investors offer private equity investments with a high level of transparency. Finally, the asset class also lowers the costs of investment, since there are no transaction costs except for bid-ask spread, and in general lower management fees than for unlisted private equity (LPX Group, 2010). A potential disadvantage of LPE is that it has been shown that correlation with stock markets tend to be higher than for its unlisted counterpart. Besides, being listed on a stock exchange always increase overheads, administrative cost and disrupts focus from the business as a result of the transparency requirements of being a public company.

Listed private equity can be categorized into three different organizational structures. The majority of listed private equity companies are organized as *listed direct private capital investment companies*. The term *direct* indicates that the company is invested directly in the underlying companies, and not via limited partnerships. Through the purchase of a share traded on an exchange, the investor gets exposure to a diversified portfolio of private companies directly held by the listed company. In contrast to an investment in a traditional limited partnership, this organisational structure offers an investor not only a direct exposure to a diversified portfolio of private companies but also a participation on general partner revenues generated by the additional fund management business. Ratos is an example of LPE structured in this way.

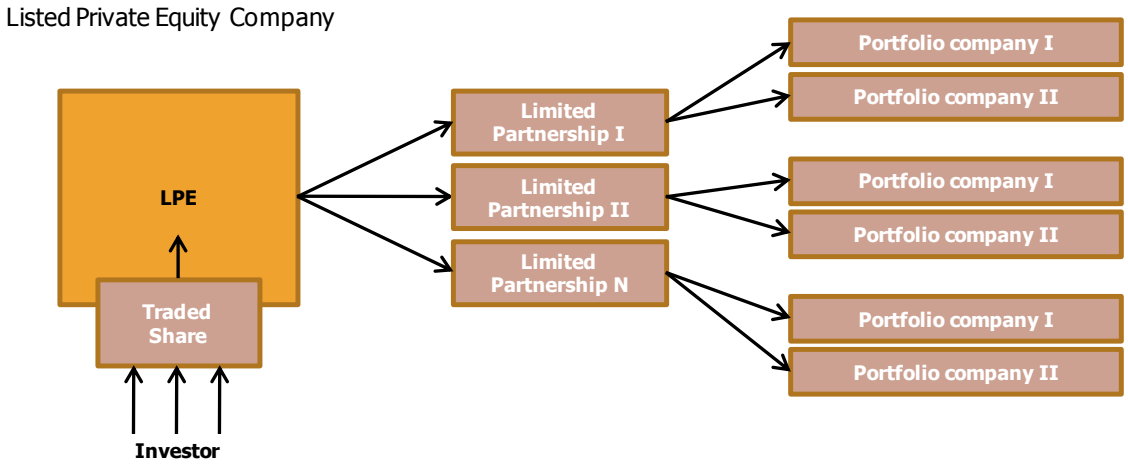
Graph 2: Listed Direct Private Capital Investment Companies



A *listed indirect private equity investment company (Fund of Funds)* is a listed company with the purpose of committing capital to traditional private equity limited partnerships. The word *indirect* indicates that the company does not invest capital directly in private equity deals but

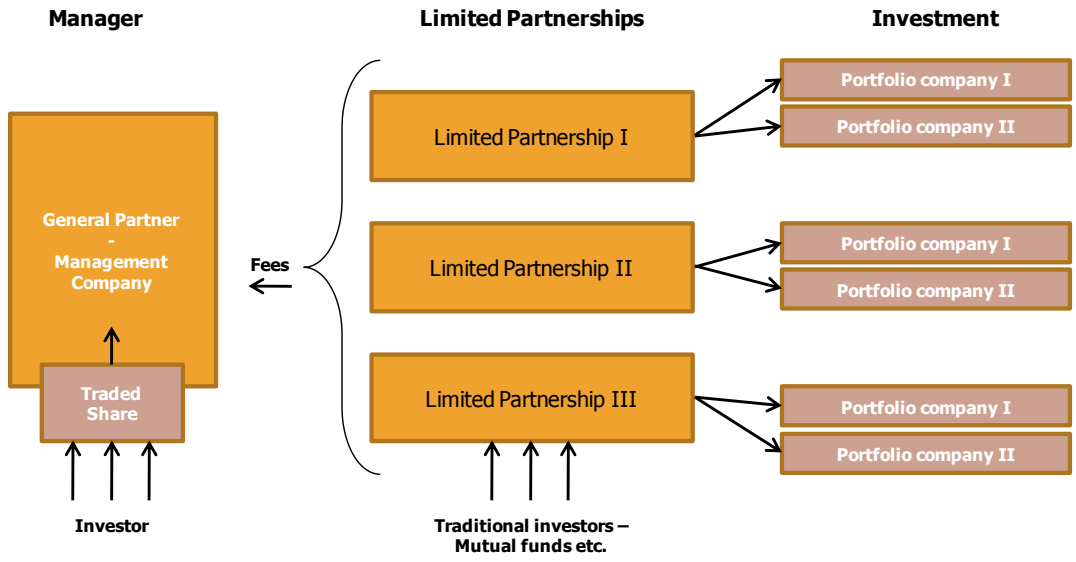
indirectly via investments in limited partnerships. An investor buys a share of the listed company over an exchange and in the end owns a portfolio of limited partnerships diversified across vintages, regions, etc. An example of LPE structured in this way is the Swedish listed company NAXS.

Graph 3: Listed Indirect Private Equity Investment Company (Fund Of Funds)



Listed private equity fund managers represent a minority of the listed private equity universe. Typically, listed fund managers have no direct or indirect exposure to private companies. The acquired interest is instead held in managed limited partnerships. The investor simply buys a listed interest in the general partner. 3i is an example of LPE structured as a listed private equity fund manager.

Graph 4: Listed Private Equity Fund Managers



III. THEORETICAL FRAMEWORK

In this section we present the theories and literature relevant to our study.

Previous research has studied whether private equity provides a "free lunch" to investors, i.e. a higher risk adjusted return than the market. The results are mixed and there is no current consensus regarding private equity's claimed ability to beat stock markets. The difference in results mainly derives from scarce data stemming from the proprietary nature of the return data and the problem of valuing unrealised investments. Surprisingly, there have been few studies approaching LPE and their returns.

Current literature regarding private equity returns often focuses on valuation techniques and methods in order to get a "fair" value of unrealised investments. However, the markets price LPE on a daily basis and therefore it is possible to apply recognised asset allocation methods on LPE to understand the potential benefits of these assets.

LPE´s ability to provide diversification and increased risk adjusted returns to investment portfolios

Could an investor be better off by investing part of the portfolio in LPE? According to Markowitz (1952) and modern portfolio theory an investor should always try to create a portfolio that maximises return for a given amount of risk. The key to do so is through diversification in a portfolio since a diversified portfolio will have less risk than the weighted average risk of its constituent assets. It has been shown that diversification lowers risk in a portfolio when the correlation between assets is not equal and even when a positive correlation exists.

To understand what affect LPE has on portfolio performance we need to look at the risk return relationship for portfolios combining LPE and stocks. We have chosen to use the asset allocation methods presented in the book Corporate Finance (Berk and DeMarzo 2006).

Adding an additional asset to a portfolio will contribute with its expected return as well as its risk. The relevant question for an investor is therefore if the additional asset contributes with relatively more return than risk to the portfolio. In order to determine if that is the case Berk and DeMarzo derive the *required contribution return* condition. If the expected return $E(R_i)$ of the additional asset i exceeds the *required return*, which equals the expected return necessary to

compensate for the risk the investment will contribute to the portfolio, an investor should add the asset to its portfolio since it improves the portfolio's Sharpe ratio.[2]

Let *p* denote the portfolio and *i* the additional asset being investigated whether or not to be included. Asset *i* should be included in the portfolio if it fulfils the required return contribution condition:

$$\underbrace{E(R_i) - r_f}_{\text{Additional return from investment i}} > \underbrace{(\sigma_{R_i}\rho_{R_iR_p})}_{\text{Incremental volatility from investment i}} \underbrace{\frac{E(R_p)-r_f}{\sigma_{R_p}}}_{\text{Return per unit of volatility available from portfolio p}} \quad (1)$$

By combining the volatility and correlation terms in equation 1, the *Beta* of asset *i* with portfolio *p* can be defined*:*

$$\beta_i^p \equiv \frac{\sigma_{R_i\, x\, \rho_{R_iR_p}}}{\sigma_{R_p}} \quad (2)$$

Hence, β_i^p then provides a sensitivity measure for the impact on asset *i*'s return depending on the fluctuations of portfolio *p*. By restating equation (1) with the definition of β_i^p, the minimum *required return* necessary to compensate for the risk contributed by asset *i* to the portfolio can be defined:

$$R_i = r_f + \beta_i^p[E(R_p) - r_f] \quad (3)$$

If *i*'s expected return exceeds the required return than adding more of it will improve the performance of the portfolio.

The theory explains the relationship between expected return, risk (defined as standard deviation) and correlation. According to the authors a high expected return is not good enough to base an investment decision upon, nor is a low correlation or risk. In fact there are many cases where for example adding a security with low expected return (lower than the expected return of the

[2] The Sharpe ratio was developed by William Sharpe (1966) and is a measure of excess return per unit of risk held in a portfolio. The ratio can be used to show how well a portfolio or asset performs for a given amount of risk, the higher the Sharpe ratio the better.

$$S_p = \frac{E(R_p) - r_f}{\sigma_{R_p}}$$

investor's portfolio) and fairly high risk can be beneficial due to low correlation and vice versa. Hence, an investor needs to take all the three concepts into consideration when making an investment allocation decision.

Central concepts for analysis are thus expected return, risk, and correlation. In section V *Methodology* we explain in detail how we have calculated these factors.

To sum up, we use Berk and DeMarzo's methodology in order to determine whether LPE, in our study defined as the various LPX indices, has contributed to an increased risk adjusted return for investors during the period December 1993 to May 2010 and define our first hypothesis as:

Hypothesis 1: Adding listed private equity to a portfolio of equity stocks during 1993-2010 has improved the risk return profile of an investor's portfolio

Relation of LPX and MSCI returns to macroeconomic variables

Following our first hypothesis a number of questions arise e.g. why would LPE improve a portfolio's risk return profile, and if so is the case, is it possible to isolate the factors which could cause such an effect? According to financial theory, including CAPM and Fama-French, an investor should only be rewarded for taking on systematic risk, as the company specific risk should be reduced by diversification. Consequently, the only way to receive higher returns is if the asset shows a different exposure to systematic risk i.e. to the general economy.

In their book *Modern portfolio theory and investment analysis* (1991) Elton and Gruber suggest that an efficient way of studying this sort of questions is through regression analysis. The authors see regression analysis as a way to describe the correlation structure of security returns and hence a way of assessing prediction of future returns. Elton and Gruber discuss a certain type of fundamental multi-index models relating security returns to macroeconomic variables. In their example they use Chen, Roll and Ross (1986) models as an example of how regression analysis is a useful method for linking the general economy to securities.

In order to relate LPE returns to macro economic variables we use a fundamental multi-index model developed by Bauer et. al (2001) where the authors specify a number of exogenous variables that characterises the global state of the economy and study whether the risk profile of listed private equity investments are different from traditional investments. Bauer et. al identifies the following variables as proxies for the general economy, *Global GDP growth, Global stock market volatility, Credit spread, Term spread, TED-spread, Global IPO volume, Global stock markets and M&A activity* and define their model:

$$R_t = \beta_0 + \beta_1 V_1 + \beta_2 V_2 + \cdots + \beta_k V_k + \varepsilon_t \quad (4)$$

where R_t is the excess return of the LPE portfolio over the risk-free rate in period *t*, V_j, j=1...*k* stands for the change of the *j:*th economic variable, β_0 is a constant, and β_j, j=1...*k* captures the influence of the *j:*th variable at *t* and ε_t denotes the residual.

Bauer et al. conclude that the investment characteristics of publicly traded private equity are sufficiently different from those of the general stock market in order to be qualified as a separate asset class with attractive diversification benefits.

In light of the above, our second hypothesis is stated as the following:

Hypothesis 2: Listed private equity has been affected differently by the global state of the economy than the general stock market during 1993-2009 and hence has been providing attractive diversification benefits to investors.

In section V *Methodology* we describe the model used in this study and our modifications to it in terms of time period, source of data and change of exogenous variables.

IV. DATA AND SAMPLES

In this section we present the data used for our analysis as well as the construction of the data set.

Dataset description

Our dataset has been constructed based on raw data downloaded from Thomson Datastream, Factset and OECD. The raw data consists of 48,706 observations of stock and LPX index prices as well as macroeconomic data, spanning from December 1993 to May 2010. As starting point we have used the first data point available for the LPX50 index, December 1993. For calculations of returns and correlation, daily data have been used until the end point, May 2010. For the regression analysis the ending point is November 2009, the latest reliable and available observation of GDP growth on a global level. All data in the regression analyses except for GDP growth has been obtained on a daily basis and converted into quarterly data in order to correspond to the GDP data intervals (only available on a quarterly basis). After this conversion, observations for 64 quarters, i.e. 16 years, remain in the data set. Observations in the regression analysis with standard residuals larger than three standard deviations have been considered outliers and thus been excluded. In general, this corresponds to between zero and three observations per regression dataset.

In the risk-return study the risk-free rate used for excess return and required return calculations has been based on the 3-month LIBOR rate. For required return the risk free rate has been defined as the average interest rate during the studied time period e.g. the average rate during December 1993 to May 2010. The volatility measure in the risk-return analysis is defined as the rolling one-month annualised standard deviation of the stock returns.

Listed Private Equity Index family – LPX

Our source of data for LPE is based on the LPX indices. The LPX index family was launched by the Swiss company LPX GmbH in late 2003 and was the first private equity index that tracks listed private equity companies worldwide. The indices include companies whose predominant business purpose (at least 50% of the investment portfolio) is in unlisted equity. Companies which only partly invest in unlisted equity are excluded from the indices. The indices cover LPE companies with all kinds of possible investment styles (buyout, venture, growth capital etc.) and include companies of all three organisational structures present in the industry. The various LPX indices are calculated daily and are built to meet the criteria of being investable, tradable and transparent. The index family is divided into various global, regional and style indices.[3]

[3] For further information please refer to the LPX website (lpx.ch).

The indices used in our study are described below:

LPX50: The LPX50 index is a global index covering the 50 largest and liquid listed private equity companies covered by LPX.

LPX Buyout: The LPX Buyout index covers the most actively traded listed private equity companies covered by LPX who have a business model mainly focused on the appropriation of buyout capital or in the investment in such funds.

LPX Venture: The LPX Venture index covers the most actively traded listed private equity companies covered by LPX whose business model focuses mainly on the provision of venture capital or in the investment in venture capital funds.

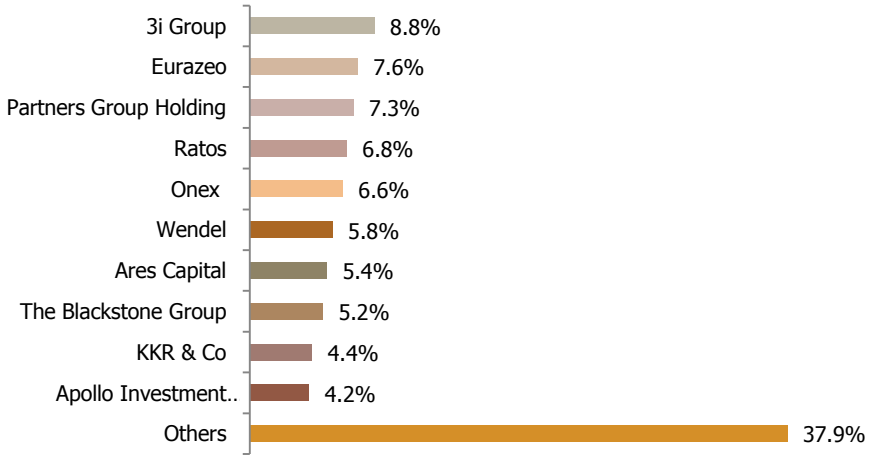
LPX Europe: This index covers the most actively traded listed private equity companies listed on a European stock exchange and covered by LPX.

LPX America: The index covers the most actively traded listed private equity companies covered by LPX and listed on a North American stock exchange.

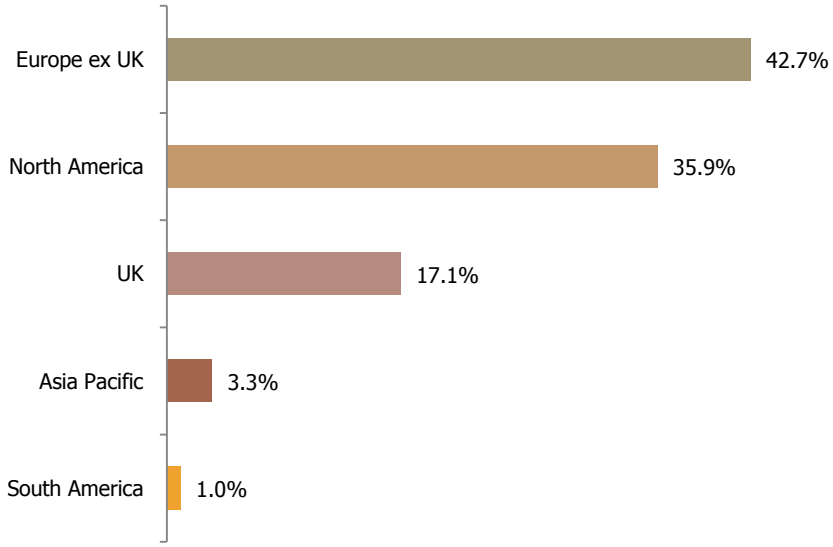
For illustrative purposes, Graph 5 and Graph 6, describe the constituents of the LPX50 index with regards to size and geography.[4]

[4] As of September 2010.

Graph 5: LPX50 - Largest holding (MktCap in index)



Graph 6: LPX50 – index market cap by region



Descriptive statistics

The summary statistics for the risk-return analyses are presented in Table 1. The data used in our analysis is found in the "Since start" column, which shows the data since the start of the LPX index family. The table shows the return of each index used in our study given an entrance 1, 3, 5, 10, 15 and 16 years ago. The average return demonstrates the annual geometrical average of the returns since the same time periods. Finally, the average annual volatility (as defined previously) is shown for the corresponding periods.

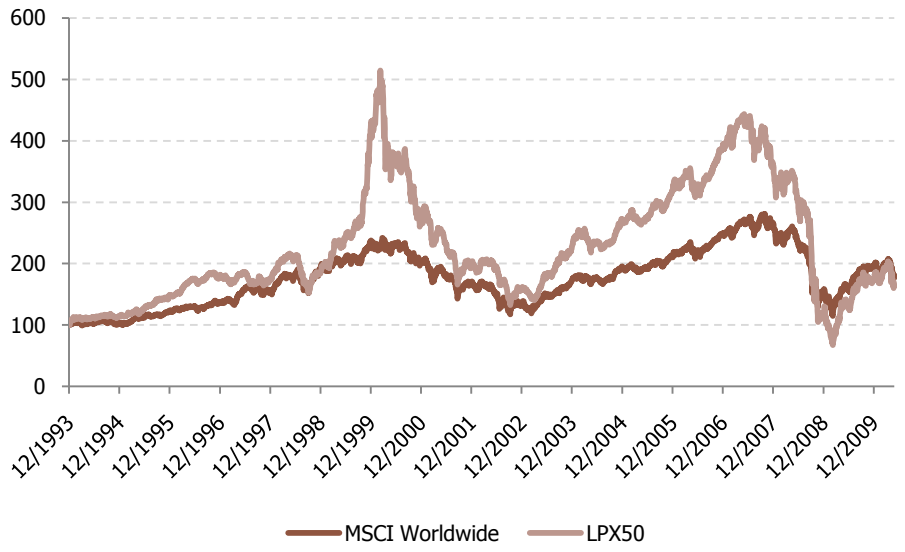
Table 1: Descriptive statistics – risk-return analysis

Last:	*1 year*	*3 years*	*5 years*	*10 years*	*15 year*	*Since start*	*Rolling 1 year*
Return MSCI	13.1%	-32.5%	-5.9%	-17.0%	60.6%	***80.5%***	---
Average annual return MSCI	13.1%	-12.3%	-1.2%	-1.9%	3.2%	***3.7%***	5.9%
Volatility MSCI	16.4%	21.3%	16.4%	15.3%	14.0%	***13.5%***	13.5%
Return LPX50	28.5%	-61.3%	-37.4%	-50.7%	39.1%	***68.9%***	---
Average annual return LPX50	28.5%	-27.1%	-8.9%	-6.8%	2.2%	***3.2%***	9.9%
Volatility LPX50	24.6%	29.3%	22.1%	18.4%	16.9%	***16.3%***	16.3%
Return LPX Buyout	44.9%	-62.6%	-34.0%	4.7%	123.1%	***147.1%***	---
Average annual return LPX Buyout	44.9%	-28.0%	-8.0%	0.5%	5.5%	***5.7%***	11.3%
Volatility LPX Buyout	29.6%	34.7%	25.4%	17.9%	15.4%	***15.1%***	15.1%
Return LPX Venture	11.7%	-54.0%	-44.2%	-72.6%	8.4%	***53.9%***	---
Average annual return LPX Venture	11.7%	-22.8%	-11.0%	-12.1%	0.5%	***2.7%***	10.5%
Volatility LPX Venture	18.3%	23.9%	20.7%	19.8%	20.6%	***20.1%***	20.1%
Return LPX Europe	25.2%	-60.5%	-27.8%	-33.6%	99.5%	***134.6%***	---
Average annual return LPX Europe	25.2%	-26.6%	-6.3%	-4.0%	4.7%	***5.3%***	11.4%
Volatility LPX Europe	26.5%	31.9%	24.4%	19.2%	16.6%	***16.2%***	16.2%
Return LPX America	45.6%	-59.7%	-44.3%	-49.3%	---	***-15.1%***	---
Average annual return LPX America	45.6%	-26.1%	-11.0%	-6.6%	---	***-1.3%***	5.3%
Volatility LPX America	31.8%	43.6%	30.9%	26.1%	---	***26.2%***	26.2%
Average riskfree interest rate	0.5%	3.3%	3.9%	4.2%	4.9%	***5.0%***	5.0%
Average riskfree interest rate US	0.5%	3.3%	3.9%	4.2%	---	***4.6%***	4.6%

Note: The data for the LPX America index starts in December 1997 and therefore the values in the "since start" column are based on 12.4 years instead of 16.4 years as for the other indices. Return averages are based on geometrical averages (CAGR).

The price development of LPX50 and MSCI Worldwide is presented in Graph 7. The equivalent charts for the other LPX indices are found in the appendix. As seen in the graph, LPX50 has historically tended to have higher peaks than the MSCI while following the index quite closely during downturns.

Graph 7: Price development LPX 50 vs. MSCI Worldwide 1993-2009 (rebased)



Note: Daily return since December 1993 = 100.

The summary statistics for the quarterly macro economical variables input data used in the regression analysis are presented in Table 2. All regression outputs are found in the appendix. As previously mentioned this data is based on 64 observations spanning from December 1993 to November 2009. The definitions of the variables are presented in the next section, "Methodology".

Table 2: Descriptive statistics – regression analysis, quarterly

Descriptives	*GDP growth*	*MSCI world volatility*	*Credit spread*	*Term spread*	*TED spread*
Mean	0.54%	6.72%	0.93%	1.60%	1.71%
Standard Error	0.08%	0.49%	0.06%	0.15%	0.14%
Median	0.67%	6.21%	0.81%	1.55%	1.56%
Standard Deviation	0.59%	3.85%	0.45%	1.17%	1.11%
Kurtosis	12.17	10.79	12.81	(1.12)	(0.80)
Skewness	(3.10)	2.75	3.23	0.14	0.26
Minimum	(2.29%)	2.97%	0.55%	(0.49%)	(0.19%)
Maximum	1.39%	26.09%	3.07%	3.65%	4.06%
Sum	33.18%	410.22%	56.55%	97.85%	104.13%

V. METHODOLOGY

In this section we explain the methodology behind our research and provide the reader with the model specification used in our regressions.

We have applied four sources of theory and methods to answer our two research questions. For hypothesis one, we have used the asset allocation method provided in the book by Berk and DeMarzo (2006). For the mathematical definitions of each variable, we have used the same methods as Milner and Vos (2003) use in their study of how private equity affects the performance of an investment portfolio which is primarily weighted in the stock market. For hypothesis two, we have taken use of the index model framework provided in Elton and Gruber (1991) as well as the fundamental multi-index model developed in the study performed by Bauer et al (2001).

LPE´s ability to provide diversification and increased risk adjusted returns to investment portfolios

In order to examine whether adding LPE to investment portfolios has provided diversification benefits to an investor and consequently an increased risk-return ratio we apply the method of required return provided by Berk and DeMarzo. Our base case has been to study the effect of including the global LPE universe into an investor's current portfolio. As a proxy for the global LPE universe we have used the LPX50 index and for the current portfolio the MSCI Worldwide index. As previously mentioned, the LPE universe consists of companies with various investment styles and geographic focus. In order to understand whether the investment styles and/or geographic focuses imply different effects on the portfolio we have also performed the same study on the various LPX sub-indices LPX Buyout, LPX Venture, LPX Europe and LPX America.

Since our thesis is a study of historical performance, the expected return variable in the Berk and DeMarzo model de facto becomes actual returns for the period December 1993 to May 2010. Milner and Vos (2003) define historical return as the geometrical average of the time period, in other words the compounded annual growth rate of the portfolio (CAGR).

$$CAGR_{t_0 t_n} = \left(\frac{V_{t_n}}{V_{t_0}}\right)^{\left(\frac{1}{t_n - t_0}\right)} - 1 \qquad (5)$$

where $V_{t_0}$is the start value, $V_{t_n}$the finish value and $t_n - t_0$the number of years. We have chosen to use the same principle in our study. We also use the same measure and calculation of risk as Milner and Vos do in their study, i.e. standard deviation.

In order to use Berk and DeMarzo's methodology and understand whether LPE can provide diversification opportunities we also need to understand how returns of LPE vary in relation to the investment portfolio, in our case, the stock market. The first step of this correlation computation is to calculate the covariance between LPE's and stock markets where covariance of asset i and j is defined as:

$$COV_{ij} = \frac{\sum(i - \bar{\imath})(j - \bar{\jmath}}{N} \tag{6}$$

Covariance is not sufficient for our purpose to correlate LPE to stock market returns, however, as it provides the information of which direction the assets move together but not the strength of this co-movement. In order to put the co-movement of LPE and stocks into perspective we need to calculate the correlation between the two assets where the correlation coefficient ρ between assets *i* and *j* is defined as follows:

$$\rho_{ij} = \frac{COV_{ij}}{\sigma_i \sigma_j} \tag{7}$$

We have calculated the correlations between daily returns of the studied LPX and MSCI indices for the period 31/12/1993 to 28/05/2010. The obtained correlation coefficients have been statistically tested in order to determine its significance. This has been done through a two-tailed *Pearson Product-Moment Correlation Coefficient* test where the null hypothesis $H_{0:}\ \rho = 0$ is tested against the alternative hypothesis $H_{1:}\ \rho \neq 0$. The test statistic is:

$$t = \frac{\rho}{\sqrt{\frac{1 - \rho^2}{N - 2}}} \tag{8}$$

and approximately follows the student's t-distribution with N-2 degrees of freedom. A result where the null hypothesis is rejected implies correlation between the two assets *i* and *j* and thus less diversification possibilities. However a negative or a low correlation can still provide attractive asset characteristics from a portfolio point of view.

When "expected return" (in our case actual return), risk and correlation have been derived, we apply them on Berk and DeMarzo's required return model in order to answer our question whether an investor has achieved a better risk-adjusted return as a result of diversification from adding LPE to an investment portfolio.

Relation of LPX and MSCI returns to macroeconomic variables

In order to understand what can be the cause of an eventual diversification potential provided by LPE we need to investigate whether LPE have a different exposure to the general economy than what the stock market has. We use the multi-index regression model used by Bauer et al. in their study of LPE's exposure to macroeconomic variables, but modified in terms of exogenous variables. We complement their research by using the LPX indices as the primary base of our empirical studies and extend the study by observing a longer period of time and a broader spectrum of sub-indices allowing us to differentiate between e.g. buyout and venture funds.

We relate LPX returns to the movement in selected macro economic variables in a multi-index model. The model we use contains five exogenous variables; *GDP growth*, *stock market volatility*, *credit spread*, *term spread* and *treasury-eurodollar spread* (TED-spread), each being considered a proxy for the global state of the economy. The estimated model is:

$$R_{i_t} - r_{f,i_t} = \alpha_t + \Delta GDP_t + Vol_t + Cred_t + Term_t + TED_t + \varepsilon_t \tag{9}$$

where $R_{i_t} - r_{f,i_t}$ is the excess return of the studied index *i* (LPE or MSCI) at time *t* over the risk free rate r_f.

ΔGDP_t represents the percentage development in GDP from quarter t-1 to quarter t. In the dataset the GDP growth variable is defined as follows:

$$\Delta GDP_t = \frac{GDP_t}{GDP_{t-1}} - 1 \tag{10}$$

and is denominated in percentages.

The global GDP variable describes the real growth rate of the gross domestic product of the OECD countries. The effect of GDP growth on returns has two sides. The effect would be expected to be positive as the LPE funds would be able to profitably exit investments at good prices and thus lead to better performances. However, economic growth could also result in increased competition among funds, which would lead to higher investment prices, and thus lower returns,

which could imply a negative relationship with the LPX indices. The net effect of the GDP growth is determined by the relative impact of the two offsetting factors. We expect the GDP growth coefficient to be positive.

Vol_t is the quarterly volatility of the last three months daily returns of the MSCI Worldwide stock market index during period t. In the dataset the volatility variable is defined as follows:

$$VOL_t = STDEV_{90days}\left(R_{MSCI\ Worldwide_t}\right) * \sqrt{\frac{265}{4}} \tag{11}$$

denominated in percentages.

Stock market volatility has been calculated on a quarterly basis based on daily returns. Hence our volatility variable is measured by the standard deviation of the daily returns of the MSCI Worldwide index during a quarter. High global volatility is expected to imply higher risk premium and thus lower returns. Hence, a negative sign on the coefficient is expected.

$Cred_t$ represents the credit spread in quarter t. In the dataset the Credit spread variable is defined as follows:

$$CreditSpread_t = Baa_t - Aaa_t \tag{12}$$

and is denominated in percentage units.

The credit spread is measured by calculating the difference between Baa1 and Aaa corporate bonds based on Moody's corporate bond indices. An increasing spread is a sign of a deteriorating economic climate and LPE would thus have difficulties in exiting portfolio companies at good multiples and face high cost of raising new debt. The expected impact on the returns of a changing credit spread is expected to be negatively correlated with both the LPX indices as well as the stock market.

$Term_t$ is the term spread in quarter t. In the dataset the Term spread variable is defined as follows:

$$TermSpread_t = USB10Y_t - USTB3M_t \tag{13}$$

denominated in percentage units.

The term spread is the spread between the long term and short term interest rates and can be used as an indicator of investors' expectations on the future economy. An increasing spread

implies a belief of a better state of the economy and therefore we expect a positive correlation with returns. We have used the 10-year U.S. government bonds as indicator for the long-term interest rate and the 3-month Treasury bills for the short term one.

TED_t is the TED spread in quarter t. In the dataset the TED spread variable is defined as follows:

$$TEDSpread_t = LIBOR3m_t - USTB3M_t \tag{14}$$

denominated in percentage units.

The TED spread is calculated taking the difference between the 3-month US Treasury bills and the 3-month LIBOR. The TED spread can be used as an indicator of credit risk in the general economy as the difference in the two rates represents the "risk premium" of lending to a bank instead of to the U.S. government. An increase in the TED spread indicates an increasing risk of a default on interbank loans and a downturn in the stock market as liquidity is being withdrawn. The spread is thus a particularly interesting variable to study with regards to the recent financial crisis, where the TED spread sky rocketed to levels several times higher than the normal levels. We expect an increase in TED spread to be negatively correlated with returns.

Description of hypothesis test statistics

The same regression model is applied on the general stock market in order to get reference values for the macro economy variables' effect on stock returns. We have used MSCI Worldwide as a proxy for the global stock market. The coefficients obtained in the regressions are statistically tested against each other to determine if they significantly differ from each other, and thus affect LPE and stock returns differently. For the regional LPX indices (Europe and America) the coefficients have been compared to MSCI Europe and MSCI America respectively.

The obtained beta coefficients are tested with a two-tailed t-test. The test statistic is:

$$t_{obs_i} = \frac{\hat{\beta}_{variable\_i(LPX)} - \hat{\beta}_{variable\_i(MSCI)}}{SE_{\hat{\beta}_{variable\_i(LPX)}}} \tag{15}$$

and follows the *student's t-distribution* with $\upsilon = N$ degrees of freedom under the null hypothesis. The decision rule is:

Reject H_0 if $t_{obs} > t_{crit}$ or $t_{obs} < -t_{crit}$

(16)

We define H_0 as the opposite of our research hypothesis in order to minimize type-1 error (this method is adopted for all our hypothesis tests) where H_0 is defined as:

$$H_0: \hat{\beta}_{variable_{-i(LPX)}} - \hat{\beta}_{variable_{-i(MSCI)}} = 0$$

(17)

VI. EMPIRICAL RESULTS AND ANALYSIS

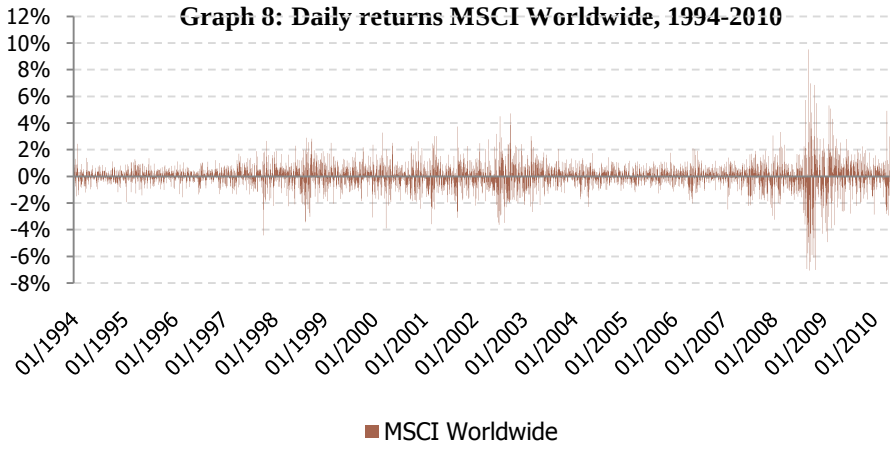
In this section we present the results from our study, show the statistical answers to our hypotheses and briefly discuss the implication of the outcome.

The results of our analysis show that since December 1993 the best performing index has been LPX Buyout with a compounded annual growth rate of 5.7% closely followed by LPX Europe (5.3%). This can not by any means be considered to be impressive return. The low returns are however linked to the fact that our study ends in a period of strong recession which is confirmed by the low returns levels of the MSCI index of 3.7% for the period.

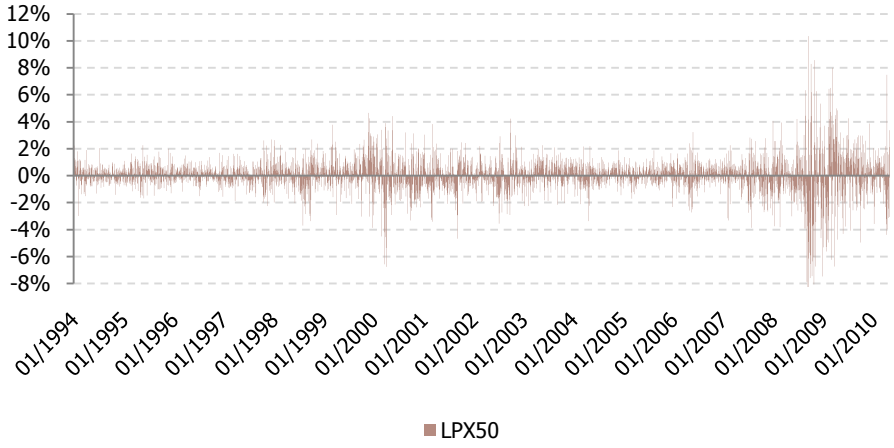
The standard deviations are compared to the returns very high (13.5% - 26.2%) and also linked to the recent economic turmoil which has increased volatility on the stock markets. For this rather extraordinary period an investor could have received an average annual return of 5% by investing in the risk-free interest rate.

The result also shows that there has been a positive correlation between the studied LPX indices and the global stock markets during the period December 1993 to May 2010. The strength of the correlation range between 0.54 for LPX Venture and MSCI Worldwide and 0.73 for LPX 50 and MSCI Worldwide and is statistically significant on the 1% level for all indices. An interesting finding present in all studied series is the trend of increased correlation between LPE and stock markets when volatility increases. In Graph 8 to 10 we show this finding in the case of LPX50 vs. MSCI Worldwide. Graph 8 and 9 plots the daily returns of respective index since December 1993. These graphs can be interpreted as a visual plot of volatility. Graph 10 shows the rolling 1-month correlation between LPX50 and MSCI Worldwide and a rolling 1-year average of the monthly correlations.

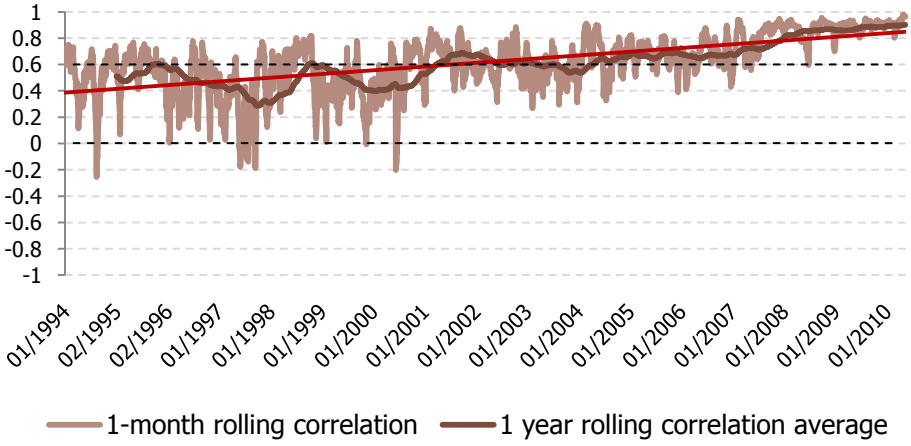
Graph 8: Daily returns MSCI Worldwide, 1994-2010



Graph 9: Daily returns LPX50, 1994-2010



Graph 10: Correlation between LPX 50 and MSCI Worldwide 1994-2010



Periods marked by economic turmoil such as the IT-crash in 2000 to 2002 and the financial crisis in 2008 and 2009 show signs of higher volatility. This tendency is slightly more pronounced in the LPX50 index than in MSCI Worldwide. Interestingly, there is a clear trend over time towards higher correlation between LPE and stock markets. Not only is the trend positive (in a statistical meaning) but the variance of the correlation is also converging towards the trend line. Using the same definition of *low correlation* as the Swedish pension authorities, $\rho \leq 0.6$, we see that the LPX50 index has not provided low correlation with stock markets since 2004. The same patterns are present in all the other LPX indices with one exception, the LPX Venture index, which not only has a correlation below 0.6 during our entire study period but also a rolling 1-year correlation average which seldom has exceeded the 0.6 limit. This finding contradicts the common belief in the private equity universe, that private equity shows a low correlation with stock markets. A potential explanation could be that LPE shows a higher correlation with stock markets than its unlisted counterpart.

The finding of non perfect correlations and in some cases low correlations between the LPX indices and the stock markets suggest that there potentially could have been positive effects from adding LPE to an investor's portfolio. However, correlation analysis alone is not enough to determine whether this is the case. With the actual returns of the LPX indices for the period December 1993 to May 2010 we have constructed combined portfolios in order to answer our first hypothesis. The results show mixed answers depending on type of LPE investment. In Table 3 we present a summary of our risk-return findings and consequent investment decisions.

Table 3: Summary of risk-return analysis

Results	*MSCI Worldwide*	*LPX50*	*LPX Buyout*	*LPX Venture*	*LPX Europe*	*LPX America*
Actual return (CAGR)	3.7%	3.2%	5.7%	2.7%	5.3%	-1.3%
Standard deviation	13.5%	16.3%	15.1%	20.1%	16.2%	26.2%
Correlation MSCI		73.2%	68.3%	53.9%	58.8%	73.1%
Required return		3.4%	5.5%	3.1%	5.2%	-2.9%
Diversification effect?		No!	Yes!	No!	Yes!	Yes!

Note: The expected returns are approximated as the CAGR for the last 16.4 years except for LPX America where the time period is 12.4. It should also be noted that for the LPX America portfolio comparison the MSCI results have been calculated for the same time period.(Average return:1.2%, volatility:15.1%).

As shown in the table, an investor who included listed European, American and buyout private equity indices to its portfolio during December 1993 to May 2010 has benefit from better risk-adjusted returns, since the returns for the period have exceeded the required return and thus

have improved the portfolio's Sharpe ratio. However, with the same reasoning, the global LPX50 and LPX Venture indices have not provided the same benefit, and should not have been added to the investor's portfolio. Interestingly, despite the fact that LPX America clearly had negative returns for the period, it still exceeded the required return hurdle. It is worthwhile mentioning that in this specific case an investor would obviously has been better off by investing in the risk free rate. However, since our aim of the paper is to study whether an investor who have included LPE to its investment portfolio during the period Dec 1993 to May 2010 have benefit from a better risk-adjusted return, the answer is still that the index should have been added.

How come these assets have provided further diversification? According to our results the answer is due to a different macroeconomic risk profile. A summary of the results of our regressions of the LPX and the MSCI indices are presented in the table below. (For full information on regressions please refer to the appendix).

Table 4: Summary of regression results (coefficients and r-square value)

BETA Coefficients	*Obs = n*	*R-square*	*GDP Growth*	*MSCI Worldwide volatility*	*Credit spread*	*Term spread*	*TED spread*
LPX 50	62	0.549	11.557***	-1.659***	7.57993	1.217	-1.411
MSCI Worldwide	64	0.366	6.027***	-1.071***	7.3605*	0.2493	-0.843
LPX Buyout	63	0.469	12.261***	-1.465**	11.3791**	1.0484	-2.573*
MSCI Worldwide	64	0.366	6.027***	-1.071***	7.3605*	0.2493	-0.843
LPX Venture	63	0.387	12.570***	-2.134***	15.9358**	1.405	0.0413
MSCI Worldwide	64	0.366	6.027***	-1.071***	7.3605*	0.2493	-0.843
LPX Europe	63	0.422	10.484***	-1.556***	10.3904**	0.8904	-0.766
MSCI Europe	64	0.400	5.005***	-11.08***	7.2793**	0.659	-1.549
LPX America	46	0.449	13.457**	-1.8399**	15.328*	3.661	-4.790**
MSCI America	47	0.383	4.696***	-1.077**	5.7559	1.077	-1.490

*Note: *** p < 0.01, ** p < 0.05, * p < 0.10*

Table 4 shows the number of observations, the r-square values as well as the coefficients for the performed regressions. The regression results are presented pair wise in the same way as they are tested against our hypotheses.

Table 5: Summary of regression results (standard errors)

Standard Error	*Obs = n*	*SSE*	*GDP Growth*	*MSCI Worldwide volatility*	*Credit spread*	*Term spread*	*TED spread*
LPX 50	62	1.118	2.130	3.979	5.817	2.678	2.413
MSCI Worldwide	64	0.400	1.291	2.422	3.501	1.337	1.454
LPX Buyout	63	0.952	1.711	3.204	4.675	1.788	1.948
MSCI Worldwide	64	0.400	1.291	2.422	3.501	1.337	1.454
LPX Venture	63	1.465	2.950	5.519	7.988	3.044	3.305
MSCI Worldwide	64	0.400	1.291	2.422	3.501	1.337	1.454
LPX Europe	63	1.034	1.924	3.602	5.256	2.010	2.190
MSCI Europe	64	0.579	1.616	3.031	4.380	1.673	1.820
LPX America	46	1.094	2.655	4.920	6.986	3.146	3.341
MSCI America	47	0.319	1.426	2.641	3.716	1.660	1.756

Table 5 shows the standard error for each coefficient and the sum of square values for the regressions as well as number of observations.

We have chosen to show and discuss the regression results of one of the LPX indices that increased the Sharpe ratio and exceeded the required return rate, namely the LPX Buyout index. Results for the other indices will be discussed when differing from the LPX Buyout comparison, or otherwise presented in the appendix.

Our results show that GDP growth affects LPX Buyout returns positively and is statistically significant on the 1% level. Stock market volatility (5% level) and TED spread (10% level) affects the index returns negatively and is also significant. We also find the credit spread to be significant, on the 5% level, however not with the anticipated sign of being negatively related to stock market returns. Surprisingly, our regression analysis returns positive beta coefficients for this variable in all data sets. Further, despite showing the expected sign we cannot find evidence which supports that the term spread affects index returns significantly on any relevant significance level. This is also a bit surprising since earlier studies find these variables significant (Bauer et. al 2001). Our findings are in line with Phalippou and Zollo (2005) who find that private equity funds are significantly pro-cyclical and that GDP growth affects return performance positively.

The regression on the MSCI Worldwide index shows that stock market returns are positively related to GDP growth, credit spread and term spread while negatively related to volatility and TED spread. A deviation from the expected sign is found in the effect from the credit spread. GDP growth, stock market volatility and credit spread are significant on the 1%, 1% and 10% level respectively.

The regressions return fairly high R^2 values with most of the models returning an R^2 value above 40%. More precisely our five chosen variables explain 47% of LPX Buyout excess returns and 37% of MSCI Worldwide excess returns. Interestingly, however, we notice that the R^2

values generally are slightly higher for the LPX regressions, meaning that our model better explains LPX returns than stock market returns.

The findings are in line with our expectations and we are not surprised to find that the state of the economy do matter for returns. However we also find that the coefficients seem to differ between LPE and MSCI in terms of magnitude. In order to understand why LPE could provide positive diversification effects we need to test if the coefficients statistically differ from each other.

Statistical test results

As seen in Table 6 we reject the H_0 hypothesis of the GDP coefficient being equal for LPX Buyout and MSCI Worldwide on the 10% significance level. The result therefore suggests that GDP growth affects LPX Buyout and MSCI differently (the same results are found for LPX Europe vs. MSCI Europe and LPX America vs. MSCI America). It is interesting to see that the GDP growth coefficient for the LPX Buyout regression is twice as large as the MSCI Worldwide coefficient. The tendency of a large difference in terms of size of the coefficients is the same for all the other sub-indices.

Table 6: GDP variable

GDP growth-test		
Beta_GDP Growth_LPX Buyout		12.26115189
Beta_GDP Growth_MSCI Worldwide		6.02775489
n-1		63
H0: Beta_GDP Growth_LPX Buyout - Beta_GDP Growth_MSCI Worldwide =		0
H1: Beta_GDP Growth_LPX Buyout - Beta_GDP Growth_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.669402222
T(critical) @ significance level:	5%	1.998340522
T(critical) @ significance level:	1%	2.656145008
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_GDP Growth_LPX Buyout - Beta_GDP Growth_MSCI Worldwide / SE(Beta_GDP Growth_LPX Buyout)		
		1.844
Decision at 10% significance level:		Reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		7.0%

The result does not support the claim that private equity do not correlate with business cycle, rather the opposite since the GDP growth coefficient is positive and significant. However, seen from a diversification perspective, the difference in effect from GDP growth on LPE and stock market returns could be favorable and a potential explanation of our findings of a better risk-adjusted return for investors including LPE in the portfolios.

We continue our study by comparing the effect of stock market volatility. Our result does not support that the effect of a change in stock market volatility affects LPX Buyout and MSCI differently.

Table 7: Volatility variable

Volatility-test		
Beta_MSCI Worldwide volatility_LPX Buyout		-1.465356605
Beta_MSCI Worldwide volatility_MSCI Worldwide		-1.071635223
n-1		63
H0: Beta_MSCI Worldwide volatility_LPX Buyout - Beta_MSCI Worldwide volatility_M		0
H1: Beta_MSCI Worldwide volatility_LPX Buyout - Beta_MSCI Worldwide volatility_M		0
T(critical) @ significance level:	10%	1.669402222
T(critical) @ significance level:	5%	1.998340522
T(critical) @ significance level:	1%	2.656145008
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_MSCI Worldwide volatility_LPX Buyout - Beta_MSCI Worldwide volatility_MSCI Worldwide / SE(Beta_MSCI Worldwide volatility_LPX Buyout)		
		-0.660
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		51.1%

The hypothesis test result suggests that LPE does not differ from stock markets in terms of how they react to volatility or, in other words, market risk. If LPE were to have a different risk profile, a different outcome of our hypothesis test would have been favorable. Hence, market volatility cannot explain the diversification effects from adding LPE to a stock portfolio.

The credit spread is the third variable that is significant, albeit on the 5% level (LPX Buyout) and 10% level (MSCI Worldwide). Since credit spread is an indicator of cost of debt (and ultimately risk), it is interesting to study whether LPE is differently affected by this variable than what the stock market is. The results does not support that the effect of change in the credit spread affects LPX Buyout and MSCI differently. As in the case of market volatility, credit spread cannot explain the diversification benefits provided by LPE's different risk profile.

Table 8: Credit spread variable

Credit spread-test		
Beta_Credit spread_LPX Buyout		11.37914346
Beta_Credit spread_MSCI Worldwide		7.36059811
n-1		60
H0: Beta_Credit spread_LPX Buyout - Beta_Credit spread_MSCI Worldwide =		0
H1: Beta_Credit spread_LPX Buyout - Beta_Credit spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.670648865
T(critical) @ significance level:	5%	2.000297804
T(critical) @ significance level:	1%	2.660283014
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Credit spread_LPX Buyout - Beta_Credit spread_MSCI Worldwide / SE(Beta_Credit spread_LPX Buyout)		
		0.720
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		47.4%

Since term spread and TED spread are not significant in neither of our regressions, we have chosen not to present the hypothesis test results in this section. The full result from these tests can be found in the appendix but should be interpreted with caution (if at all).

VII. DISCUSSION AND CONCLUDING REMARKS

In this section we discuss our findings and the implications of these. We will also compare our results with earlier studies and how this study contributes to the academic research on the subject. Finally we highlight potential areas of improvements of our approach and give suggestions for further research.

Let us return to our initial research question, should an investor invest in LPE? Based on historical data for the period December 1993 to May 2010, the answer is not unambiguous and certainly not as clear as often claimed by the private equity industry.

The results from the risk-return study suggest that investors can benefit from adding LPE to their portfolios but must consider what kind of LPE to include. As previously mentioned, for our study period, LPX Venture provided the lowest correlation among the studied indices, while LPX 50 showed the highest. Since venture funds invest in companies at an early stage where the main challenges are related to developing a business model, it is not unreasonable to believe that the effect from the state of the economy is less significant for these companies. This characteristic could be considered attractive for an investor but as shown in our results, the historical returns do not support adding these funds to a portfolio of stocks. LPX Buyout, LPX Europe and LPX America have shown higher correlation with stock markets than LPX Venture, but have nevertheless provided a source of diversification benefits when added to a portfolio. This reinforces the understanding that an investor needs to take into consideration not only the return and risk levels of an asset but also the asset's correlation with an investment portfolio in order to make the investment allocation decision whether to include LPE in the portfolio.

Our results show that private equity managers' claims of low correlation with stock markets might have been true during certain periods of time. However, as seen in our results, few LPE indices show low correlation with stock markets today. On the contrary, there seem to be a trend of increasing correlation with stock markets and a historical pattern of higher correlation in volatile periods. This implies that when investors need diversification the most, LPE tends to provide less diversification opportunities. This is obviously not a desirable characteristic. Bauer et al. (2001) provide similar findings and so does Longin and Solnik (1995) and Solnik, Boucrelle and Le Fur (1998).

We must bear in mind that our study period ends during what might be the largest financial crisis since the early thirties, and might affect our results. However, the correlation trend we have found has been steady since the mid-nineties and a more feasible explanation could be a

maturing LPE industry where a growing number of companies continuously are added to the indices.

Our regression analysis has provided clues of where the diversification potential comes from. We have shown that GDP growth significantly affects LPE differently and to a larger extent than it affects the stock market. Furthermore, the LPX indices that according to Berk and DeMarzo's methodology should have been added to a portfolio are the same indices which also show statistically significant different coefficients. The fact that the difference lies in the sensitivity towards GDP growth is not surprising. GDP growth is after all considered to be the closest proxy for the state of the economy. However we find it a bit surprising that our results do not support Bauer et al. (2001) findings regarding differences in credit and TED spreads between LPE and stock markets. A potential explanation could be that the last three years economic turmoil has offset the predicting power of some of the traditional macroeconomic indicators. It would be very interesting to study whether these macro indicators are significant under more "normal" conditions.

Based on our regression results, it is at least not unfair to state that the PE industry's claim of being uncorrelated with the economy and stock market is erroneous. Still though, our study does support the fact that certain LPE types do have provided diversification opportunities and return improvements to a portfolio during the period December 1993 to May 2010 and hence support our two hypotheses.

Critical discussion and suggestions for further research

There are several factors that impact the results in our paper. For the risk-return analysis a relevant issue to highlight is the methodology of calculating average returns. We have chosen to base our analysis on geometrical averages which gives the current level of a studied index a large impact. Our study ends in May 2010, which still must be considered as being part of the financial credit crunch, resulting in fairly low average returns. On the other hand this affects both LPE and the stock markets. An alternative way to assess actual returns would be to use rolling one year returns on a daily basis, and take the average of these. Interestingly, when performing this calculation (results not presented in the study) we come to the same conclusions, providing robustness and comfort in our findings.

Another relevant question is if the chosen variables for our regressions are good proxies for the general economy. It could possibly be the case that the GDP variable is such an important macro proxy leaving the remaining ones with little macroeconomic informative value (in a statistical meaning). Further, the fact that GDP data is released on a quarterly basis also impacts the regressions by significantly reducing the number of observations. A potential alternative could be to

exclude the GDP variable and replace it by industry productivity measures, unemployment rate and other variables linked to the state of the economy as well as perform the study on a daily basis.

It would also be interesting to add additional macro economic variables to the regression model, as the R-square values in our regressions indicates that there could be other macro economic variables than the studied ones that affect both LPE and stock market returns.

As to helping investors with an investment decision it is important to bear in mind that we have studied the industry as such, and that there will always be some LPE companies performing better than others. In a more realistic case, an investor is most likely deciding whether or not to invest in a given fund rather than in the LPE industry as such, which is a rather different question.

We do find support for adding certain types of LPE to investment portfolios. However, we do not investigate how much of the portfolio should be allocated to LPE. An interesting extension of our study would therefore be to apply asset allocation theories in order to find the optimal allocation between stocks, bonds and LPE.

Conclusion

So finally, do our findings have practical implications? Yes, our results suggest that investors, based on historical data, should consider including certain types of LPE to their portfolios as this has provided a better risk adjusted return historically. Given LPE's different risk profile towards GDP growth an investor should include these assets during times of increasing GDP growth. However, it is important to remember that LPE show a trend of increasing correlation with stock markets, which is an undesired effect for diversification opportunities.

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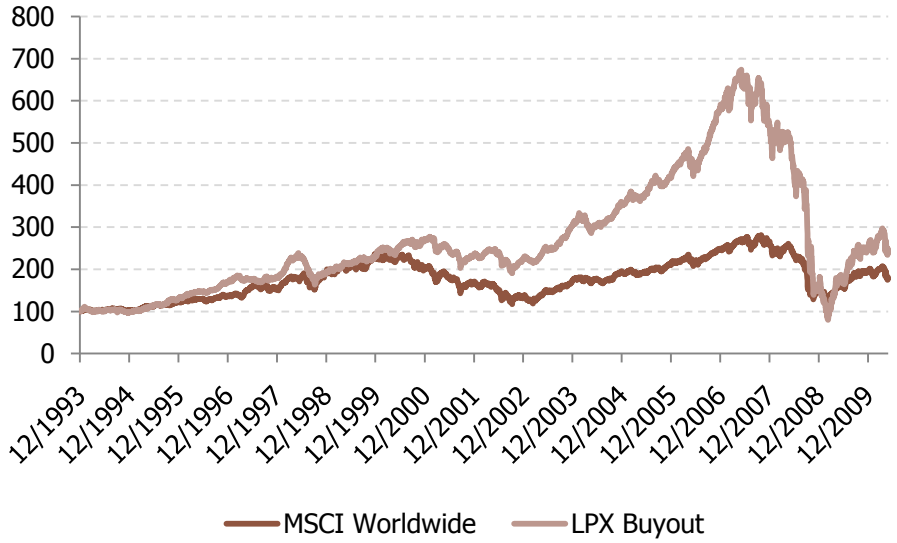
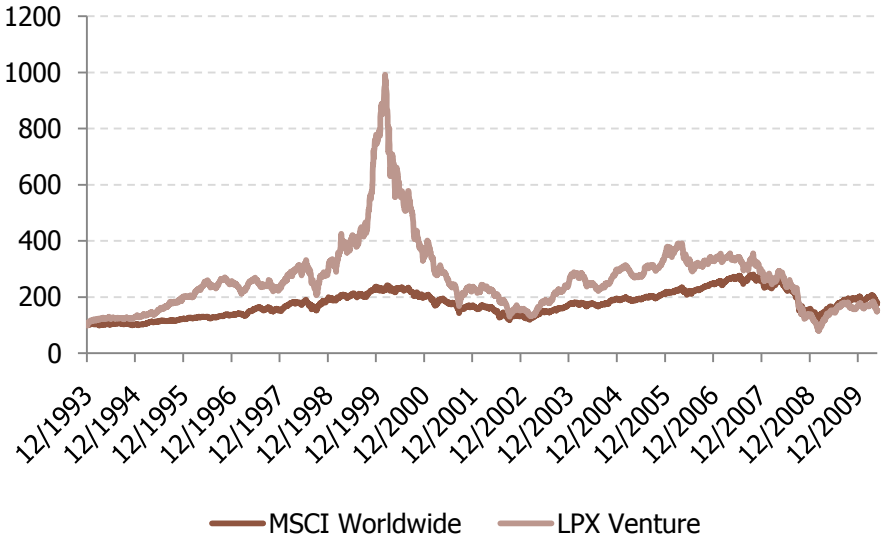
IX. APPENDIX

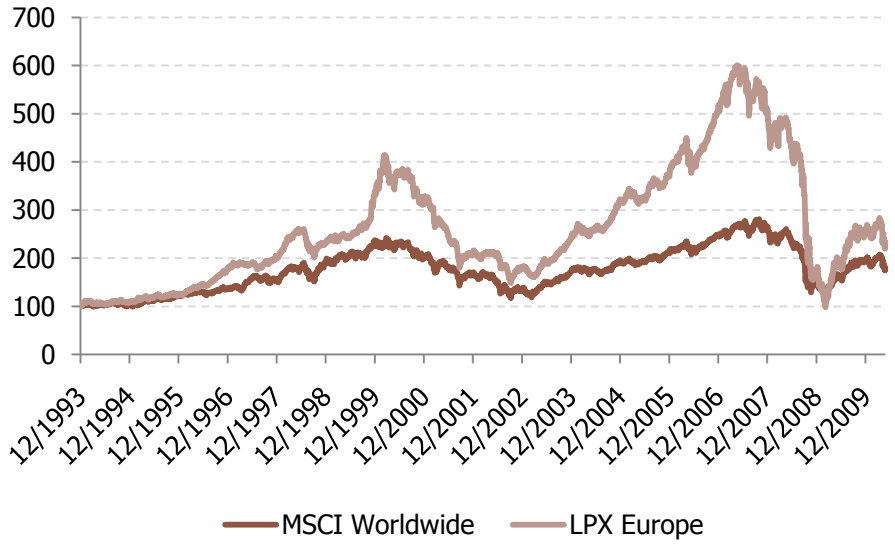
Graph 11: Price development LPX Buyout vs. MSCI Worldwide 1993-2009 (rebased)



Graph 12: Price development LPX Venture vs. MSCI Worldwide 1993-2009 (rebased)



Graph 13: Price development LPX Buyout vs. MSCI Worldwide 1993-2009 (rebased)



Graph 14: Price development LPX America vs. MSCI Worldwide 1993-2009 (rebased)

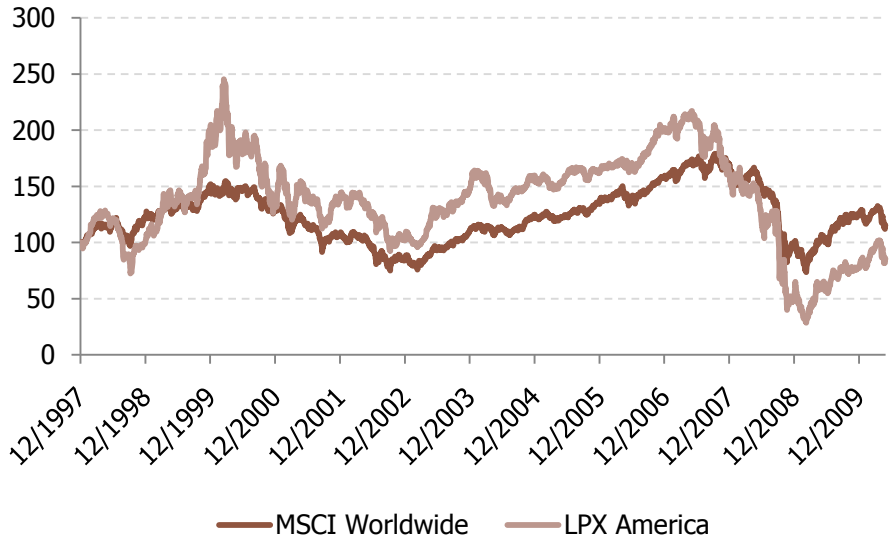


Table 9: Descriptive statistics – Regression analysis LPX50 index

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.740772125
R Square	0.548743342
Adjusted R Square	0.507720009
Standard Error	0.093632061
Observations	61

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.586350762	0.117270152	13.37637163	1.54395E-08
Residual	55	0.482182954	0.008766963		
Total	60	1.068533716			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.01759105	0.061286059	-0.287031833	78%	-0.140411055	0.105228956	-0.140411055	0.105228956
GDP growth	11.55721778	3.513575049	3.289304376	0%	4.515856085	18.59857948	4.515856085	18.59857948
MSCI world volatility_Annu	-1.65949389	0.583052113	-2.846218805	0.6%	-2.827956428	-0.491031352	-2.827956428	-0.491031352
Credit spread	7.579936719	5.843091552	1.297247639	20%	-4.129880343	19.28975378	-4.129880343	19.28975378
Term spread	1.217260532	1.284566838	0.947603889	35%	-1.357068922	3.791589985	-1.357068922	3.791589985
TED spread	-1.411753139	1.33055745	-1.061023813	29%	-4.078249838	1.254743559	-4.078249838	1.254743559

Table 10: Descriptive statistics – Regression analysis LPX Europe

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.649856261
R Square	0.42231316
Adjusted R Square	0.368823638
Standard Error	0.079593414
Observations	60

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.250086456	0.050017291	7.895250181	1.22573E-05
Residual	54	0.342096028	0.006335112		
Total	59	0.592182484			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.046563599	0.055210515	-0.843382806	40.3%	-0.157254017	0.064126818	-0.157254017	0.064126818
GDP growth	10.48477439	2.95943051	3.542835135	0.1%	4.551473495	16.41807529	4.551473495	16.41807529
MSCI world volatility_Annu	-1.556255343	0.509746848	-3.0529965	0.4%	-2.578236235	-0.534274452	-2.578236235	-0.534274452
Credit spread	10.39049419	5.160369908	2.01351732	4.9%	0.044575509	20.73641287	0.044575509	20.73641287
Term spread	0.890478399	1.095246737	0.81303908	42.0%	-1.305359085	3.086315884	-1.305359085	3.086315884
TED spread	-0.766432768	1.133302622	-0.676282533	50.2%	-3.038567706	1.50570217	-3.038567706	1.50570217

Table 11: Descriptive statistics – Regression analysis LPX America

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.669794476
R Square	0.44862464
Adjusted R Square	0.381383743
Standard Error	0.133904888
Observations	47

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.598153281	0.119630656	6.671901425	0.000124916
Residual	41	0.735151284	0.017930519		
Total	46	1.333304565			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.063874597	0.099236233	-0.643662047	52.3%	-0.264286232	0.136537039	-0.264286232	0.136537039
GDP growth	13.45714003	5.186486449	2.594654428	1.3%	2.982818267	23.93146179	2.982818267	23.93146179
MSCI world volatility_Annu	-1.839990024	0.879907409	-2.091117776	4.3%	-3.616999067	-0.062980981	-3.616999067	-0.062980981
Credit spread	15.32873434	8.362312111	1.833073692	7.4%	-1.559297392	32.21676607	-1.559297392	32.21676607
Term spread	3.661301557	2.195341432	1.667759513	10.3%	-0.77228036	8.094883474	-0.77228036	8.094883474
TED spread	-4.790110994	2.119458322	-2.260063783	2.9%	-9.070443863	-0.509778125	-9.070443863	-0.509778125

Table 12: Descriptive statistics – Regression analysis LPX Buyout

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.684973301
R Square	0.469188422
Adjusted R Square	0.423428804
Standard Error	0.099158813
Observations	64

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.504077759	0.100815552	10.25332892	4.48767E-07
Residual	58	0.570283276	0.00983247		
Total	63	1.074361035			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.03677933	0.058566957	-0.627987713	53.2%	-0.154013831	0.080455172	-0.154013831	0.080455172
GDP growth	12.26115189	3.380237257	3.627305115	0.1%	5.49487193	19.02743186	5.49487193	19.02743186
MSCI world volatility_Annu	-1.465356605	0.596103348	-2.45822576	1.7%	-2.658587088	-0.272126121	-2.658587088	-0.272126121
Credit spread	11.37914346	5.581117968	2.03886453	4.6%	0.207322136	22.55096479	0.207322136	22.55096479
Term spread	1.048466677	1.354811035	0.773884069	44.2%	-1.663482239	3.760415593	-1.663482239	3.760415593
TED spread	-2.573834348	1.381601211	-1.862935793	6.8%	-5.339409625	0.19174093	-5.339409625	0.19174093

Table 13: Descriptive statistics – Regression analysis LPX Venture

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.622308443
R Square	0.387267798
Adjusted R Square	0.331564871
Standard Error	0.117561613
Observations	61

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.480434783	0.096086957	6.952377842	4.28402E-05
Residual	55	0.760140305	0.013820733		
Total	60	1.240575088			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.097707224	0.070459971	-1.386705421	17.1%	-0.238912162	0.043497713	-0.238912162	0.043497713
GDP growth	12.57051548	4.243375095	2.962386119	0.5%	4.066601814	21.07442914	4.066601814	21.07442914
MSCI world volatility_Annu	-2.134085597	0.738011046	-2.891671621	0.5%	-3.613092773	-0.655078421	-3.613092773	-0.655078421
Credit spread	15.93583425	6.66728155	2.390154687	2.0%	2.574303529	29.29736496	2.574303529	29.29736496
Term spread	1.405318729	1.616764058	0.869216954	38.9%	-1.834748824	4.645386281	-1.834748824	4.645386281
TED spread	0.041329414	1.659362547	0.024906802	98.0%	-3.284107419	3.366766247	-3.284107419	3.366766247

Table 14: Descriptive statistics – Regression analysis MSCI Worldwide

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.605288727
R Square	0.366374443
Adjusted R Square	0.31175155
Standard Error	0.066100051
Observations	64

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.146529162	0.029305832	6.707342363	5.41263E-05
Residual	58	0.25341457	0.004369217		
Total	63	0.399943732			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.017729686	0.039041198	-0.454127602	65.1%	-0.095879133	0.060419762	-0.095879133	0.060419762
GDP growth	6.02775489	2.253292944	2.675087102	1%	1.517299044	10.53821074	1.517299044	10.53821074
MSCI world volatility_Annual	-1.071635223	0.397367216	-2.696838542	1%	-1.867052119	-0.276218326	-1.867052119	-0.276218326
Credit spread	7.36059811	3.720417468	1.978433381	5%	-0.086626524	14.80782274	-0.086626524	14.80782274
Term spread	0.249374026	0.903127773	0.276122641	78%	-1.558432613	2.057180665	-1.558432613	2.057180665
TED spread	-0.84330913	0.920986316	-0.915658697	36%	-2.686863528	1.000245267	-2.686863528	1.000245267

Table 15: Descriptive statistics – Regression analysis MSCI Europe

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.632806496
R Square	0.400444061
Adjusted R Square	0.345938976
Standard Error	0.073304982
Observations	61

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.197397579	0.039479516	7.346911914	2.46682E-05
Residual	55	0.295549123	0.00537362		
Total	60	0.492946702			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.015054136	0.043715947	0.344362566	73%	-0.072554579	0.102662851	-0.072554579	0.102662851
GDP growth	5.005571656	2.511386403	1.993150735	5%	-0.027359129	10.03850244	-0.027359129	10.03850244
MSCI world volatility_Annual	-11.08093567	3.602125229	-3.076221664	0%	-18.29975589	-3.862115442	-18.29975589	-3.862115442
Credit spread	7.279322119	4.148716046	1.754596371	8%	-1.034890573	15.59353481	-1.034890573	15.59353481
Term spread	0.6597401	1.025531719	0.643315159	52%	-1.395471377	2.714951577	-1.395471377	2.714951577
TED spread	-1.549625116	1.040067043	-1.489928102	14%	-3.633966033	0.534715802	-3.633966033	0.534715802

Table 16: Descriptive statistics – Regression analysis MSCI America

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.618475101
R Square	0.382511451
Adjusted R Square	0.307207969
Standard Error	0.069348897
Observations	47

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	0.122145791	0.024429158	5.079598482	0.001028523
Residual	41	0.197180051	0.00480927		
Total	46	0.319325842			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.002231342	0.051394115	0.043416289	0.965580453	-0.101561179	0.106023862	-0.101561179	0.106023862
GDP growth	4.696011944	2.686064112	1.748287363	0.087899391	-0.728604519	10.12062841	-0.728604519	10.12062841
MSCI world volatility_Annual	-1.077813646	0.455701126	-2.365176615	0.022834302	-1.998120729	-0.157506562	-1.998120729	-0.157506562
Credit spread	5.755945226	4.330813678	1.329067851	0.191174641	-2.990310335	14.50220079	-2.990310335	14.50220079
Term spread	1.07777536	1.136960038	0.947944803	0.348711656	-1.218361994	3.373912714	-1.218361994	3.373912714
TED spread	-1.490565893	1.097660428	-1.357948101	0.181906784	-3.707336075	0.726204288	-3.707336075	0.726204288

Table 17: Hypothesis test - LPX50 vs. MSCI Worldwide

GDP growth-test		
Beta_GDP Growth_LPX 50		11.557
Beta_GDP Growth_MSCI Worldwide		6.028
n-1		60
H0: Beta_GDP Growth_LPX 50 - Beta_GDP Growth_MSCI Worldwide =		0
H1: Beta_GDP Growth_LPX 50 - Beta_GDP Growth_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.671
T(critical) @ significance level:	5%	2.000
T(critical) @ significance level:	1%	2.660
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic T(obs)= Beta_GDP Growth_LPX 50 - Beta_GDP Growth_MSCI Worldwide / SE(Beta_GDP Growth_LPX 50)		1.574
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		12.1%

Volatility-test		
Beta_MSCI Worldwide volatility_LPX 50		-1.659
Beta_MSCI Worldwide volatility_MSCI Worldwide		-1.072
n-1		60
H0: Beta_MSCI Worldwide volatility_LPX 50 - Beta_MSCI Worldwide volatility_MSCI Worldwide		0
H1: Beta_MSCI Worldwide volatility_LPX 50 - Beta_MSCI Worldwide volatility_MSCI Worldwide		0
T(critical) @ significance level:	10%	1.671
T(critical) @ significance level:	5%	2.000
T(critical) @ significance level:	1%	2.660
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic T(obs)= Beta_MSCI Worldwide volatility_LPX 50 - Beta_MSCI Worldwide volatility_MSCI Worldwide / SE(Beta_MSCI Worldwide volatility_LPX 50)		-1.008
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		31.7%

Credit spread-test		
Beta_Credit spread_LPX 50		7.580
Beta_Credit spread_MSCI Worldwide		7.361
n-1		60
H0: Beta_Credit spread_LPX 50 - Beta_Credit spread_MSCI Worldwide =		0
H1: Beta_Credit spread_LPX 50 - Beta_Credit spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.671
T(critical) @ significance level:	5%	2.000
T(critical) @ significance level:	1%	2.660
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic T(obs)= Beta_Credit spread_LPX 50 - Beta_Credit spread_MSCI Worldwide / SE(Beta_Credit spread_LPX 50)		0.038
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		97.0%

Term spread-test		
Beta_Term spread_LPX 50		1.217
Beta_Term spread_MSCI Worldwide		0.249
n-1		60
H0: Beta_Term spread_LPX 50 - Beta_Term spread_MSCI Worldwide =		0
H1: Beta_Term spread_LPX 50 - Beta_Term spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.671
T(critical) @ significance level:	5%	2.000
T(critical) @ significance level:	1%	2.660
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic T(obs)= Beta_Term spread_LPX 50 - Beta_Term spread_MSCI Worldwide / SE(Beta_Term spread_LPX 50)		0.361
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		71.9%

TED spread-test		
Beta_TED spread_LPX 50		-1.412
Beta_TED spread_MSCI Worldwide		-0.843
n-1		60
H0: Beta_TED spread_LPX 50 - Beta_TED spread_MSCI Worldwide =		0
H1: Beta_TED spread_LPX 50 - Beta_TED spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.671
T(critical) @ significance level:	5%	2.000
T(critical) @ significance level:	1%	2.660
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic T(obs)= Beta_TED spread_LPX 50 - Beta_TED spread_MSCI Worldwide / SE(Beta_TED spread_LPX 50)		-0.427
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		67.1%

Table 18: Hypothesis test - LPX Venture vs. MSCI Worldwide

GDP growth-test		
Beta_GDP Growth_LPX Venture		12.57051548
Beta_GDP Growth_MSCI Worldwide		6.02775489
n-1		60
H0: Beta_GDP Growth_LPX Venture - Beta_GDP Growth_MSCI Worldwide =		0
H1: Beta_GDP Growth_LPX Venture - Beta_GDP Growth_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.670648865
T(critical) @ significance level:	5%	2.000297804
T(critical) @ significance level:	1%	2.660283014
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_GDP Growth_LPX Venture - Beta_GDP Growth_MSCI Worldwide / SE(Beta_GDP Growth_LPX Venture)		1.542
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		12.8%

Volatility-test		
Beta_MSCI Worldwide volatility_LPX Venture		-2.134085597
Beta_MSCI Worldwide volatility_MSCI Worldwide		-1.071635223
n-1		60
H0: Beta_MSCI Worldwide volatility_LPX Venture - Beta_MSCI Worldwide volatility_		0
H1: Beta_MSCI Worldwide volatility_LPX Venture - Beta_MSCI Worldwide volatility_		0
T(critical) @ significance level:	10%	1.670648865
T(critical) @ significance level:	5%	2.000297804
T(critical) @ significance level:	1%	2.660283014
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_MSCI Worldwide volatility_LPX Venture - Beta_MSCI Worldwide volatility_MSCI Worldwide / SE(Beta_MSCI Worldwide volatility_LPX Venture)		-1.440
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		15.5%

Credit spread-test		
Beta_Credit spread_LPX Venture		15.93583425
Beta_Credit spread_MSCI Worldwide		7.36059811
n-1		60
H0: Beta_Credit spread_LPX Venture - Beta_Credit spread_MSCI Worldwide =		0
H1: Beta_Credit spread_LPX Venture - Beta_Credit spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.670648865
T(critical) @ significance level:	5%	2.000297804
T(critical) @ significance level:	1%	2.660283014
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Credit spread_LPX Venture - Beta_Credit spread_MSCI Worldwide / SE(Beta_Credit spread_LPX Venture)		1.286
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		20.3%

Term spread-test		
Beta_Term spread_LPX Buyout		1.405318729
Beta_Term spread_MSCI Worldwide		0.249374026
n-1		60
H0: Beta_Term spread_LPX Buyout - Beta_Term spread_MSCI Worldwide =		0
H1: Beta_Term spread_LPX Buyout - Beta_Term spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.670648865
T(critical) @ significance level:	5%	2.000297804
T(critical) @ significance level:	1%	2.660283014
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Term spread_LPX Buyout - Beta_Term spread_MSCI Worldwide / SE(Beta_Term spread_LPX Buyout)		0.715
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		47.7%

TED spread-test		
Beta_TED spread_LPX Venture		0.041329414
Beta_TED spread_MSCI Worldwide		-0.84330913
n-1		60
H0: Beta_TED spread_LPX Venture - Beta_TED spread_MSCI Worldwide =		0
H1: Beta_TED spread_LPX Venture - Beta_TED spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.670648865
T(critical) @ significance level:	5%	2.000297804
T(critical) @ significance level:	1%	2.660283014
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_TED spread_LPX Venture - Beta_TED spread_MSCI Worldwide / SE(Beta_TED spread_LPX Venture)		0.533
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		59.6%

Table 19: Hypothesis test - LPX Europe vs. MSCI Europe

GDP growth-test		
Beta_GDP Growth_LPX Europe		10.48477439
Beta_GDP Growth_MSCI Europe		5.005571656
n-1		59
H0: Beta_GDP Growth_LPX Europe - Beta_GDP Growth_MSCI Europe =		0
H1: Beta_GDP Growth_LPX Europe - Beta_GDP Growth_MSCI Europe ≠		0
T(critical) @ significance level:	10%	1.671093033
T(critical) @ significance level:	5%	2.000995361
T(critical) @ significance level:	1%	2.661758738
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_GDP Growth_LPX Europe - Beta_GDP Growth_MSCI Europe / SE(Beta_GDP Growth_LPX Europe)		1.851
Decision at 10% significance level:		Reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		6.9%

Volatility-test		
Beta_MSCI Worldwide volatility_LPX Europe		-1.556255343
Beta_MSCI Worldwide volatility_MSCI Europe		-11.08093567
n-1		59
H0: Beta_MSCI Worldwide volatility_LPX Europe - Beta_MSCI Worldwide volatility_M		0
H1: Beta_MSCI Worldwide volatility_LPX Europe - Beta_MSCI Worldwide volatility_M		0
T(critical) @ significance level:	10%	1.671093033
T(critical) @ significance level:	5%	2.000995361
T(critical) @ significance level:	1%	2.661758738
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_MSCI Worldwide volatility_LPX Europe - Beta_MSCI Worldwide volatility_MSCI Europe / SE(Beta_MSCI Worldwide volatility_LPX Europe)		18.685
Decision at 10% significance level:		Reject H0!
Decision at 5% significance level		Reject H0!
Decision at 1% significance level		Reject H0!
P-value:		0.0%

Credit spread-test		
Beta_Credit spread_LPX Europe		10.39049419
Beta_Credit spread_MSCI Europe		-3.585138759
n-1		59
H0: Beta_Credit spread_LPX Europe - Beta_Credit spread_MSCI Europe =		0
H1: Beta_Credit spread_LPX Europe - Beta_Credit spread_MSCI Europe ≠		0
T(critical) @ significance level:	10%	1.671093033
T(critical) @ significance level:	5%	2.000995361
T(critical) @ significance level:	1%	2.661758738
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Credit spread_LPX Europe - Beta_Credit spread_MSCI Europe / SE(Beta_Credit spread_LPX Europe)		2.708
Decision at 10% significance level:		Reject H0!
Decision at 5% significance level		Reject H0!
Decision at 1% significance level		Reject H0!
P-value:		0.9%

Term spread-test		
Beta_Term spread_LPX Europe		0.890478399
Beta_Term spread_MSCI Worldwide		0.6597401
n-1		59
H0: Beta_Term spread_LPX Europe - Beta_Term spread_MSCI Worldwide =		0
H1: Beta_Term spread_LPX Europe - Beta_Term spread_MSCI Worldwide ≠		0
T(critical) @ significance level:	10%	1.671093033
T(critical) @ significance level:	5%	2.000995361
T(critical) @ significance level:	1%	2.661758738
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Term spread_LPX Europe - Beta_Term spread_MSCI Worldwide / SE(Beta_Term spread_LPX Europe)		0.211
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		83.4%

TED spread-test		
Beta_TED spread_LPX Europe		-0.766432768
Beta_TED spread_MSCI Europe		-1.549625116
n-1		59
H0: Beta_TED spread_LPX Europe - Beta_TED spread_MSCI Europe =		0
H1: Beta_TED spread_LPX Europe - Beta_TED spread_MSCI Europe ≠		0
T(critical) @ significance level:	10%	1.671093033
T(critical) @ significance level:	5%	2.000995361
T(critical) @ significance level:	1%	2.661758738
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_TED spread_LPX Europe - Beta_TED spread_MSCI Europe / SE(Beta_TED spread_LPX Europe)		0.691
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		49.2%

Table 20: Hypothesis test - LPX America vs. MSCI America

GDP growth-test		
Beta_GDP Growth_LPX America		13.45714003
Beta_GDP Growth_MSCI America		4.696011944
n-1		46
H0: Beta_GDP Growth_LPX America - Beta_GDP Growth_MSCI America =		0
H1: Beta_GDP Growth_LPX America - Beta_GDP Growth_MSCI America ≠		0
T(critical) @ significance level:	10%	1.678660414
T(critical) @ significance level:	5%	2.012895567
T(critical) @ significance level:	1%	2.687013484
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_GDP Growth_LPX America - Beta_GDP Growth_MSCI America / SE(Beta_GDP Growth_LPX America)		1.689
Decision at 10% significance level:		Reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		9.8%

Volatility-test		
Beta_MSCI Worldwide volatility_LPX America		-1.839990024
Beta_MSCI Worldwide volatility_MSCI America		-1.077813646
n-1		46
H0: Beta_MSCI Worldwide volatility_LPX America - Beta_MSCI Worldwide volatility_		0
H1: Beta_MSCI Worldwide volatility_LPX America - Beta_MSCI Worldwide volatility_		0
T(critical) @ significance level:	10%	1.678660414
T(critical) @ significance level:	5%	2.012895567
T(critical) @ significance level:	1%	2.687013484
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_MSCI Worldwide volatility_LPX America - Beta_MSCI Worldwide volatility_MSCI America / SE(Beta_MSCI Worldwide volatility_LPX America)		-0.866
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		39.1%

Credit spread-test		
Beta_Credit spread_LPX America		15.32873434
Beta_Credit spread_MSCI America		5.755945226
n-1		46
H0: Beta_Credit spread_LPX America - Beta_Credit spread_MSCI America =		0
H1: Beta_Credit spread_LPX America - Beta_Credit spread_MSCI America ≠		0
T(critical) @ significance level:	10%	1.678660414
T(critical) @ significance level:	5%	2.012895567
T(critical) @ significance level:	1%	2.687013484
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Credit spread_LPX America - Beta_Credit spread_MSCI America / SE(Beta_Credit spread_LPX America)		1.145
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		25.8%

Term spread-test		
Beta_Term spread_LPX America		3.661301557
Beta_Term spread_MSCI America		1.07777536
n-1		46
H0: Beta_Term spread_LPX America - Beta_Term spread_MSCI America =		0
H1: Beta_Term spread_LPX America - Beta_Term spread_MSCI America ≠		0
T(critical) @ significance level:	10%	1.678660414
T(critical) @ significance level:	5%	2.012895567
T(critical) @ significance level:	1%	2.687013484
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_Term spread_LPX America - Beta_Term spread_MSCI America / SE(Beta_Term spread_LPX America)		1.177
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		24.5%

TED spread-test		
Beta_TED spread_LPX America		-4.790110994
Beta_TED spread_MSCI America		-1.490565893
n-1		46
H0: Beta_TED spread_LPX America - Beta_TED spread_MSCI America =		0
H1: Beta_TED spread_LPX America - Beta_TED spread_MSCI America ≠		0
T(critical) @ significance level:	10%	1.678660414
T(critical) @ significance level:	5%	2.012895567
T(critical) @ significance level:	1%	2.687013484
Decision rule		
Reject H0 if T(obs) > T(critical) or T(obs) > -T(critical)		
Test statistic		
T(obs)= Beta_TED spread_LPX America - Beta_TED spread_MSCI America / SE(Beta_TED spread_LPX America)		-1.557
Decision at 10% significance level:		Cannot reject H0!
Decision at 5% significance level		Cannot reject H0!
Decision at 1% significance level		Cannot reject H0!
P-value:		12.6%