Master Thesis

Asset Management – University Endowments

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Abstract

The asset allocation of endowments covered by NACUBO Endowment Studies has changed considerably over the last two decades. Today, endowments allocate more capital to alternative asset classes. This thesis analyzes the changes in the asset allocation among university endowments mainly in the USA and Canada, assesses the characteristics of the asset classes and examines the performance of policy portfolios representing the various asset allocation strategies applied by university endowments. The greatest shift in the asset allocation towards alternative asset classes was made by the largest endowments. Other endowments mimic this asset allocation but with some time lag. The analysis of asset classes shows that alternative asset classes offer different mean-variance profiles and return distributions, varying correlations, and greater potential for active portfolio management than conventional asset classes. The main disadvantages are the lack of information and non-investable benchmarks associated with these assets. Using historical returns on these asset classes for calculation of seven portfolios reveals that policy portfolios including alternative assets generate better results compared to conventional 60/40 portfolios. Although the portfolios with alternative assets exhibit similar structural betas as 60/40 portfolios, there exists a positive correlation between the allocation to alternative assets and total return. However, the volatility stays on the same level – between 9-10%. The thesis also shows that alternative asset classes enable the portfolio to pay out more to the university while preserving purchasing power. The maximum possible spending rate of Yale's policy portfolio, which still preserves purchasing power, is by 3 percentage points higher than that of a 60/40 portfolio. These results are, however, subject to several assumptions, especially the use of non-investable benchmarks. Therefore, simply mimicking the asset allocation of the top performing endowments may not lead to the same results.

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1. Introduction

Today, the university endowments are, especially due to the pioneering asset allocation strategies of Harvard and Yale endowments, well-known sort of the institutional investors and support both educational and research capacities. In fiscal year 2010, the endowment contained in the NACUBO[1] Endowment Study managed about $352.7 billion. The asset allocation policies have significantly changed over the last two decades. Twenty years ago, the average endowment portfolio resembled the conventional 60/40 asset allocation but today endowments – especially large ones - invest considerable capital in alternative assets and many of them achieve very good performance. Therefore, the motivation for this thesis is to examine whether this change in the asset allocation towards the alternative assets is beneficial for the endowments and whether both large and small endowments will profit from investing in alternative assets. Accordingly, the goal of this thesis is to provide answers to the following questions. Do the asset allocation policies with increased allocation to alternative assets lead to superior performance compared to the conventional 60/40 portfolio? What are the limits of these alternative asset allocations? I found out that the asset allocations with higher proportion of alternative assets tends to generate higher returns compared to returns on 60/40 portfolio. In contrast, the total volatility of the portfolios remains almost the same. This result is, however, limited as there are some assumptions, especially regarding the average return and risk of alternative asset classes and active portfolio management, which may not necessarily apply to the whole range of university endowments.

In order to identify the trends in the asset allocation among the university endowments, I analyze the asset allocations of the endowments both in the cross section and over time mainly using data from NACUBO Endowment Studies. As the thesis deals with various allocations to alternative asset classes a proper understanding of these asset classes is needed. Therefore, a substantial part of the thesis studies both the quantitative and qualitative characteristics of both conventional and alternative asset classes. The quantitative analysis is based mainly on the concept of Capital Asset Pricing Model. Finally, I construct several portfolios that represent various asset allocations and use historical returns on the asset classes to 'simulate' the performance of these portfolios. I analyze the portfolio performance applying - among other things – the Capital Asset Pricing Model.

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[1] NACUBO stands for National Association of College and University Business Officers

The rest of the thesis is structured as follows. The remainder of this introduction chapter deals with the relevant literature on university endowments and mentions some general but important questions. Second chapter describes the data and methodology used and analyzes the individual asset classes. Third chapter introduces the portfolios, defines the ‘simulation’ and methodology for the analysis of the results and analyzes the portfolio performance. Fourth chapter concludes and discusses the results.

1.1. Related Literature and Some General Issues

Of course, starting point has to be a proper understanding of what university endowments are and which goals they have. Above all, Ms. Ramsebner did great work and she provides in her thesis Asset Management and University Endowment (2009) a very comprehensive overview of all aspects of university endowments such as the features of university endowments, the investment process, endowment managers and compensation, and spending policies. Therefore, these topics are not covered in this thesis and I would like to refer everyone who wants to get comprehensive insight into these topics to the thesis of Ms. Ramsebner. However, before I start dealing with the central question of this thesis, there are a number of aspects and other questions, which have to be mentioned when thinking of university endowments. I categorize these questions into three levels.

The first question is the most strategic and even perhaps philosophical question and it regards the existence and form of university endowments. Why should universities hold huge endowments and accumulate further capital? Hansmann (1990) asks for detailed examination of real purposes of university endowments in order to prove their existence in today’s form. In the fiscal year 2010, according to the NACUBO-Commonfund Study of Endowments, the 865 higher education endowments covered by this study managed $ 352.7 billion. What is the purpose of holding that large amount of money in endowment form and how should this money be invested? David F. Swensen – Chief Investment Officer at Yale University - provides in his book Pioneering Portfolio Management (2000) a number of purposes of university endowments. He mentions that university endowments enhance university autonomy, provide independent source of revenue, reducing the dependence on governmental funding, student tuitions, and donations, increase financial stability, and create an excellent teaching and research environment, increasing the university attractiveness. However, there is an important question how long the gifted money should be invested and whether the endowment should accumulate the capital. Although this question is more complicated than it seems to be and will not be resolved in this thesis, I would like to mention at least some factors which are commonly considered. First, there are donators who, usually, are interested in a long-term or permanent character of their support. Moreover, as Swensen (2000) mentions, universities have long-term commitments and seek a correspondent long-term sustainable source of funding. Furthermore, Tobin (1974) introduces a concept of ‘intergenerational equity’ requiring zero rate of time preference of endowment trustees. Waldeck (2008) states that further common argument for large endowments is that they serve as savings for 'rainy' days. These arguments should support the goal of preserving the endowment's purchasing power over time. On the other hand, for instance Hansmann (1990) states that these arguments may not necessarily ask for today's form of endowments which spend only few per cent of the endowment value each year and accumulate further capital. Accordingly, Hansmann introduces the concept of 'intergenerational efficiency'. He argues that when taking into account such aspects as the growth in per capita real gross national product, portion of household income spent on higher education, increasing costs of education, and tax incentives, the holding of huge endowments may not necessarily be the optimal way to support higher education and research. Furthermore, one has to ask whether it is better to preserve the money and invest it on capital markets or to spend all of it, 'produce' large number of graduates and expect higher donations from them in future. If a university believes that it produces better than average graduates, who are willing to support the university in future, why should the university invest the money on capital markets and expect only average profit? Hansmann (1990) "[…] when a university adds a dollar to its endowment for the purpose of making an intergenerational transfer, it is implicitly making the judgment that the dollar will have a higher rate of return if invested in stocks and bonds than in educating an undergraduate, or doing research in biophysics, or adding books to the library." Moreover, according to Waldeck (2008) from an overall look at the whole higher educational sector, the large endowments lead to a concentration of both highly talented students and faculty at the associated universities. This concentration, however, may not necessarily be optimal for the whole society.

When we accept the form of today's endowments as given, the next important questions regard the tactical goals of university endowments, the objective function of university endowments and the factors which affect the portfolio management. Although these questions are not sufficiently answered as well, there are more specific arguments and some empirical evidence, which provide some guidance, how to think about university endowment goals and management. According to Brown et al. (2010)*[2], in 2008 the average endowment size was approximately the same as the annual budget of the corresponding university. However, the smallest 10% among the endowments accounted only for 10% of the annual university budget, while the largest 10% of endowments were more than twice as high of the annual budget of an associated university. Therefore, the relative importance of an endowment to its associated university may vary considerably. Furthermore, Brown et al. (2010)*[3] and Brown and

[2] Please note that this paper was written by Jeffrey R. Brown et al. Do not confuse him with Keith C. Brown mentioned later. In order to distinguish these two paper the work of Jeffrey R. Brown et al. is marked with '*'

[3] Brown et al. (2010) examine only doctoral universities

Tiu (2009) report that average payout rates are between 4% and 5.3% of the total endowment market value. However, there are great differences in spending, with highest payout rate of about 20% and lowest payout rate of approximately 1%. According to Brown et al. (2010), the average payout from endowment accounts for approximately 5% of the university's total budget. The universities in the 90th percentile rely, at least, by 12% on payout from endowment, while the universities in the 10th percentile only by 0.4%. In summary, endowments are very important source of funds for some universities, but an almost negligible funding for other. Similarly, not the same statement about the objective functions can be done. Acharya and Dimson (2007) mention that maximizing the long-term total return at an acceptable level of risk, the long-term preservation of capital with a reasonable and predictable level of income, and the maintenance and enhancement of the real value of endowment and spending while minimizing risk are the most frequent objectives among Oxbridge institutions. Among the U.S. endowments in 2004 the most frequent objectives were to outperform a specific benchmark, exceed a minimum rate of return, or outperform the peer group. It is important to note that each university has different characteristics and needs and thereby different requirements on the associated endowment.

The university revenue can be divided in endowment revenue and non-endowment revenue. Dimmock (2010) shows that the volatility of the non-endowment income affects the choice of endowment portfolio. Dimmock's results show that standard deviation of non-endowment revenues is a statistically significant factor influencing negatively the allocation to alternative assets. Furthermore, the allocation to alternative (risky) assets depends on the size of the endowment. Dimmock suggests three explanations: "First, it is possible that their allocations are stable over time and larger funds became large because of their greater allocation to risky assets. Second, it is possible that the universities exhibit decreasing absolute risk aversion and this causes greater risk tolerance at wealthier universities. Third, it is possible that it requires greater skill to manage a risky portfolio than a safe one, and an investment skill has a fixed cost." Further, he suggests that the relative importance of endowment revenue for the relevant university may have impact on the riskiness of the endowment portfolio. A further factor is the university's ability to control the tuition fees. Therefore, the selectivity of the university and the elasticity of the demand for that university education may affect the needs for portfolio liquidity influencing the portfolio policy and risk. For instance, the most prestigious universities can increase tuition fee without significant drop in the number of excellent applicants. The donations to the university endowment are the next important factor. According to Dimmock (2010) "Donations affect portfolio choice in two ways. First, giving provides a regular stream of cash. This increases liquidity and allows the endowment to invest more in illiquid assets such as private equity partnerships. Second, donations allow for greater risk taking as financial losses can be replaced through new contributions. This leads to the hypothesis that universities with a higher ratio of donations to endowment size will take on greater portfolio risk and will choose to invest in less liquid asset classes." Further factors affecting the risk taking potential of endowments may be the relative amount of cost spent on research, the status (public vs. private) of the university and university's debt-to-asset ratio.

Last but not least, the spending rules also can affect the portfolio management considerably. According to Acharya and Dimson (2007): "Until relatively recently, 'income-only' spending rules were mandatory in the UK. Consequently, Oxbridge institutions invested for income, which dictated asset allocation choices as well." Therefore, under 'income-only' spending rules – only income such as dividend or coupons may be paid out from the endowment to the university – the endowments are forced to allocate capital to 'high-yielding' assets to generate income. In contrast, under 'total return' spending rules, which enable to pay out both income and capital gain, the endowments enjoy greater flexibility in asset allocation and portfolio management.

In summary, it may be assumed that universities 'manage' the overall sources of revenues, i.e. both endowment and non-endowment revenue, seeking revenue which will secure the university educational and research goals. The characteristics, relative importance and controllability of the individual components of the university's total revenue have impact on other revenue components, especially on revenue from endowments. In order to determine some guiding principle, I assume in this thesis that universities are risk-averse, long-term investors seeking stable cash flows from their associated endowments.

The third group of questions regards the composition of the portfolio, in this case the investing in alternative asset classes. Is investing in alternative assets in line with the goal to support the associated university? Do the alternative asset allocation policies have the potential to generate superior performance compared to the conventional 60/40 portfolio? This is the main point of this thesis. Therefore, this thesis compares the performance of the conventional 60/40 portfolio with the performance of portfolios with various mixtures of alternative assets according to the recent trend among university endowments. If we take Markowitz (1952) into account and consider the great sensitivity of the optimization based on Modern Portfolio Theory, we get the intuition, that as long as the alternative asset classes exhibit at least partially different mean-variance profiles and lower correlation to the conventional asset classes, their inclusion in the portfolio may be beneficial and help to adjust the portfolio to the requirements of the investors. Therefore, a substantial part of this thesis deals with both qualitative and quantitative description of alternative asset classes.

How important actually is the asset allocation for the whole portfolio performance? This question was examined by Ibbotson and Kaplan (2000). Using the data of mutual and pension funds, they find out that about 90 per cent of the variability of total return over time can be explained by the variability of asset allocation policy. In contrast, the variability of asset allocation explains only about 40 per cent of of the variation of total return in the cross section. Moreover, they report that the ratio of policy benchmark return to the fund's actual return is about 100 per cent. Brown et al. (2010)[4] examine several questions regarding the role of asset allocation and the role of active and passive portfolio management. They use data from a series of annual surveys[5] of university endowments from 1984 to 2005. By decomposing the total return into the return from asset allocation, return from market timing, and return from security selection, they find that the return from asset allocation is the largest component of the endowment's total returns (same result as that in Ibbotson and Kaplan (2000)). At the same time, however, they show that according to the Spearman correlation index there is no correlation between total return and asset allocation return. Furthermore, they proved that simple mimicking the asset allocation of the top endowments alone did not secure the same top performance. According to further analyses they conduct, variation in the asset allocation return explains on average 74.22% of the variation in total return over time, while only 15.22% in the cross section. Brown et al. (2010) provide following explanation: "Since the cross-sectional variance of the returns generated from asset allocation is small, it appears as if cross-sectional policy returns are constant in each period of our sample. Thus, since policy returns are a linear combination of the endowment asset allocation weights and the returns of the asset classes specific to that time period, it appears that endowments do act as if subjected to an implicit linear constraint on their policy weights, which in turn causes the variance of the policy returns to be relatively small in the cross-section. We conclude that the policy returns are similar in the cross-section not because all endowments have comparable actual allocations, but rather because these funds effectively subject themselves to a similar constraint in their strategic policy decision; […]" Furthermore, endowments which rely less on the asset allocation tend to have higher total return and endowments, which try to apply more security selection, seem to generate higher total return as well. Moreover, the total returns seem to be positively correlated with the lagged total assets under management, suggesting that managers of larger endowments possess superior active portfolio management skills. By using similar model to that of Fama and French (1993) and of Carhart (1997), Brown et al. (2010) find out that overall endowments do not generate significant risk-adjusted performance. However, endowments whose total return is less affected by asset allocation decision (active endowments) have significantly higher (by at least 4.21%) risk-adjusted returns than passive endowments.

[4] Almost the same results are published in further two papers: Brown, K.C. Garlappi, L. Tiu, C (2010) and Brown, K.C. Tiu, C (2009)

[5] The annual surveys are administered by National Association of College and University Business Officers (NACUBO)

Lerner et al. (2008) try to identify the real drivers of the performance among university endowments. Similarly to Brown et al. (2010), Lerner et al. (2008) doubt whether the simply mimicking the asset allocation strategies of the top endowments secures the same performance. The most successful endowments base the performance more on active portfolio management. On average, 73% of endowment return accounted for the return from allocation policy, but in the case of Ivy League endowments (these endowments exhibit the highest average return) only 66% of the total return can be ascribed to the asset allocation. On the other hand, the superior performance of the endowments with high allocation to alternative asset classes might arise from accidental accumulation of superior performance of the alternative asset classes. However, there is no guaranty that this performance will continue.

The recent shift in the asset allocation policy to alternative asset classes may resemble the situation among university endowments in the 1920s - 1940s. Goetzmann et al. (2010) focus on the university endowments in crises and identify the trends in asset allocation in the 1930s and 1940s. They especially try to find parallels between the crises in the 1930 and in 2008. Using the data from ACES[6] study, they identify a significant shift from the allocation to fixed income to the allocation to equity among large endowments and mid-sized endowments from 1926 to 1941. Since the 1920s, the investors had begun being affected by the book ‘Common Stock as Long Term Investments’ by Smith (1924), who shows that in the long term, stocks yield more than bonds. In 1926, large and mid-sized endowments held approximately 60% in bonds and 9% in equity. Fifteen years later, they held “only” 42% in bonds, while 30% in equity. Goetzmann et al. (2010) try to compare the change in investing in the 1930 - i.e. the shift from bond investing to the equity investing- with the changes in the 1990s and the 2000 - i.e. increased emphasis on alternative asset classes. By using back-testing with various asset allocation policies, they show that the increased emphasis of portfolio managers on equity investments in the time of (and after) the great stock market crash 1929 seems to be the right decision, even if the managers faced a great challenge of pushing ahead this investment strategy in that time. Similarly, it is interesting to examine whether the increasing allocation to the alternative asset classes over the last twenty years is the right decision as well.

Basch (2008) compares the simulations of typical endowment portfolio from 1997 to the Yale endowment policy portfolio from 2007. He shows that the Yale endowment policy portfolio with expected annual return of 6.3% and standard deviation of 12.4% enables higher spending rate (approximately 5.9%) that preserve the endowment’s purchasing power with 50% probability over the

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[6] ACES stands for American Council on Education Studies

long run than the typical endowment portfolio from 1997. However, even in case of Yale portfolio, high probabilities of decreasing the real portfolio value are present.

My thesis distinguishes from the research of Brown et al. (2010) in that my thesis aims only at the first return component of the portfolio as defined in Brinson et al. (1986) - namely return from asset allocation[7] - and compares only this return component on various portfolios. Figure 1 shows the decomposition of the total portfolio return according to Brinson et al. (1986). The return from asset allocation policy (i.e. policy return or passive portfolio benchmark) is in the first quadrant.

Figure 1: Return Components

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Selection</td></tr>
<tr><td>Actual</td><td>Passive</td></tr>
<tr><td rowspan="2">Timing</td><td>Actual</td><td>(IV) Actual Portfolio Return

$\sum_{i}$=(Wai*Rai)</td><td>(II) Policy and Timing Return

$\sum_{i}$=(Wai*Rpi)</td></tr>
<tr><td>Passive</td><td>(III) Policy and Security Selection Return

$\sum_{i}$=(Wpi*Rai)</td><td>(I) Policy Return (Passive Portfolio Benchmark)

$\sum_{i}$=(Wpi*Rpi)</td></tr>
</table>

Source: Brinson, G.P., Hood, L.R., Beebower, G.L. (1986), Wpi = policy (passive) weight for asset class I, Wai = actual weight for asset class I, Rpi = passive return for asset class I, Rai = active return for asset class i

The mimicking experiment conducted in Brown et al. (2010) mentioned above tries to find out whether mimicking the asset allocation policy of the top endowments ensures comparable result. Brown et al. (2010) obviously compare the return of the mimicking portfolio with the total return of all other endowments. This is in fact comparing the first component of return (policy return, quadrant 1 in Figure 1) with total return (quadrant 4 in Figure 1). This procedure is, of course, excellent for the question examined in Brown et al. (2010), but it does not answer the question in this thesis. The goal of this thesis is to examine whether asset allocation policies which include alternative assets are able to generate superior return-risk profile compared with the return-risk profile of conventional 60/40

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[7] The return from asset allocation is sometimes called policy return, return on policy portfolio, passive return, or return from passive portfolio management.

portfolio. In this case, the portfolio returns are only return from asset allocation policies. Neither the return from market timing, nor the return from security selection is included. The relevance of this question may be stressed by the comment of the results in Brown et al. (2008) "An endowment primarily concerned about its absolute return performance over time should concentrate on the strategic allocation choice; the fund more concerned with out-performing its peers will find such policy-level decision to be less useful."

2. Trends in the Asset Allocation among University Endowments

2.1. Data and Methodology

The main source of the data on asset allocation of university endowments is the set of NACUBO Endowment Studies. These data are supplemented by the data from Brown et al. (2009) who use both data from NACUBO Endowment Studies and data from their own research. NACUBO monitors the university endowments especially in the United States and Canada and its studies are the most comprehensive and longest running studies on university endowments. The number of participating institutions has increased consistently over the last decades and in 2008, the NACUBO Endowment Study comprised 796 institutions in the United States and Canada. These endowments managed about $415 billion in 2008. Furthermore, I use the information provided in the yearly reports from Harvard Management Company and Yale Investment Office in order to get information of asset allocation of two endowments supposed to be the most pioneering ones, as regards the use of alternative asset classes. The base of the data on alternative asset classes are the indices administered by Cambridge Associates (Cambridge Associates U.S. Venture Capital Index® and Cambridge Associates Private Equity Index®), National Council of Real Estate Investment Fiduciaries (NCREIF Property Index), Hedge Fund Research (HFRI Index), and Goldman Sachs Commodity Index. The conventional asset classes are characterized by the well-known indices such as S&P500, MSCI EAFE, S&P/IFCI and Barclay Capital U.S. Aggregate Bond index. 13-week T-Bill rate is used as a proxy for risk-free interest rate. The use of these well-known and easily accessible indices is in line with the purpose that the asset allocation policy should require little knowledge and little research. Therefore, the investors should be able to make use of easily accessible data. Of course, the investors can conduct their own research on the particular asset class and use those results for asset allocation decision, but such a research would exceed the potential of smaller endowments.

I have calculated the standard quantitative characteristics of the asset classes over various periods. On the one hand, in order to capture the main characteristics of each asset class, some calculations are based on the whole publicly available monthly or quarterly data time series. The data over the maximal available time period illustrate how much (little) the investor knows about the particular asset class and how reliable the results are. On the other hand, in order to provide results which are comparable among the individual asset classes, I calculated the same measures again, but over the same time period for every asset class. I used quarterly data from Q2 1990 to Q3 2010. The reason why I use quarterly data is that private equity and venture capital indices provided by Cambridge Associates and NCREIF real estate index provided by National Council of Real Estate Investment Fiduciaries are available only on quarterly basis. Therefore, where necessary, the data of other asset classes are transformed from monthly data to quarterly data. I admit that some information may be lost, when using only quarterly data, but it is the 'only' way how to consistently compare the quantitative characteristics of these asset classes over the same period and later simulate the portfolio performance on a comparable basis. It is important to mention that the results from both calculations – calculation over the whole period and calculation over the period from 1990-2010 – may be very different. For instance, international stocks represented by MSCI EAFE have average yearly return of 8.46% since inception, but only 4.89 from 1990-2010. How can now an investor make an opinion about this asset class? I think that for the general opinion about the asset class, the most comprehensive data are relevant. In contrast, in order to compare the performance with other asset classes over a particular time period and simulate the portfolio performance, the results over the identical time period from 1990 to 2010 are necessary. As the data which I used in my calculations may not necessarily capture the quantitative characteristics of the asset classes in the right way, I have systematically compared these results with results from other authors and more comprehensive researches. Sometimes, I denote my results as similar to results from other authors, although the numbers are different in absolute terms. The reason is the comparison of the characteristics relative to other asset classes and not the evaluation of the values in absolute terms. Proper understanding of the properties of each asset class and its relationship to other asset classes is the key factor, when evaluating the recent trend in asset allocation policy. As Leibowitz et al. (2010) suggest, for this purpose it is not the question whether an alternative asset class is attractive or not, but rather how the alternative asset class is attractive in relation to other asset classes in a specific portfolio context.

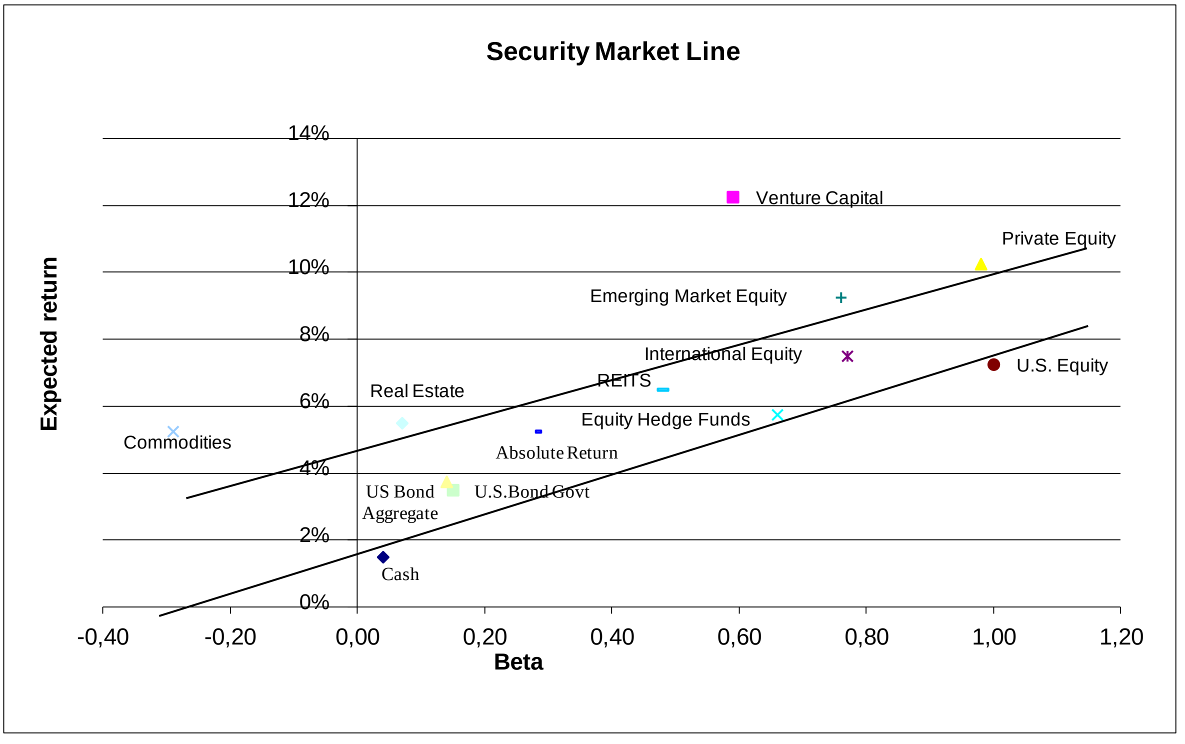
Besides the common measurements such as average return and standard deviation, I use similar procedure as suggested in Leibowitz et al. (2010). This includes following: According to CAPM, the return of each asset class is initially decomposed in two parts which are associated with "different risks". See Formula 1.

$$E(Rp_i)=r_f+\beta_i*[E(r_m)-r_f]$$

Formula 1

The first part is the risk-free rate, whose volatility is, by definition, zero. I use the arithmetic average of T-Bill rate as a proxy for risk free rate in this thesis. The second component is the (expected) beta excess return that is defined by both the asset class's beta (structural beta), which is related to beta risk and market risk premium. Leibowitz et al. (2010) provide following description: "The second return component (3.17 percent) – the return between the risk-free return line and the beta line - is a direct linear function of an asset class's beta and could, in theory, be replicated by a combination of equities and cash." If we calculate the return from empirical data, the return may deviate from that suggested by CAPM. As a result, we can identify third return component, namely the difference, between the theoretical asset class's return from CAPM and the true return from empirical data. According to the methodology used by Leibowitz et al. (2010), this return is called structural alpha and is related to alpha risk. In Figure 2, there is the excess return of each asset class the distance over the beta line.

Figure 2: Security Market Line



This figure is taken over from Leibowitz et al. (2010, p. 16). A number of asset classes are plotted in a diagram, where x-axis measures the structural beta of each asset class with respect to U.S. stocks and y-axis measures the expected return. The security market line is the line splitting between risk-free investment (cash) and U.S. stocks. The position of other asset classes over the Security Market line indicates the risk-adjusted return.

According to Leibowitz et al. (2010), structural beta is a conventional beta concept applied to individual asset classes in the context of asset allocation. In my analysis, the structural beta is always based on U.S. stocks (represented by S&P500) and it expresses the common risk factor of S&P500 contained in the individual asset classes. Accordingly, the whole analysis is related to S&P500 and not to the whole universe of all asset classes. Consequently, the security market line in Figure 2 is biased by this fact. In this way, the beta multiplied with the market risk premium[8] captures the remuneration for the U.S. stock risk component contained in the individual asset class. See Formula 2.

$$E(\text{Beta return}_i)=\beta_i*[E(r_{S\&P500})-r_f]$$

Formula 2

Using structural beta, it is also possible to express the beta volatility, which can be calculated by multiplying the structural beta of the relevant asset class with sigma of S&P500. See Formula 3. The beta volatility is usually referred to as systematic risk. Within this thesis the systematic risk is always related to the volatility of S&P500.

$$\text{Systematic risk:} \quad \sigma_{\beta i}=\beta_i*\sigma_{S\&P500}$$

Formula 3

Leibowitz et al. (2010, p. 22) define structural alpha as a return component, which is the excess return over the risk free return and (expected) beta excess return. This return is uniquely associated with each individual asset class and cannot be replicated by combination of U.S. stocks and cash. See Formula 4.

$$E(\alpha_i)=E(Rp_i)-r_f+\beta_i*[E(r_m)-r_f]$$

Formula 4

Structural alpha is related to other risks than risks contained in U.S. stocks, namely unsystematic risk. Probably, more sophisticated multi-factor pricing models would explain a substantial portion of the structural alpha and relate this return to concrete risk factors. By definition, unsystematic risk (structural alpha risk) is the difference between the total volatility and systematic risk (beta volatility). "Structural alpha risk […] represents what is required to take the β-based volatility […] to […] total volatility […]" Leibowitz et al. (2010). Moreover, alpha risks are probably not related to the common U.S. stocks risks and thereby alpha is likely to provide diversification potential. "Structural alpha risk, which has zero correlation with U.S. equity, reflects other risk factors, such as currencies, interest rates, liquidity concerns, and so forth." (Leibowitz et al. (2010)) A detailed return decomposition of

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[8] In this thesis, the market risk premium is defined as the difference between the average return on U.S. stocks represented by S&P500 and average T-Bill rate.

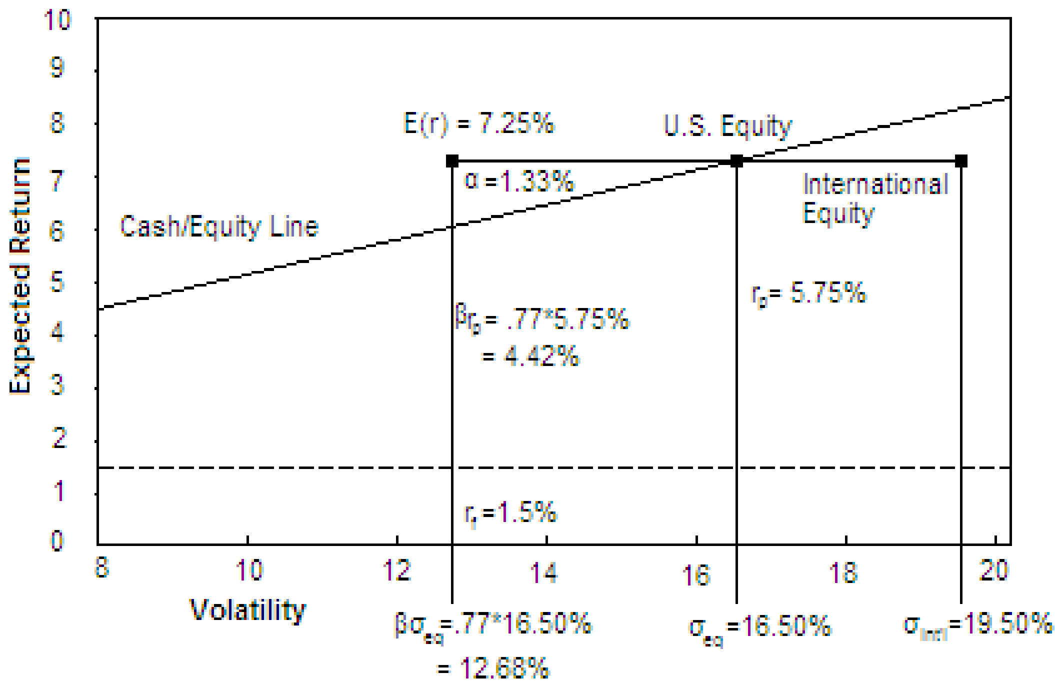
International Equity return is illustrated in Figure 3[9]. The risk-free part of the return is the dashed line (1.5%). The beta excess return is represented by the cash/equity line. As the international equity has structural beta of 0.77, the beta excess return is 0.77*market premium (5.75%). The remaining part 7.25%-4.42%-1.5%=1.33% is the structural alpha. Similar procedure may be done in the case of the risk. The systematic rick (beta risk) of International equity is 0.77*16.5%=12.68% [10]. The unsystematic risk (alpha risk) can be calculated according to the Formula 5:

$$\text{Unsystematic risk: } \sigma_\alpha = \sqrt{\sigma_{total}^2 - \sigma_\beta^2}$$

Formula 5

Therefore, the unsystematic (alpha) risk is $\sqrt{(19.50^2-12.68^2)}=14.82\%$

Figure 3: Return Decomposition – International Equity



This figure is taken over from Leibowitz et al. (2010, p. 22). It shows the decomposition of return on and risk of International equity. The return is decomposed into three parts: risk-free return of 1.5%, beta excess return of 4.42% (market premium of 5.75% times structural beta of international equity of 0.77) and structural alpha return of 1.3

[9] Figure 3 as well as the example of International equity is taken over from Leibowitz et al. (2010, p. 22).

[10] 16.5% is the standard deviation of U.S. equity in Leibowitz (2010, p. 15)

It is important to distinguish between conventional active alpha and structural alpha. According to Leibowitz et al. (2010) "In this analysis, alpha is structural, therein it refers neither to managerial skill (for example, excess return), the equity risk premium, nor a more general return over the risk-free rate. Instead, it is the return above the cash-equity line. […] Of course, these alphas [understand structural alphas] are an intrinsic component of the total expected return from the asset class, and as such would be incorporated in any standard optimization procedure."

The above analysis examines the usual behavior of the individual asset classes. However, it is important to look how the asset classes behave under stress during crises and whether their characteristics change in those times, with regard to other classes. The key in this analysis is to examine whether and how the correlation to other asset classes changes, especially to marketable stock. In other words, do the individual asset classes provide the same diversification power under stressed conditions as in normal times? During the time period I am looking at, there were two severe crises on the U.S. stock markets. The first one was the burst of the so-called Dot-com bubble. In August 2000, the index S&P500 peaked at 1,571. Two years later the, index was down by 47% to the value of 800. The second downturn is the recent financial crisis. In October 2007, S&P500 reached its peak of 1,557. By March 2009, the index dropped by approximately 50% to 756. I calculate 'stressed' structural betas and correlations over these periods. Additionally, I plot the monthly or quarterly returns of each asset class and S&P500 in a diagram and find the quadratic regression line, which is able to illustrate the change in the relationship to S&P500 in dependence on the S&P500 returns.

2.2. Asset Allocation among University Endowments

Table 1 shows the trend in the allocation to particular asset classes. In 1993, the average asset allocation policy resembled the conventional 60/40 asset allocation policy. Equities accounted for 53%, fixed income together with cash, which consists of short term fixed income securities as well, accounted for 42.3% and only 3.8% of capital was invested in alternative asset classes and other investment opportunities. However, this asset allocation changed considerably over the past sixteen years. The allocation to marketable equities rose to almost 65% in the end of the 1990s. Since then, it has declined and dropped to 51.6% in the fiscal year 2008. In the case of fixed income investment (and cash) the negative trend is more obvious. The allocation to this kind of investments has declined almost consistently over the past sixteen years to reach 23.1% in 2008. A quite opposite trend was in the case of alternative investments. Asset allocation to alternative investments rose from bare 3.8% in 1993 to 23.5% in 2008 – a sixfold increase. The highest increase was by hedge funds, whose allocation grew from only 0.7% to 12.9% by 2008. The second biggest alternative asset class among university endowments is real estate, whose allocation almost doubled over the past eighteen years. Allocation to private equity rose steadily over the last sixteen years and reached 3.3% in 2008. Very high increase

Table 1: Average Asset Allocation 1993-2008 (NACUBO)

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
1993	53.0	34.9	2.1	7.4	0.7	0.2	0.5	0.3	0.9	3.8
1994	54.3	32.6	2.1	7.5	1.5	0.2	0.5	0.3	0.3	4.6
1995	56.9	31.2	2.0	6.5	1.6	0.2	0.6	0.3	0.7	4.7
1996	60.9	28.5	1.9	5.3	1.8	0.2	0.7	0.2	0.5	4.8
1997	63.4	26.1	1.9	4.7	2.2	0.3	0.7	0.3	0.4	5.4
1998	63.5	25.6	2.1	4.3	2.8	0.4	0.7	0.2	0.4	6.2
1999	64.3	23.6	2.0	4.0	3.1	0.8	1.4	0.2	0.5	7.5
2000	62.1	23.3	2.0	4.1	3.0	1.0	2.4	1.4	1.7	9.8
2001	59.4	24.9	2.4	4.1	4.2	0.9	1.5	0.4	2.1	9.4
2002	57.4	26.9	2.7	3.9	5.1	0.9	1.1	0.4	1.6	10.2
2003	57.1	25.9	2.8	4.0	6.1	1.3	0.8	0.4	1.6	11.4
2004	59.9	22.1	2.8	3.7	7.3	1.3	0.8	0.6	1.6	12.8
2005	58.5	21.5	3.1	3.5	8.7	1.6	0.8	0.9	1.4	15.1
2006	57.7	20.2	3.5	3.4	9.6	1.9	0.9	1.5	1.4	17.4
2007	57.6	18.6	3.5	3.5	10.6	2.3	0.9	1.6	1.4	18.9
2008	51.9	19.2	4.1	3.9	12.9	3.3	1.0	2.2	1.5	23.5

This table shows the average asset allocation among university endowments covered by the NACUBO Endowment Study. The first column indicates the fiscal year, which starts on July 1st each year and ends on June 30th the following year. The further nine columns indicate the asset allocation to the individual asset classes in per cent. The last column is the sum of allocation to alternative asset classes and is calculated as follows: Real Estate + Hedge Fund + Private Equity + Venture Capital + Natural Resources. Source: NACUBO Endowment Studies from 2002 to 2008.

was recorded also by natural resources. In 2008, university endowments invested in this asset class seven times more capital than in 1993. Allocation to venture capital investments increased as well. However its peak was in 2000, when university endowments invested, on average, 2.4% of their fund in venture capital funds.

It is not clear how much the changes in the asset allocation can be referred back to the changes in the asset allocation policy (affected or not by recent performance of the particular asset classes) and how much to the slow portfolio rebalancing reactions. It can be assumed that the board of each university endowment set a target asset allocation for each fiscal year. However, especially the illiquid nature of the alternative asset classes and long holding periods may make the prompt rebalancing considerably difficult. Therefore, the reported asset allocation may be driven in some cases mainly by the past asset class performance. Above all the peak of the allocation to venture capital in the year 2000, when the allocation reached 2.4%, is caused by the extraordinary performance of this asset class in the same year. In this fiscal year, venture capital clearly outperformed all other asset classes and yielded 216.6%.

However, this trend is not the same across the whole endowment universe. Table 2 shows the average asset allocation of six subgroups of university endowments by asset under management. In 2008, the largest endowments (over $1 billion asset under management) invested almost half of the capital in alternative asset classes. This portion is declining along with the declining assets under management – the smallest endowments, with less than $25 million under management, invested only 6.8% in alternative assets in 2008. A quite opposite relation is between fixed income and the endowment size. In 2008, the largest endowments put approximately 11% in fixed income, while the smallest invested 27.1% in these assets. Similarly, the largest endowments allocated 39.4% to marketable equities, while the smallest endowments almost 56%. Brown et al. (2010) find mainly the same results. They examine the differences in the average asset allocation of the endowments in the top AUM (Asset under Management) quartile and that of the endowments in the bottom AUM quartile and find statistically significant differences in the asset allocation between top and bottom AUM quartile by most of the asset classes in years 1989, 1995, 2000, 2005[11].

[11] According to Brown et al. (2010) the results are similar in other years, but were not published.

Table 2: Asset Allocation by Endowment Size

Over $1-Billion

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
2002	45.1	20.5	4.3	1.9	17.8	4.3	3.9	1.7	0.5	32
2003	44.8	18.6	4.2	1.8	19.5	5.2	3	1.9	0.7	33.8
2004	46.3	15.2	4	2.7	20.2	4.9	3.5	2.6	0.7	35.2
2005	44.9	14.2	4	2	21.7	5.7	3.6	3.4	0.4	38.4
2006	44.9	12.5	4.4	1.7	22.4	5.9	3.5	4.2	0.5	40.4
2007	47	11.2	5	1.6	20.5	7.1	3.3	3.6	0.6	39.5
2008	39.4	10.8	6.4	1.4	22.6	10	3.6	5.3	0.5	47.9

$501 Million - $1 Billion

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
2002	56.4	19.5	3.9	1.3	11.4	3.5	2.4	0.8	0.8	22
2003	54.4	18.2	4.2	1.4	13.4	4.2	2.7	1.1	0.4	25.6
2004	56.9	15.7	2.9	1.9	14.4	4.5	2.1	1.2	0.4	25.1
2005	53.7	16	3.7	1.7	15.8	4.7	2	1.9	0.4	28.1
2006	52.9	13.6	3.9	1.9	17.4	5.1	2.2	2.5	0.4	31.1
2007	50.5	13.3	5.3	2.3	17.7	5.6	2.1	2.4	0.8	33.1
2008	42.5	14.6	6.1	1.9	19.2	7.7	2.8	3.5	1.7	39.3

$101 Million - $500 Million

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
2002	56.9	25.3	2.8	2.8	6.7	1.7	1.5	1.6	0.7	14.3
2003	56.5	23.5	2.9	2.7	8.3	2.2	1.3	0.8	1.8	15.5
2004	59.1	19.5	3.1	2.5	10	2	1.2	0.9	1.7	17.2
2005	57.8	18.9	3	2.5	11.4	2.2	1.1	1.3	1.7	19
2006	56.8	16.9	4	2.7	12.3	2.6	1	2	1.8	21.9
2007	56.6	15.1	3.6	2.8	13.8	2.8	1.1	2.1	2	23.4
2008	50.4	16.5	4.1	2.5	16.4	4.3	1.2	3	1.7	29

This table shows the average asset allocation to individual asset classes in six subgroups of university endowments by assets under management. The first column indicates the fiscal year which starts on July 1st each year and ends on June 30th the following year. The further nine columns indicate the asset allocation to the individual asset classes in per cent. The last column is the sum of allocation to alternative asset classes and is calculated as follows: Real Estate + Hedge Fund + Private Equity + Venture Capital + Natural Resources. Source: NACUBO Endowment Studies from 2002 to 2008.

Table 2 (cont.)

$51 Million - $100 Million

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
2002	60.8	27.5	2.6	3.5	4.1	0.2	0.2	0.1	0.9	7.2
2003	58.7	27.2	2.8	4.9	4.3	0.6	0.3	0.1	1.1	8.1
2004	62.5	22.1	2.7	4.6	5.6	0.5	0.4	0.2	1.5	9.4
2005	60.6	22.1	3.2	3.8	7	0.7	0.4	0.5	1.7	11.8
2006	59.8	20.7	3.4	3.6	7.8	0.9	0.5	1.2	2.1	13.8
2007	60.1	19.2	3.6	3.8	8.7	1.2	0.4	1.3	1.8	15.2
2008	54.1	20.3	4.2	4.4	11.5	1.8	0.5	1.9	1.4	19.9

$25 Million - $50 Million

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
2002	59.8	28.7	2.4	3.9	3.2	0.3	0.3	0.1	1.3	6.3
2003	60.2	27.7	2.6	3.5	4.2	0.2	0.2	0.1	1.4	7.3
2004	61.5	24.6	3.3	4	4.6	0.3	0.2	0.2	1.4	8.6
2005	61.2	23.3	3.8	3.3	5.8	0.3	0.3	0.6	1.5	10.8
2006	62.3	22.1	3.4	3.5	6	0.5	0.1	0.8	1.4	10.8
2007	63.2	21.3	3.1	3.1	6.9	0.5	0.1	0.8	1	11.4
2008	57.6	20.8	4.1	3.4	10.4	1	0.3	1.2	1.1	17

Less than $25 Million

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Alternative Assets
2002	55.4	31	2.2	4.8	1.3	0.2	0.1	2	2.9	5.8
2003	57	29.8	2.2	6.6	1.6	0.2	0.1	0	2.5	4.1
2004	61.7	27.2	1.3	5	1.8	0.2	0	0	2.6	3.3
2005	60.7	27.8	1.7	6.1	2.4	0.2	0	0.1	1	4.4
2006	58.9	29	2.3	5.3	2.6	0.5	0.2	0.3	0.9	5.9
2007	59.5	27.5	1.8	6.4	2.9	0.4	0.2	0.3	0.9	5.6
2008	55.9	27.1	2.2	8.1	3.3	0.6	0.3	0.4	2.1	6.8

This table shows the average asset allocation to individual asset classes in six subgroups of university endowments by assets under management. The first column indicates the fiscal year which starts on July 1st each year and ends on June 30th the following year. The further nine columns indicate the asset allocation to the individual asset classes in per cent. The last column is the sum of allocation to alternative asset classes and is calculated as follows: Real Estate + Hedge Fund + Private Equity + Venture Capital + Natural Resources. NACUBO Endowment Studies from 2002 to 2008.

In this way, the largest endowments seem to be the pioneers in the alternative asset allocation among university endowments. The two largest university endowments – Harvard and Yale endowments - pursue completely different allocation policy, with especially strong focus on alternative asset classes. Harvard's asset allocation policy for 2010 was 33% equity, 16% absolute return, 14% commodities, 13% fixed income, 13% private equity, 9% real estate, and 2% cash[12]. In 2010, Yale allocated only 16.9% to equity, only 4% to fixed income, but 21.0% to absolute return, 30.3% to private equity, 27.5% to real estate, and 0.4% to cash[13].

The smallest endowments seem to adopt the alternative asset allocation policy with considerable time lag. The proportion, which the smallest endowments invested in fixed income in 2008, corresponds to the average portion invested by all endowments in 2002[14]. At the same time, the portion of 6.8% which the smallest endowments invested in alternative assets in 2008 corresponds to the average allocation to this asset class in year 1998 and 1999.

As Table 3 shows, the differences in the asset allocation between the largest (over $1 Billion) and smallest endowments (less than $25 Million) have increased by almost all asset classes (except for venture capital and other) over time. For instance, in 2002 the smallest endowments invested by 10.3% more of their capital in equities than the largest endowments. In 2008, this difference was already 16.5%. An even stronger increase was by alternative assets. The differences in the asset allocation between the largest and second smallest endowments also increased over time, but not as dramatically. On the contrary, the larger endowments ($101-500 Million and $501 Million - $1 Billion) managed to maintain or even lower the differences in the asset allocation. For instance, endowments with $501 Million- $1 Billion assets under management lowered the difference in the allocation to alternative assets by 1.4 percentage point from 2002 to 2008. Therefore, it seems that the ability/incentive/willingness to adopt alternative asset allocation policy is related to the endowment size.

[12] Source: Harvard's endowment report 2010.

[13] Source: The Yale Endowment 2010 report

[14] In 2002 was the allocation to fixed income high probably due to the crash on the stock markets.

Table 3: Differences in Asset Allocation

Differences between endowments over $1-Billion and endowments less than $25-Million

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Altern. Assets
2002	-10.3	-10.5	2.1	-2.9	16.5	4.1	3.8	-0.3	-2.4	26.2
2003	-12.2	-11.2	2	-4.8	17.9	5	2.9	1.9	-1.8	29.7
2004	-15.4	-12	2.7	-2.3	18.4	4.7	3.5	2.6	-1.9	31.9
2005	-15.8	-13.6	2.3	-4.1	19.3	5.5	3.6	3.3	-0.6	34
2006	-14	-16.5	2.1	-3.6	19.8	5.4	3.3	3.9	-0.4	34.5
2007	-12.5	-16.3	3.2	-4.8	17.6	6.7	3.1	3.3	-0.3	33.9
2008	-16.5	-16.3	4.2	-6.7	19.3	9.4	3.3	4.9	-1.6	41.1

Differences between endowments over $1-Billion and $25-50-Million endowments

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Altern. Assets
2002	-14.7	-8.2	1.9	-2	14.6	4	3.6	1.6	-0.8	25.7
2003	-15.4	-9.1	1.6	-1.7	15.3	5	2.8	1.8	-0.7	26.5
2004	-15.2	-9.4	0.7	-1.3	15.6	4.6	3.3	2.4	-0.7	26.6
2005	-16.3	-9.1	0.2	-1.3	15.9	5.4	3.3	2.8	-1.1	27.6
2006	-17.4	-9.6	1	-1.8	16.4	5.4	3.4	3.4	-0.9	29.6
2007	-16.2	-10.1	1.9	-1.5	13.6	6.6	3.2	2.8	-0.4	28.1
2008	-18.2	-10	2.3	-2	12.2	9	3.3	4.1	-0.6	30.9

Differences between endowments over $1-Billion and $51-100-Million endowments

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Altern. Assets
2002	-15.7	-7	1.7	-1.6	13.7	4.1	3.7	1.6	-0.4	24.8
2003	-13.9	-8.6	1.4	-3.1	15.2	4.6	2.7	1.8	-0.4	25.7
2004	-16.2	-6.9	1.3	-1.9	14.6	4.4	3.1	2.4	-0.8	25.8
2005	-15.7	-7.9	0.8	-1.8	14.7	5	3.2	2.9	-1.3	26.6
2006	-14.9	-8.2	1	-1.9	14.6	5	3	3	-1.6	26.6
2007	-13.1	-8	1.4	-2.2	11.8	5.9	2.9	2.3	-1.2	24.3
2008	-14.7	-9.5	2.2	-3	11.1	8.2	3.1	3.4	-0.9	28

This table shows the differences in the average asset allocation between the subgroup of the largest endowments and all other subgroups. The first column indicates the fiscal year which starts on July 1st each year and ends on June 30th the following year. The further nine column indicate the difference in asset allocation to the individual asset classes in per cent. The last column is the sum of the differences in allocation to all alternative asset classes. Negative value indicates that the smaller endowment allocates more to the particular asset class and vice versa. Source: NACUBO Endowment Studies from 2002 to 2008.

Table 3 (cont.)

Differences between endowments over $1-Billion and $101-500-Million endowments

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Altern. Assets
2002	-11.8	-4.8	1.5	-0.9	11.1	2.6	2.4	0.1	-0.2	17.7
2003	-11.7	-4.9	1.3	-0.9	11.2	3	1.7	1.1	-1.1	18.3
2004	-12.8	-4.3	0.9	0.2	10.2	2.9	2.3	1.7	-1	18
2005	-12.9	-4.7	1	-0.5	10.3	3.5	2.5	2.1	-1.3	19.4
2006	-11.9	-4.4	0.4	-1	10.1	3.3	2.5	2.2	-1.3	18.5
2007	-9.6	-3.9	1.4	-1.2	6.7	4.3	2.2	1.5	-1.4	16.1
2008	-11	-5.7	2.3	-1.1	6.2	5.7	2.4	2.3	-1.2	18.9

Differences between endowments over $1-Billion and $501-Million - 1-Billion endowments

Fiscal Year	Equity	Fixed Income	Real Estate	Cash	Hedge Fund	Private Equity	Venture Capital	Natural Resources	Other	Altern. Assets
2002	-11.3	1	0.4	0.6	6.4	0.8	1.5	0.9	-0.3	10
2003	-9.6	0.4	0	0.4	6.1	1	0.3	0.8	0.3	8.2
2004	-10.8	-0.5	1.1	0.8	5.8	0.4	1.4	1.4	0.3	10.1
2005	-8.8	-1.8	0.3	0.3	5.9	1	1.6	1.5	0	10.3
2006	-8	-1.1	0.5	-0.2	5	0.8	1.3	1.7	0.1	9.3
2007	-3.5	-2.1	-0.3	-0.7	2.8	1.5	1.2	1.2	-0.2	6.4
2008	-3.1	-3.8	0.3	-0.5	3.4	2.3	0.8	1.8	-1.2	8.6

This table shows the differences in the average asset allocation between the subgroup of largest endowments and all other subgroups. The first column indicates the fiscal year which starts on July 1st each year and ends on June 30th the following year. The further nine column indicate the difference in asset allocation to the individual asset classes in per cent. The last column is the sum of the differences in allocation to all alternative asset classes. Negative value indicates that the smaller endowment allocates more to the particular asset class and vice versa. Source: NACUBO Endowment Studies from 2002 to 2008.

The considerable differences in the asset allocation policy between large and small endowments are probably caused by both incentives and obstacles, which are associated with investing in alternative asset classes. One feature which distinguishes most of the alternative asset classes from the traditional ones is the absence investable benchmark, and thereby absence of the "market return" – except for commodities, which enables investment in commodity ETFs. "In fact, investors in alternative asset classes must pursue active management, since market returns do not exist in the sense of an investable passive option. Even if investors could purchase the median result in real estate, venture capital, or even leveraged buyouts, the results would likely disappoint, since historical returns tend to lag comparable marketable security results. Only by generating superior active returns do investors realize the promise of investing in alternative assets." (Swenson (2000)) Therefore, a meaningful alternative asset allocation requires some active management skills. This, according to Brown et al. (2008), prohibits small endowments from investing in alternative asset classes, as small endowments cannot afford to hire managers with sufficient expertise in alternative assets. Further explanation suggested by Brown et al. (2008) is that small endowments hardly meet the minimum amount, required when investing in alternative assets, especially hedge funds. Similarly, Lerner et al. (2008) states that the most successful private equity and hedge funds are often closed to new investors, making it important being pioneer in the alternative asset allocation. Dimmock (2010) provides further explanation for the differences in the asset allocation between large and small endowments. He shows that the endowment size is positively related to portfolio standard deviation and allocation to risky assets. Dimmock (2010) uses log of average donations as a proxy for fund size. His results indicate that large funds allocate less capital to fixed income and more to alternative assets and real estate. Dimmock explains it, among other things, by the assumption that endowments have decreasing absolute risk aversion. Further characteristic of alternative asset classes is that they may be exposed to different kinds of risk, especially liquidity risk. As mentioned by many authors (e.g. Brown et al. (2008)), larger endowments can better overcome the low liquidity of these assets.

A very special case are the endowments of Oxbridge colleges, which held 22 per cent of the capital in real estate at the end of fiscal year 2002 (Acharya and Dimson (2007). The high allocation to real estate among these endowments is probably driven by the age of these institutions. Acharya and Dimson (2007) state following: “While endowment wealth is not a clear indicator of size of property investments of institutions in Oxford or Cambridge, the age of some of the Colleges may have been an influencing factor”. Furthermore, it seems that these institutions have created a great expertise in managing the real estate portfolio over the long time. “Oxbridge institutions may not have been pioneering by investing in private equity or hedge funds, but they have been innovative in their approaches to investing in property, albeit without a conscious strategy in doing so. While such approaches to asset management may have evolved from the constraints imposed on them historically, the Colleges have evolved into niche players in the property market by virtue of their long-term ownership of prime property assets.” (Acharya and Dimson (2007))

2.3. Conventional Asset Classes

The focus of this section is the analysis of the main asset classes. The goal is to identify what an investor can expect from each asset class, what she or he has to be careful of and what is the role which each asset class in a portfolio plays.

Usually, the portfolio consists of a number of asset classes. As the overall portfolio is expected to achieve goals defined by the needs of the associated university, every asset class should contribute to the achievement of these goals. Therefore, the portfolio manager has to find strong arguments why an asset should be included in the portfolio. There are various reasons why to allocate capital to an asset class. Usually the expected return, risk, and diversification are the factors, which are mentioned most often. Within the scope of asset allocation policy, an asset class should either drive the portfolio return, or provide diversification effects, especially during crises. Therefore, even an asset class with negative risk premium may reasonably be included in a portfolio, if for instance the asset class is expected not to be correlated with other asset classes or be even negatively correlated with them. In the course of further decisions, such as market timing and security selection, additional characteristics such as liquidity or market efficiency are relevant.

2.3.a. U.S. Stocks

In a model, where only marketable equity and fixed income investments exist – 60/40 portfolio - , the marketable equities are usually expected to serve as the main source of the very best return of the portfolio. At the same time, they are the substantial source of the total portfolio volatility. Table 4 Panel A shows the data of S&P500 (total return) – representative of U.S. stocks. Index S&P 500 generated average yearly return 10.58% with volatility 14.85% over the time period from 1988 to 2010. This result places U.S. stock on higher lever than fixed income with regard to both return on fixed income with regard to both return an volatility. Leibowitz et al. (2010) recorded a return on U.S. stocks of 7.25% - superior to return on fixed income (3.75%) - and volatility of 16.5%[15] (see Table 4 Panel C). Similarly, Swensen (2000) reports the inflation-adjusted return on U.S. Equity[16] of 9.2% and volatility of 21.7% (Table 4 Panel D). Although it depends on the time period used and the chosen index, historically the arithmetic mean of yearly returns on marketable equities is usually higher than on fixed income investments. Therefore, it can be assumed that U.S. marketable equities are likely to outperform the fixed income and are responsible for generating higher returns on the portfolio. As the S&P500 is used as a reference point[17] for all other asset classes, the correlation coefficients and structural betas are mentioned by the relevant asset classes. The monthly returns from 1990-2010 are not normally distributed (see Table 4 Panel B). There is a negative skewness of -0.5, but insignificant kurtosis of 0.66. As a consequence, the Sharpe ratio overstates the performance of the S&P500.

The U.S. stocks market can be split into many segments according to various criteria, e.g. NASDAQ composite, Russell 3000. These segments may exhibit ‘slightly’ different characteristics, especially with regard to average return and standard deviation. The correlation of these segments with S&P500 is, however, very strong, and therefore the diversification potential of these indices is very limited.

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[15] Leibowitz et al (2010) mention Morgan Stanley Research as the source of the data, but do not specify, on which indices or group of securities the calculations are based.

[16] Swensen (2000) uses mix of 70% weight on the S&P500 (1926-1997), 30% weight on the Russell 2000 (1979-1997) or DFA Small Companies Deciles 6-10 (1926-1978) as proxy for U.S Equity.

[17] Reference point for the purpose of structural beta calculation and market premium calculation

Table 4 Panel A: Asset Class Characteristics – maximal time period

	T-Bill	Venture capital	Private equity	Hedge fund	Internat. stocks	Emerg. markets	U.S. Stocks	Real estate	Fixed income	Natural resources
Frequency	M	Q	Q	M	M	M	M	Q	M	M
Time period	'60-'11	'81-'10	'86-'10	'90-'10	'70-'11	'95-'11	'88-'10	'78-'10	'76-'10	'70-'11
Mean (%)	5.19	14.45	12.89	11.70	8.46	12.08	10.58	8.70	8.14	11.59
Standard deviation (%)	0.83	21.54	9.67	7.02	17.20	24.78	14.85	4.54	5.75	20.30
Beta		0.653	0.431	0.339	0.837	1.143		0.070	0.242	-0.107
Beta (crisis 1)		0.337	0.280	0.290	0.748	1.050		0.010	0.188	-0.414
Beta (crisis 2)		0.283	0.474	0.356	1.157	1.502		0.227	1.082	0.405
Correlation		0.429	0.696	0.731	0.710	0.744		0.228	0.166	-0.082
Correlation (crisis 1)		0.405	0.839	0.803	0.852	0.805		0.121	0.165	-0.360
Correlation (crisis 2)		0.725	0.853	0.810	0.941	0.878		0.504	0.626	0.231
Beta excess return (%)		3.52	2.33	1.83	4.51	6.17		0.38	1.30	-0.58
Alpha return (%)		5.74	5.38	4.69	-1.24	0.72		3.13	1.65	6.99

The data are based on following indices: Venture capital: Cambridge Associates U.S. Venture Capital Index®, Private equity: Cambridge Associates U.S. Private Equity Index®, Hedge funds: Hedge Fund Research Index, International stocks: MSCI EAFE, Emerging markets: S&P/IFCI, U.S. stocks: S&P500, Real estate: NCREIF, Fixed income: Barclays Capital U.S. Aggregate Bond Index and Natural resources: Goldman Sachs Commodity Index S&P GSCI®. In the row 'Frequency', 'M' refers to 'monthly' and 'Q' refers to 'quarterly'. The row 'Time period' indicates the time period the calculation is based on. Mean refers to the arithmetic average. Beta is the structural beta of each asset class with regard to U.S. stocks. Beta (crisis 1) and beta (crisis 2) refer to the structural beta of each asset class during the Dot-com crisis (2000-2002) and the financial crisis (2007-2009), respectively. Correlation is the correlation coefficient between the particular asset class and U.S. stocks. Correlation (crisis 1) and correlation (crisis 2) also refer to the two crises. Beta excess return is calculated according to CAPM. Alpha return is the structural alpha return of each asset class.

Table 4 Panel B: Asset Class Characteristics: identical time period: 1990-2020

	T-Bill	Venture capital	Private equity	Hedge fund	Internat. stocks	U.S. Stocks	Real estate	Fixed income	Natural resources	Emerging Markets
Mean (%)	3.68	18.28	14.04	11.84	4.89	9.48	6.61	7.16	6.76	12.94
Standard deviation(%)	0.99	25.49	10.36	8.86	19.17	16.55	5.14	4.05	25.43	28.34
Beta	0.01	0.68	0.44	0.29	0.97	1.00	0.04	-0.02	0.13	1.16
Correlation	0.10	0.44	0.71	0.54	0.83		0.14	-0.07	0.08	0.74
Beta excess return (%)		3.93	2.58	1.69	5.66	5.80	0.25	-0.10	0.74	5.81
Alpha return (%)		10.67	7.78	6.47	-4.44	0.00	2.68	3.58	2.34	3.82
Beta sigma (%)		11.22	7.35	4.82	16.13	16.55	0.71	†	2.10	20.82
Alpha risk (%)		22.88	7.31	7.44	10.36	0.00	5.09	4.04	25.34	19.22
Sharpe ratio		0.58	1.00	0.93	0.06	0.35	0.59	0.88	0.12	0.34
Skewness		3.17***	-0.61**	-0.92***	-0.26	-0.50**	-1.6***	-0.06	0.01	-0.19
Kurtosis		18.3***	1.78***	3.09***	3.81***	0.66	3.98***	-0.30	3.62***	-0.265

The data are based on following indices: Venture capital: Cambridge Associates U.S. Venture Capital Index®, Private equity: Cambridge Associates U.S. Private Equity Index®, Hedge funds: Hedge Fund Research Index, International stocks: MSCI EAFE, Emerging markets: S&P/IFCI, U.S. stocks: S&P500, Real estate: NCREIF, Fixed income: Barclays Capital U.S. Aggregate Bond Index and Natural resources: Goldman Sachs Commodity Index S&P GSCI®. All calculations are based on quarterly returns over the time period from 1990 to 2010 (except for emerging markets). In the case of emerging markets, the calculations are based on the time period from 1995 to 2010. Mean refers to the arithmetic average. Beta is the structural beta of each asset class with regard to U.S. stocks. Beta excess return is calculated according to CAPM. Alpha return is the structural alpha return of each asset class. Beta sigma is the volatility of each asset class based on the relevant structural beta and is calculated according to Formula 3. Alpha risk is the remaining risk of the particular asset class and can be calculated according to Formula 5. The last two rows show the skewness and the kurtosis of the return distributions. ***,**,* denote significance at the 1 per cent, 5 per cent, and 10 per cent levels, respectively. †- standard deviation (beta sigma) cannot take negative value. The pure calculation would result in a negative beta sigma, as positive standard deviation is multiplied with negative sigma. The absolute value of the result would be 0.29%.

The CAPM is based on the assumption that there is a single systematic risk factor, namely market risk[18]. However, a number of papers, especially Fama and French (1992) and (1993) suggest that equities are exposed not only to the systematic market risk but also to other systematic risk factors such as company size and book-market value ratio. Later, Carhart (1997) added fourth risk factor, namely momentum. Splitting the equity market according to these criteria creates further 'asset subclasses' with various characteristics and new options for asset allocation policy.

Table 4 Panel C: Asset Class Characteristics: Data from Leibowitz et al.(2010)

	Cash	Venture Capital	Private Equity	Equity Hedge Funds	Internat. Equity	U.S. Equity	Emerging Market Equity	Absolute Return	Real Estate	US Bond Aggreg.	Commo-dities
Mean (%)	1.5	12.25	10.25	5.75	7.50	7.25	9.25	5.25	5.50	3.75	5.25
Standard deviation(%)	2.00	27.75	23.00	12.75	19.50	16.50	28.00	9.25	12.00	7.50	19.00
Beta	0.04	0.59	0.98	0.66	0.77	1.00	0.76	0.28	0.07	0.14	-0.29
Correlation with U.S. Equity	0.35	0.35	0.70	0.85	0.65	1.00	0.45	0.50	0.10	0.30	-0.25
Beta excess return (%)		3.38	5.61	3.78	4.42	5.75	4.39	1.61	0.42	0.78	-1.66
Alpha return (%)		7.37	3.14	0.47	1.33	0.00	3.36	2.14	3.58	1.47	5.41
beta sigma (%)		9.71	16.10	10.84	12.68	16.50	12.60	4.63	1.20	2.25	-4.75 †
alpha risk (%)		25.99	16.4	6.72	14.82	0.0	25.0	8.01	11.94	7.15	18.40

Source: Leibowitz, M.L., Bova, A., Hammond, P.B. (2010) The Endowment model of Investing. † Beta sigma, which is basically the beta standard deviation cannot be negative, as standard deviation is squared root of variance. Here, the negative value results from a multiplication of positive sigma with negative beta. The results are taken over from Leibowitz et. al. (2010)

Table 4 Panel D: Asset Class Characteristics: Data from Swensen (2000)

	Cash	Private Equity	Absolute return	Developed Equity	U.S. Equity	Emerging Equity	Real estate	US Bond Aggregate
Observations (years)	72	16	20	38	72	13	21	72
Mean (%)	-0.40	19.10	17.60	6.30	9.20	11.10	3.50	1.20
Standard deviation (%)	4.10	20.00	11.80	18.90	21.70	27.90	5.10	6.50

Source: Swensen D.F., (2000) Pioneering Portfolio Management.

[18] The market risk is defined as S&P500 risk in this thesis.

Besides the quantitative features of U.S. stocks, the simplicity of investing in U.S. stocks is one of the reasons for the high allocation to these assets among university endowments. There are a number of ETFs, which are very easily accessible by every investor. These ETFs cover not only the S&P500 or Dow Jones Industrial Average but also various groups of stocks, according to diverse investment strategies, e.g. Russell 3000 Growth Stocks.

Further reason for endowments to include marketable equities in their portfolios is that they provide higher potential for active management than fixed income. According to Swensen (2000), the opportunities for active portfolio management vary across the market. The market for U.S. large capitalization stock is very efficient and provides few opportunities, while the market for small stock, often uncovered by any analyst, offers some opportunities for hardworking portfolio managers. Therefore, in an only stock-fixed income world, investors are more likely to exploit opportunities for active management on the stock market than on the fixed income market.

These characteristics clearly distinguish the equities from fixed income and clearly determine the role of marketable equities in the two-asset-class world. However, in the world with more asset classes than only marketable U.S equities and fixed income (and cash) other asset classes may substantially change the role of U.S. stocks in the overall portfolio.

2.3.b. International Stocks

International equities are a further group of marketable equities. International stocks may not necessarily be considered a separate asset class. However, from the point of view of university endowments, which in this thesis refer mainly to U.S and Canada endowments, international equities bear additional risks. International equities can be divided into developed foreign markets, which are represented by MSCI EAFE in this thesis, and emerging markets, which are represented by S&P/IFCI Composite index. Swensen (2000) mentions some risks which are specific for international equity investments from U.S. investor's point of view. First, the investors are exposed to currency risk. Second, additionally to the common stock risk, international equities are exposed to foreign interest rates. Third, international equities are affected mainly by inflation in their home country and not by inflation in U.S. Especially emerging markets are affected by a number of additional risks, e.g. political risks. As shown in Table 4 Panel A, the average return on MSCI EAFE is 8.46%, with volatility of 17.20%. The average return on stocks on emerging markets is 12.08%, with volatility of 24.78%. Both Swensen (2000) and Leibowitz et al. (2010) report similar results, which rank developed markets and emerging markets on similar position relative to other asset classes. The monthly returns on MSCI EAFE from 1990 to 2010 seem to be normally distributed – the skewness and kurtosis are not significant (Table 4 Panel B). Regarding the correlation, both MSCI EAFE and S&P/IFCI exhibit high correlation with S&P500 of 0.83 and 0.74, respectively (see Table 4 Panel B). Accordingly, both indices exhibit high structural betas of 0.97 and 1.16, respectively (see Table 4 Panel B). The structural alpha return of MSCI EAFE is negative -4.44% (Table 4 Panel B) - the lowest value among all asset classes. Structural alpha return of S&P/IFCI is higher, namely 3.82%. Monthly returns on S&P500 and monthly returns on MSCI EAFE and S&P/IFCI Emerging Markets are plotted in Figure 4 Panel A and B, respectively. The slightly negatively downward sloped quadratic regression lines at the left-hand side of the diagrams suggest increasing sensitivity of international stock prices during U.S. stock. In fact, the structural beta dropped marginally during the Dot-com crisis, but increased to 1.16 during the financial crisis in the case of developed international stocks. Similarly, structural beta of emerging markets dropped marginally in the dot-com crisis, but increased to 1.50 during the financial crisis (see Table 4 Panel A). Therefore, the diversification potential of both developed markets and emerging markets is limited and decreases during crises. Eventually, it is quite logical that international stocks do not provide protection against the global-wide crisis.

According to Swensen (2000), international equities offer greater potential for active management. The market efficiency even on the most developed overseas markets is lower, when compared with U.S. stock markets. On the other hand, the active management on the overseas market is associated with a number of hurdles (e.g. availability of information, foreign language problems), which may make active management for university endowments very costly.

When summarized, especially emerging markets provide potential of achieving higher returns. International stocks are more volatile and seem to imitate the movements of U.S. stocks. The diversification potential is quite limited, especially for long-term investors, such as university endowments. It is quite intuitive that international equities will not protect the investors against global crises. International stock may play a similar role as U.S stocks – drive the portfolio return. Additionally, they provide some possibilities for active portfolio management.

Figure 4: Quadratic Regression Lines – Asset Classes

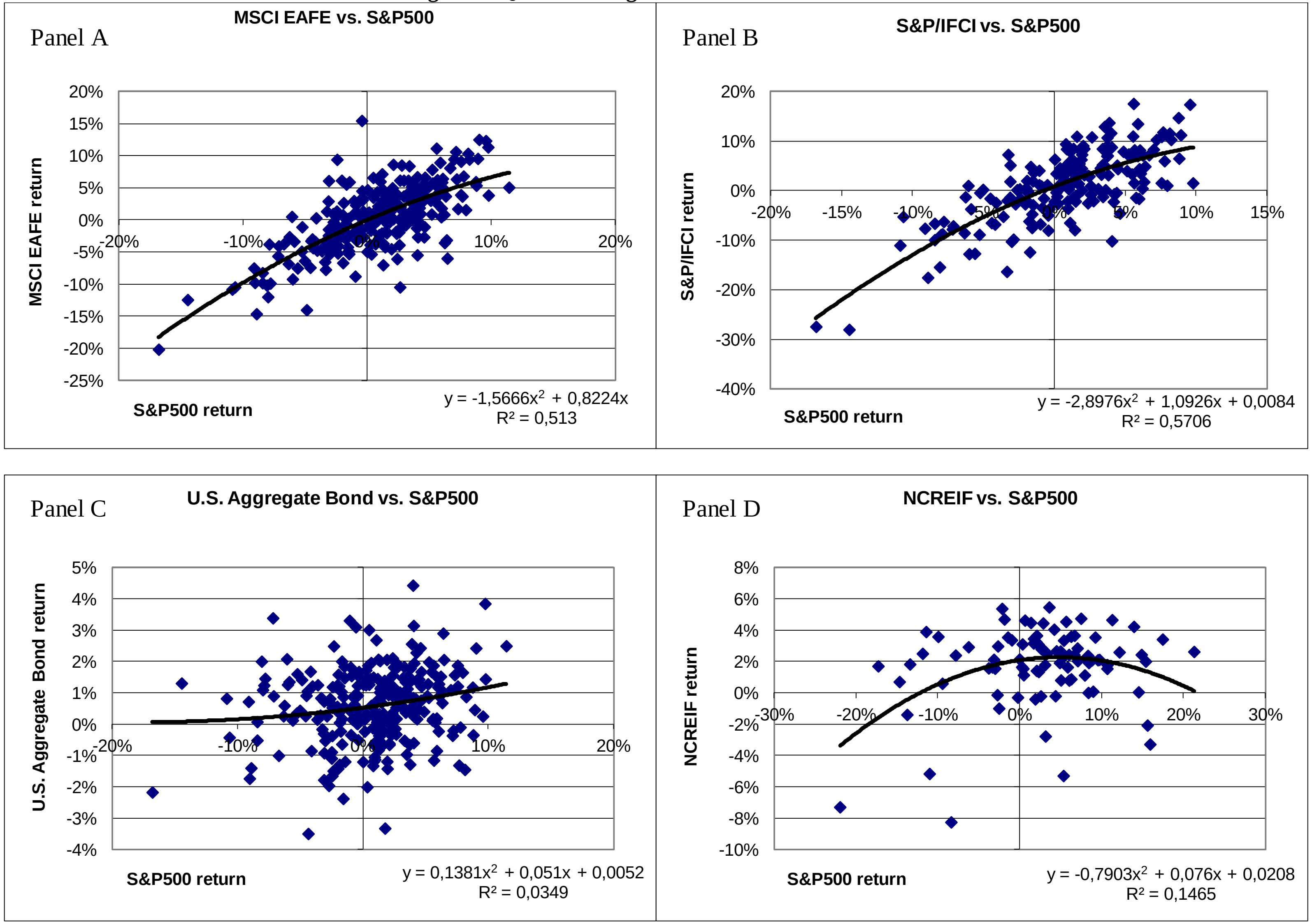

Figure 4 (cont.)

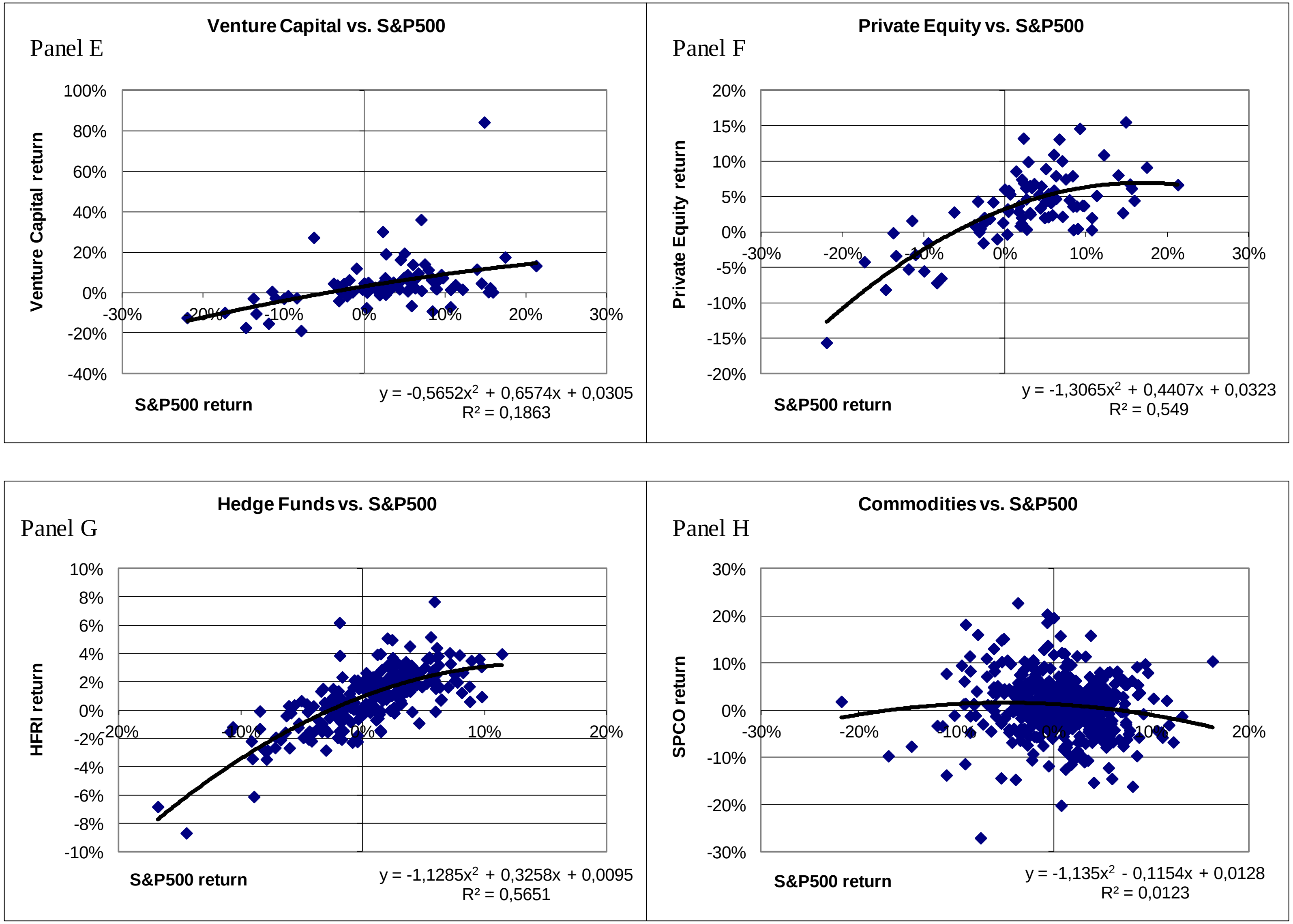

Figure 4 shows diagrams, where the x- axis are the monthly or quarterly returns on S&P500 and the y-axis are the monthly or quarterly returns on the particular asset class. In each diagram, there is a quadratic regression line, which indicates how the relationship between the S&P500 return and the returns on the particular asset class changes. The regression equation (including R-squared) is in the right-hand bottom corner of each diagram. The increase downward sloping on the left-hand side of the regression line indicates increased sensitivity of the returns on the particular asset class to the S&P500 returns.

2.3.c. Fixed income

The role of fixed income in a portfolio that consists only of stocks and bonds was usually different from the role of stocks. The main reason for including fixed income instruments in the portfolio is their strong diversifying power. Therefore, in the equity-bond world fixed income instruments are the main source of diversification. Table 4 Panel A shows that the average return on Barclays Capital Aggregate Bond index is 8.14% and the volatility is 5.75% over the period from 1976 to 2010. The results over the period from 1990 to 2010 (Table 4 Panel B) rank the fixed income on lower level relative to S&P500. I have to admit that the average return seems to be overestimated and the volatility underestimated, especially when you compare these figures with figures from Swensen (2000) and Leibowitz et al (2010) (Table 4 Panel C and D). The reason may be the not sufficiently long time series of data. Leibowitz et al. (2010) report an average return on fixed income of 3.75% with volatility 7.5% and Swensen (2000) reports an inflation adjusted average return of 1.2% with volatility of 6.5%. The monthly returns over the period from 1990 to 2010 are normally distributed. The correlation coefficient between fixed income and U.S. stocks is slightly positive 0.17 over the period from 1976 to 2010 (Table 4 Panel A) and close to zero over the period from 1990 to 2010 (Table 4 Panel B). Swensen (2000) provides basically the same figure 0.06 (Table 4 Panel D) and Leibowitz et al. (2010) report a slightly more positive correlation, namely 0.3 (Table 4 Panel C). From this figures, it is obvious that fixed income instruments do not (or do only extremely weakly) correlate with U.S. stocks, and thereby are able to provide the portfolio with the desired diversification. It is important to mention that my calculations are based on Barclays Capital Aggregate Bond Index, which covers mainly high quality Aaa U.S. bonds[19]. This means that the index captures the risks related to high quality U.S. bonds. Of course, there is a large variety of different sorts of bonds (e.g. high yield bonds, convertible bonds, callable bonds, etc.). These fixed income instruments are, however, exposed to a number of additional risks, which may substantially increase not only the volatility but also the correlation with equity. According to Swensen (2000), investors should include only as much fixed income in their portfolio as it is necessary for protection against hostile financial environment, because the opportunity costs of holding bonds are relative high. Furthermore, Swensen states that in order to use the fixed income for the main purposes, namely diversification and protection against hostile

[19] For detailed information, please see the Barclays Capital Factsheet of U.S. Aggregate Bond Index

financial environment, investors should invest only in long-term, non-callable bonds with the highest quality. Although in boom periods high-yield bonds may generate higher returns, they fail to provide protection during crisis – in times when their protective power is most needed. In other words, investing in bonds with lower rating means accepting risks that are already included in equity investments, thereby reducing the diversification effect.

According to the fact that there is virtually no correlation between fixed income and U.S. stock, the structural beta is also very low. This results in a minimum beta excess return of -0.1% leaving 3.58% for structural alpha (Table 4 Panel B). Leibowitz et al. (2010) provide basically similar results. As a result, most of the fixed-income return is not related to the U.S. stock risk factor.

According to Swensen (2000), fixed income provides protection against unanticipated price deflation, but it is especially vulnerable to unanticipated inflation. It is caused mainly by the fixed nature of the nominal coupon and the principal value. While the unanticipated fall in prices makes the real yield from fixed income higher, the unanticipated rise in prices depreciates the real value of the inflows.

How did the fixed income behave during crises? The above analysis shows that fixed income does not correlate with U.S. stocks providing enough room for diversification. However, the diversification is mostly important when U.S. stocks are stressed. Figure 4 Panel C depicts a quadratic regression line in a diagram of S&P500 returns and U.S. Aggregate Bond return. The regression line is almost horizontal and almost straight. The lack of curvature means that the 'relationship' between U.S. stock returns and U.S. fixed income return is independent of the U.S stock return. Moreover, the R-squared is very low and thereby the regression line has no explanatory power. The 'stressed' structural betas over the periods of the two recent severe U.S. stock downturns changed only marginally, and therefore, fixed income is able to retain the diversifying power, when U.S. stock prices decline dramatically, and it constantly diversifies the portfolio.

According to Swensen (2000): "Active management of high-quality fixed income makes little sense, as U.S. Treasury securities trade in the broadest, deepest, most liquid market in the world. On a bottom-up basis, in competing with the world's most sophisticated financial institutions, managers face little prospect of identifying mispriced assets. From a top-down perspective, when dealing with the staggering variety of variables influencing interest rates, managers face almost certain failure in attempting to time markets. Holding a passively managed portfolio of high-quality, long-term, noncallable bonds best serves a fixed income portfolio's fundamental mission." According to the results mentioned above and to the statement by Swensen (2000), the main role of fixed income in portfolio seems to be the diversification.

At this point, I have defined two asset classes that have different characteristics and obviously play a different role in portfolio construction. These two asset classes (together with cash) enable to construct a great number of portfolios, which may match the requirements of many investors. Actually, in the previous section it was stated that twenty years ago the endowments, on average, limited themselves to invest mainly in marketable equities and bonds (and cash). Today, the small endowments still construct their portfolios mainly by stocks and bonds and make only limited use of the alternative asset classes.

2.4. Alternative Asset Classes

2.4.a. Opportunities and Threats

The asset classes, such as real estate, venture capital, private equity, hedge funds and commodities, are usually called alternative assets. However, the question is whether these classes really offer something different than the marketable equities and fixed income do, and whether they create new opportunities of asset allocation. An asset class is usually defined as a group of assets that are exposed to particular risk factors and respond to these risk factors in a specific way. Anson (2000) provides a very critical view on classification of assets. "In most cases, alternative assets are a subset of an existing asset class. This may run contrary to the popular view that alternative assets are separate asset classes.[1] However, we take the view, that what many consider separate "classes", are really just different investment strategies within an existing asset class." He suggests a classification in three *super* classes: (i) Capital assets: claims on the future cash flows of an enterprise. Anson (2000) takes the Modigliani-Miller theorem into account and classifies hedge funds, private equity funds, and credit derivatives as capital assets. (ii) Assets that can be used as economics inputs: physical commodities that are used as economic inputs to production of other assets and cannot be valued by net present value analysis. (iii) Assets that are a store of value: finished products that cannot be valued by net present value e.g. art. According to Anson (2000), real estate is not an alternative asset class but rather a fundamental one that should be contained in every diversified portfolio. As the purpose of this thesis is the comparison of the performance of various university endowment portfolios with 60/40 portfolio, every asset class different from stocks and bonds (together with cash) is considered alternative. An exception is the category 'Other', which is not sufficiently specified.

What can alternative asset classes bring to the asset allocation process? First, some alternative asset classes may open opportunities of investing in completely different assets, whose performance is driven by fundamentally different factors. For instance, commodities may be driven by some other risk factors than U.S. stocks, or respond to the same risk factors in a completely different way than U.S. stocks do. Of course, a question may arise why to invest, for instance, directly in wheat and not in an agricultural firm producing wheat? However, these two investments may distinguish substantially, as the following three examples suggest. (i) Supposing the price for wheat is rising due to poor harvest in some regions this year. If an investor invests directly in wheat (e.g. future contract on wheat), he or she is able to make a profit of the increasing wheat price. However, if the investor invests in wheat producing firm, there may not necessarily be a reason why the stock price of that firm will rise, as even this firm may produce very poor harvest. (ii) Supposing the price for wheat is rising due to the extremely high price for oil, which is one of the main cost factors in wheat production. If an investor invests directly in wheat, he or she is able to take advantage of the increasing wheat price, regardless of the high oil price. The stock price of the wheat producing company may quite easily stay the same, as the company is not expected to achieve higher profits due to the higher price for inputs. (iii) In addition to the price for wheat, the company is exposed to further factors such as internal productivity which is affected mainly by the staff know-how, management, organization structure, and technical equipment. Therefore, alternative asset classes have the potential to expose the portfolio to further factors and make it less dependent on the traditional U.S. stock risks. In quantitative terms, this should be reflected in a lower correlation coefficient.

Second, alternative asset markets may provide greater potential for exploiting active portfolio management skills. Swensen (2010) "Alternative asset pricing lacks the efficiency typical of traditional marketable securities, leading to opportunities for astute managers to add substantial value in the investment process. In fact, investors in alternative asset classes must pursue active management, since market returns do not exist in the sense of an investable passive option." Therefore, this potential and the fundamental differences mentioned in the previous point allow alternative assets to exhibit different return-risk profiles giving the portfolio new dimensions and shifting the efficient frontier. Actually, there are some firms such as BlackRocks, Red Rocks, etc., which offer ETFs or mutual fund investing in listed e.g. private equity firms. There is, however, a question whether this is the right approach how to invest in private equity. For sure, an investor can overcome the liquidity problem in this way, but he or she takes actually a direct exposure to the U.S. stock risk. In fact, the U.S. stock market could be divided into groups of firms focusing on real estate, commodities, private equity, etc. Then the investor can decide how much capital to invest in each of those segments. This is however not target-aiming to the central question of this thesis and rather answers the question how to allocate across the U.S stock market and not across all asset classes.

Alternative asset classes can differentiate from the conventional asset classes not only in common characteristics such as average return, standard deviation, and correlation, but also in further aspects, such as reliability of the data and relative management cost of investing. Unlike marketable equities and fixed income, whose quantitative characteristics were observed for several decades, alternative asset classes often lack sufficient data, making even the conventional evaluation of characteristics such as average return and standard deviation very difficult. Therefore, one significant risk arises already by the data input. When the input data lack the necessary validity, then decisions are not done under risk but rather under uncertainty. Leibowitz et al. (2010) address these concerns and call them dragon risk. According to Leibowitz et al. (2010), dragon risks may arise from a number of concern about alternative asset classes: (i) The mean-variance model may be misspecified. (ii) The risk of asymmetries and fat tails. (iii) The wider range of performance outcomes for less-efficient assets that depend more on a manager's skill. (iv) Potential material shifts away from historical results as a novel asset class becomes more fashionable and finds itself in a more crowded space. (v) The greater headline and embarrassment risks. (vi) The possibility of singular sour outcomes that may not be widely shared among peer institutions.

The fact that some alternative asset classes lack enough information about the return and standard deviation might substantially influence the decision-making process and the final asset allocation. In fact, the lack of information about alternative asset classes together with lack of opportunity for passive investments might be an explanation why first the large endowments began to allocate capital to the alternative asset classes. The large endowments simply had the necessary size, which enabled economies of scale in the case of 'knowledge-based' investing in alternative assets.

Goetzmann and Dhar (2005) asked institutional investors about how long-term, expected return on the real estate component in their portfolio compares with the long-term expected return on the equity, fixed income, hedge funds, private equity/venture capital and emerging markets. While the most surveyed investors were able to rank the expected return for real estate relative to equity and fixed income, almost 40% of the surveyed investors were not able to rank the return on real estate relative to the return on hedge fund, approximately 28% of the surveyed investors were not able to rank it in relation to the return on private equity/venture capital and about 30% of the surveyed investors were not able to rank it in relation to the return on emerging markets. In contrast only 12% of the investors could not rank the return on real estate in relation to the traditional asset classes (equity and fixed income). The findings are similar for relative ranking of the risk of real estate. Obviously, the awareness of the properties of the alternative asset classes was low among institutional investors at the time of the survey[20].

Even if the conventional quantitative characteristics such as average return and volatility were available in sufficient quality, these measures would not necessarily capture the real nature of the alternative assets. In case of marketable equities and fixed income, it is usually assumed that the

[20] The survey was conducted in late 2004.

returns are normally distributed[21]. Accordingly, measures such as average return, standard deviation, and covariance and correlation matrix are sufficient for an optimization according to Markowitz's Modern Portfolio Theory. In case of alternative asset classes, it is necessary to examine whether these measures sufficiently capture the real nature of these assets or whether further measures (higher moments of distribution) such as skewness and kurtosis are necessary.

Further features that distinguish alternative asset classes from the traditional ones are the relative management costs of investing in the particular asset class. Investments in marketable equities or fixed income require 'little knowledge'. This is also due to the existence of benchmarks, which enable passive portfolio management, relative large number of historical observations and dense coverage by financial analysts. Therefore, a passive portfolio manager, who foregoes market timing and security picking strategies, is able to invest simply in that asset class according to his or her requirements and risk attitude without extensive knowledge. In contrast, investing in alternative asset classes whose quantitative characteristics are very uncertain, asks for a sophisticated manager who understands the features of the particular asset class and possesses skills for reasonable active portfolio management.

2.4.b. Real Estate

Real estate is the alternative asset class with the second largest allocation among university endowments, on average. What are the characteristics of real estate and why should investors include real estate in their portfolios?

Swensen (2000) suggests that real estate is an asset class that spans between fixed income and equity: "The fixed nature of cash flows from a lease obligation resembles a coupon payment stream from a bond. The more fully leased the property and the longer the term of the leases are, the more bond-like a real estate property becomes. In contrast, the variable nature of the residual value of a property gives real estate holdings equity-like attributes. Short-term leases and high vacancy rates contribute to equity risk in real estate positions".

Table 4 Panel A shows that according to my calculation the average return on NCREIF was 8.7% and the volatility 4.54% over the period from 1978 to 2010. These results basically support the Swensen's hypothesis. Leibowitz et al. (2010) report an average return on real estate of 5.5% and risk of 12%. (Table 4 Panel C). From Table 5 it is obvious that real estate is not correlated with U.S. stocks. The

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[21] This may not necessarily be correct - I found negative skewness of the returns on S&P500, but this skewness is low compared to that of alternative asset classes.

correlation coefficient based on date from 1978 to 2010 is approximately zero. Similar results are provided by Swensen (2000) and Leibowitz et al. (2010). Table 5 shows also that real estate is not or very weakly correlated with all other asset classes and thereby provides great diversification potential when regarding not only U.S. stocks, but all other asset classes. Similarly, the structural beta (Table 4 Panel B) is approximately zero. It results in minor beta excess return and substantial structural alpha of 2.59%. According to Table 4 Panel B, the distribution of the returns is negatively skewed and has fat tails suggesting higher frequency of very low returns and extreme returns.

Table 5: Correlations – Asset Classes

	T-Bill	VC	PE	HFRI	MSCI EAFE	S&P500	NCREIF	US Bond Aggragate	SPCO
T-Bill	1.00								
VC	0.24	1.00							
PE	0.08	0.62	1.00						
HFRI	0.16	0.48	0.64	1.00					
MSCI EAFE	-0.06	0.36	0.64	0.49	1.00				
S&P500	0.10	0.44	0.71	0.54	0.85	1.00			
NCREIF	0.23	0.18	0.39	0.10	0.15	0.14	1.00		
US Bond Aggragate	0.21	-0.20	-0.20	-0.24	-0.09	-0.07	-0.15	1.00	
SPCO	0.11	0.15	0.12	0.02	0.05	0.08	0.24	0.12	1.00

This table shows the correlation coefficient among the examined asset classes. The correlations are calculated from quarterly returns over the time period from Q2 1990 to Q3 2010. The individual asset classes are represented by the same indices as in Table 4 Panel A: Venture capital: Cambridge Associates U.S. Venture Capital Index®, Private equity: Cambridge Associates U.S. Private Equity Index®, Hedge funds: Hedge Fund Research Index, International stocks: MSCI EAFE, U.S. stocks: S&P500, Real estate: NCREIF, Fixed income: Barclays Capital U.S. Aggregate Bond Index and Natural resources: Goldman Sachs Commodity Index S&P GSCI®. Emerging Markets are not included in this table, as the available data on S&P/IFCI are only from 1995.

The results above show that real estate has many similarities to fixed income - similar average return, low volatility and almost no correlation with U.S. stocks, suggesting that real estate may substitute the fixed income in the portfolio. However, real estate provides something different than fixed income. Even though the correlation coefficient of real estate to equity is almost the same as the correlation coefficient of fixed income to equity, real estate moves differently. Table 5 shows that the correlation coefficient between real estate and fixed income is slightly negative, namely -0.15. As a result, fixed income and real estate are able to diversify not only U.S. stocks (and remaining asset classes) but also each other. Therefore, splitting the allocation between these two asset classes is likely to provide more diversification benefits than allocating capital to merely one of them.

The behavior of real estate during crises is a little bit puzzling. Figure 4 Panel D shows a curved quadratic regression line suggesting increasing sensitivity to U.S. movements during stressed times on the U.S. stocks markets. However, the R-squared of the regression line is only about 15%. Table 4

Panel A shows that the structural beta and correlation coefficient did not increase during the Dot-com crisis. However, both structural beta and correlation more than doubled during the financial crisis. This is in line with the broad consensus among economists that the recent financial crisis is directly related to real estate markets. Therefore, real estate may or may not undergo correlation tightening when stock prices are falling. It probably depends on the real trigger of or reason for the crisis.

Furthermore, Swensen (2000) states that real estate provides (at least partial) protection against unexpected inflation. This is 'exactly' the opposite of fixed income, which provides protection against unexpected deflation. This inflation-protective feature makes real estate even more different from fixed income. Therefore, including both real estate and fixed income not only provides the desired diversification effect, but also protection against unexpected price movements.

Further characteristics, which distinguish real estate from fixed income, are substantial opportunities for active management and absence of an 'investable' benchmark. Investing in real estate requires active management per se. However, compared to the marketable equity market and fixed income market, the market for real estate seems not to be as efficient. It can be assumed that above all the largest endowments allocate considerable amount of capital to real estate, as they possess the skills to generate risk-adjusted return on this asset class.

How do investors think of real estate? Using web questionnaire, Goetzmann and Dhar (2005) surveyed the institutional investor views about real estate and factors that affect an institution's allocation to real estate. According to their findings, the surveyed institutional investors mentioned diversification and hedging against inflation as the top reasons for investing in real estate. It is consistent with the quantitative characteristics of real estate and with the explanation provided by Swensen (2000). Furthermore, the surveyed investors stated liquidity risk, lack of reliable data and the risk of making a poor investment as the most crucial risks of real estate. This finding is also consistent with the characteristics mentioned above. The investors also stated that statistical estimates of risk and return, long-term historical performance and relative skill of external manager are the most important elements that influence the investors' real estate asset allocation decision.

In summary, the real estate as an asset class resembles fixed income with regard to many features, especially to the diversification potential. What distinguishes real estate from fixed income is the lack of 'investable' benchmark, not a clear behavior during crises, greater opportunities for active management, lack of reliable data and different reaction to inflation. Therefore, the basic role of real estate in a portfolio is likely to be diversification and 'easily' exploitable potential for the active management.

2.4.c. *Private Equity/Venture Capital*

Table 4 Panel A shows that the average return on venture capital and private equity lies - with 14.45% and 12.89% respectively - higher than return on any other asset class. At the same time, the risk of venture capital is 21.54% and the risk of private equity 9.67%. Leibowitz et al. (2010) report lower returns and higher volatilities, but the position of these two asset classes remains the same, in relation to other asset classes. Due to the high returns, venture capital and private equity may seem to be the appropriate drivers of portfolio return. However, it is necessary to take a closer look at these asset classes before making any decision, as there are several aspects which have to be taken into account.

First of all, it is necessary to realize which assets are hidden behind the terms private equity and venture capital. Private equity and venture capital usually include funds specialized in leveraged buyout, venture capital, mezzanine capital, distressed capital, and growth capital. In fact, each of these investments is an investment in an equity (or equity-like security). Therefore, these asset classes should be exposed basically to the same fundamental risk factors as marketable equities. For instance, why should a non-listed company producing and selling beverages be less or more successful than a listed company in the same market segment? In fact, both companies are operating on the same market and selling the same products to the same customers. Therefore, their financial result should be affected by the same factors. As a result, venture capital and private equity asset should provide little space for diversification. According to Table 4 Panel A, the correlation coefficient between venture capital and S&P500 is 0.43 and the correlation coefficient between private equity and S&P500 is 0.70. Both asset classes are positively but not completely correlated with S&P500. Obviously, private equity and venture capital are at least partially exposed to different risk factors.

Anson (2000) mentions a number of attributes, which distinguish venture capital and private equity from marketable stocks. Venture capital is especially exposed to business risk of a start-up company – a risk of failure of the business plan. Generally all private equity and venture capital funds are exposed to the liquidity risk. While marketable equities are traded on the very liquid organized markets, where investors can buy or sell the securities mostly without significant price effect and without having to accept negative effects from prompt buying and selling, the markets for private equity and venture capital funds are not that liquid. Moreover, according to Swensen (2000), the illiquidity of these asset classes distorts the measured quantitative characteristics of private equity and venture capital and masks the relationship between the fundamental risk factors and performance: "[…] the less volatile private entity boasts superior risk characteristics, based solely on mismeasurement of the company's true underlying volatility. Not only does lack of valuation information reduce reported risk levels, the private company gains spurious diversifying characteristics based solely on lack of co-movement with the more frequently valued public company". Further possible 'risk factor' driving the returns of venture capital is the lack of diversification. In case of leveraged buyouts, Anson (2000) suggests that leverage buyout funds are less risky than venture capital, as buyout targets lack the risk of start-up businesses and as buyout funds are less specialized allowing higher diversification. Mezzanine debt funds are expected to perform between stocks and bonds, because of their claims character. Distressed debt funds are, in fact, very equity-like investments. Substantial risk factor is bankruptcy risk. However, Anson suggests that distressed debt funds are less risky than venture capital funds as the distressed companies usually have established products and operating history and the poor standing may be caused only by poor cash management, bad business plan, or bad management – problems that can be 'easily' removed.

Similarly to hedge funds and real estate, returns on private equity and venture capital investments are not normally distributed. Anson (2000) analyses the returns on venture capital, LBO, mezzanine debt, and distressed debt funds over the period from 1990 to 2000. He finds an extremely high kurtosis of 27.16 and a high positive skewness of 4.28 of the distribution of returns on venture capital. Although this result is likely to be 'biased' by the wild development of dot-com bubble, the character of the distribution seems to correspond with the nature of venture capital investments. Levered buyout funds have also positively skewed (1.55) distribution of returns and fat tails with kurtosis of 3.38. Anson reports similar result by mezzanine debt funds – skewness 1.25 and kurtosis 3.35. Exceptions are distressed debt funds, which exhibit negative skewness -0.73 and fat tails 5.63. In summary, according to this research most of the fund groups offer potential of generating higher returns (positive skewness) and higher frequency of outlying returns. My calculations based on the quarterly returns from 1990 to 2010 provide similar result in the case of venture capital – skewness 3.17, kurtosis 18.29 (Table 4 Panel B). In contrast, the distribution of returns on private equity seems to have negative skewness, which resembles the skewness of distribution of returns on S&P500. With regard to these two moments, venture capital seems to offer an expectation of higher frequency of very high returns. Due to the different results by private equity it is difficult to make any expectation, but the distribution seems to be not much worse than that of returns on S&P500.

Regarding the correlation to other asset classes, Table 5 shows that venture capital and private equity are positively correlated to each other, to hedge funds, weakly to real estate and marginally to commodities. A 'beta-based' analysis[22] reveals a structural beta of 0.68 in the case of venture capital and 0.44 in the case of private equity over the period from 1990 to 2010 (see Table 4 Panel B). As a

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[22] 'beta-based' analysis refers to the analysis of the individual return and risk components, which is basically based on the calculation of the structural beta.

result a big part of the total return is not generated by beta exposure: structural alpha accounts for 10.67% in the case of venture capital and 7.78% in the case of private equity. Leibowitz et al. (2010) report structural alpha of 7.37% for venture capital and 3.14% for private equity.

According to the quadratic regression line in Figure 4 Panel E, venture capital does not seem to exhibit increased sensitivity to very bad returns on S&P500. In contrast, the downward sloped regression line in Panel F of the same figure indicates increased sensitivity of private equity. Table 4 Panel A reveals that correlation coefficient of venture capital increased approximately two times during the financial crisis. In case of private equity, correlation coefficient increased during both crises. Therefore, venture capital and private equity seem to be exposed to some correlation tightening when U.S. stocks perform badly.

As in case of real estate, no passive investment exists for private equity and venture capital. Therefore, investing in private equity and venture capital require active management per se. This may be both an opportunity and a danger. If we take into account that the most successful funds may be closed for new investor and that the reported results are subject to survivorship bias and selection bias, the chance of an investor to find a fund that will generate at least the reported average return may drop considerably.

In summary, venture capital and private equity provide high return and high volatility. At the same time, their diversification potential is quite limited, because they are fundamentally similar to equity and correlate positively with some other asset classes and exhibit correlation tightening during U.S. stock crises. Lack of 'investable' benchmark makes active management necessary. Moreover, the available data do not necessarily describe the true nature of this asset class – survivorship bias, selection bias[23], low frequency of data. As a result, the role of these two asset classes in a portfolio is increasing the expected return together with providing potential for active management.

2.4.d. Hedge Funds

Hedge funds are the alternative asset class with the highest increase in allocation among university endowments over the last twenty years. Why have the hedge funds become that attractive among endowments? As Table 4 Panel A shows, the average return on hedge funds was relatively high (11.70%), while the risk was relatively low (7.02%). The average return was higher than the average

[23] For instance, Cochrane (2005) deals with the mean, standard deviation, alpha, and beta of venture capital and corrects these measures for selection bias. Accordingly, his paper 'The Risk and Return of Venture Capital' J.H. Cochrance (2004) provides insight into the consequences of selection bias.

return on U.S. stocks, and the risk was between the risk of U.S. bonds and U.S. stocks. These parameters are clearly reflected in the high Sharpe ratio of 0.93, which is the second highest one (Table 4 Panel B). Swensen (2000) reports similar results, placing hedge funds (absolute return) above U.S. stocks, with respect to the average return[24] 17.6%[25] and between U.S. stocks and U.S. bonds, according to standard deviation (11.8%) (Table 4 Panel D). However, Leibowitz at al. (2010) report much smaller average return, namely 5.25% average return on absolute return investments and 5.75% on equity hedge investments with volatility of 9.25% and 12.75%, respectively (Table 4 Panel C). The differences in the reported results arise probably from different time period and investment vehicles coverage.

Regarding the correlation, hedge funds seem to be positively correlated with U.S. stocks. While my results suggest a correlation coefficient of 0.54, Swensen (2000) reports 0.28 and Leibowitz et al. (2010) mention a correlation coefficient of 0.5 in the case of absolute return and 0.85 in the case of equity hedge. The correlation with other asset classes seems to be lower, with exception of venture capital and private equity (Table 5). The 'beta-based' analysis shows a low structural beta of 0.29 which leads to a low beta excess return of 1.69% and low beta sigma 4.82% (see Table 4 Panel B). As in case of correlation, Leibowitz et al. (2010) provide substantially higher values of structural beta. Correspondingly, the structural alphas are different as well. My calculation supplies a structural alpha of 6.47% - similar to other alternative asset classes -, while Leibowitz et al. (2010) report much lower values (Table 4 Panel C).

During crises, hedge funds seem to be exposed to correlation tightening. The regression line in Figure 4 Panel G is sloped downward at the left side with high R-squared. The structural beta remained the same during both crises, but correlation increased a little bit from 0.73 to approximately 0.80.

As in case of other alternative asset classes, a closer look reaching behind the common quantitative characteristics has to be made. The need of closer examining is stressed by the fact that only short time series of data on hedge funds as an asset class is available, making the quantitative characteristics less reliable and shifting the decision-making process from decision under risk to decision under uncertainty.

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[24] The data in Swensen (2000) are inflation adjusted.

[25] The average return reported in Swensen (2000) is calculated from the data of Yale Absolute Return Portfolio (1982-1997). Therefore, the average return differs in absolute values from my results.

First of all, it is necessary to realize that asset class 'hedge funds' comprises a number of different strategies. Brooks and Kat (2001) divide the hedge funds strategies into four main groups, namely (i) global strategies, focusing on economic changes worldwide, (ii) event-driven strategies aiming at distressed companies and company mergers, (iii) market-neutral strategies trying to exploit market opportunities by entering long and short positions, and (iv) funds of funds – hedge funds investing in other hedge funds. Therefore, hedge funds are very heterogeneous asset class and one hedge fund may be exposed to completely other risks than other hedge funds.

The evaluation of hedge funds is complicated not only due to the lack of sufficiently long time series of data but also to the fact that the conventional quantitative parameters, namely mean return and standard deviation, fail to describe the hedge fund characteristics in a proper way. Anson (2000) analyzes the data on hedge funds over the period from January 1990 to June 2000 and finds that there are three groups of hedge funds: (i) hedge funds that exhibit market risk (e.g. global macro, short selling, and equity long/short hedge funds), thereby resemble to U.S stocks. (ii) Hedge funds that exhibit credit risk especially convertible arbitrage, event driven, merger arbitrage, and relative value arbitrage strategies exhibit negative skewness and high kurtosis. He comments this finding as follows: "The investment strategies of these funds involve taking only a little market exposure – hence their label as arbitrage funds. However, these hedge funds magnify that exposure through credit risk. Additionally, these funds are exposed to event risk: the risk that one part of their arbitrage strategy will not perform as expected. Their exposure to event risk should be demonstrated with a large, downside tail in their return distribution. In other words, they should exhibit distributions with a large value of kurtosis and a negative skew." This finding is basically confirmed by Brooks and Kat (2001): "Especially Convertible Arbitrage, Risk Arbitrage, Distressed Securities and Emerging Markets exhibit not only negative skewness but also large excess kurtosis. This means that for these indices, large negative returns are much more likely than would be the case under a normal distribution. […] As is evidence by their Bera-Jarque (1987) normality test statistics, it seems safe to conclude that most hedge fund index returns are not normally distributed." (iii) Hedge funds that have low market and credit risk e.g. market neutral funds and market timing funds. My analysis of the overall HFRI index shows negatively skewed distribution (-0.92) and high kurtosis of 3.09 (Table 4 Panel B). Therefore, on the whole an investor should expect higher frequency of very low and extreme returns.

This has significant impact on the validity of the information contained in the Sharpe ratio. My calculation supplies a Sharpe ratio of 0.93 – the second highest among all asset classes (see Table 4 Panel B). Brooks and Kat (2001) note following "Hedge funds offer relatively high means and low variances, but they also tend to give investors the third and fourth moment attributes that are exactly opposite of those that investors desire. This means that the Sharpe Ratio will systematically overstate the true hedge fund performance relative to that of the standard market indices. […] High Sharpe

Ratios tend to go together with negative skewness and high kurtosis. This means that the relatively high mean and low standard deviation offered by hedge fund indices is no free lunch. Investors simply pay for a more attractive Sharpe Ratio in the form of more negative skewness and higher kurtosis. A recent study by Amin and Kat (2001a) shows that when the whole return distribution is taken into account, there is little or no evidence of superior performance in hedge fund index returns."

Regarding the correlation of hedge fund indices with equity and bond indices, Brooks and Kat (2001) find that the most examined hedge fund indices are negatively and weakly correlated to US bonds, confirming the results of my calculations. In contrast, according to Brooks and Kat (2001) most hedge fund indices exhibit a relatively high and positive correlation to equity indices, especially with Russell 2000 (HFR aggregate 0.9) and NASDAQ (HFR aggregate 0.85), suggesting that hedge funds strongly invested in small and technology companies.

This finding also has a significant implication on the common perception of hedge funds. Usually the hedge funds are not expected to be correlated to the market and to accept 'only' unsystematic' risk. It is the usual explanation why hedge funds should record low correlation to other asset classes, although hedge funds invest in the instruments and securities contained in the remaining asset classes. The systematic risk representing the risk of an asset class is simply cancelled by long and short position so that only idiosyncratic risk, which is expected to be uncorrelated to the systematic risk, remains. However, Brooks and Kat (2001) show that most hedge fund indices bear a lot of the conventional equity market risk, as they are positively correlated with equity markets. Moreover, they calculate the correlation between the hedge fund indices covering particular strategies and show that except for market neutral strategies the hedge fund indices are positively correlated to each other – correlation coefficient mostly higher than 0.5. This result can be interpreted in the way that the different hedge fund strategies still possess common systematic risk. Therefore, the potential for diversification is limited, though still present.

As it is a case of other alternative asset classes, hedge funds lack an investible benchmark, and thereby an active management is necessary. In fact, hedge funds aim per se at exploiting active management skills. Therefore, a selection of a hedge fund may equal to a selection of an active investment strategy pursued by the hedge fund managers. On the other hand, there are the so called funds of funds, which may cover a number of other funds and thereby provide some diversification within the asset class. However, the disadvantages of these investments are multiple management fees. Fung et al. (2006) examine the performance, risk, and capital flow of funds-of-funds and report that there are significant differences in ability to generate alpha return in the cross-section of funds of funds. Moreover, they report that the alpha generating funds-of-funds experience larger and steadier inflows of capital, which adversely affects the alpha-generating ability of those funds. Consequently, not only the fact that a number of top performing hedge funds are closed for new investors, but also the adverse effect of capital inflow on the alpha makes the active selecting of hedge funds more difficult for university endowment.

In summary, some researches provide attractive results, while other not. Hedge funds are able to provide some diversification potential, but are exposed to U.S. stock risk and correlation tightening. Brooks and Kat (2001) show that mean-variance model does not capture the true nature of this asset class and that further measures such as skewness and kurtosis are necessary. Despite this, hedge fund may play a meaningful role in an endowment portfolio. Especially the combination of hedge funds strategies from all three groups mentioned above can create the desired return distribution. However, especially the active selection skills will be the key to successful investment in hedge funds. Therefore, the role of the hedge funds in portfolio will mainly depend on the selected individual funds.

2.4.e. Commodities (Natural Resources)

Although the average allocation to commodities[26] is 2.2% among university endowments, commodities report one of the highest increase compared to allocation to other classes during the last 20 years. What are the characteristics of this alternative asset class? As Table 4 Panel A shows, commodities (represented by Goldman Sachs Commodity Index S&P GSCI®) generated high average yearly return of 11.59%. The volatility accounted for approximately 20%. Leibowitz et al. (2010) report much lower average return, but the same level of volatility (Table 4 Panel C). Therefore, a superficial look at these two quantitative characteristics suggests that commodities are very risky asset class, but their average return is uncertain. Commodities are very heterogeneous group of assets, which may be divided into sub-classes such as agricultural products, energy (oil and gas), metals, and meat & livestock. This classification already suggests that the prices of the particular commodities may be driven by completely different forces. Kat and Oomen (2007b) examine whether the commodity futures are mutually correlated. They suggest that common macroeconomic shocks, complementary relationship among various commodities and herd behavior might be the reasons for co-movements in commodity prices. Kat and Oomen (2007b) show that the correlations among commodities in different sub-classes (e.g. between meat/livestock and energy) are small and mostly

[26] The NACUBO Endowment Study considers allocation to natural resources. I use commodities as a proxy for this asset class.

insignificant[27]. In contrast, the correlations within the sub-classes are high. This result suggests that there is more potential for diversification across the commodity sub-classes rather than within a sub-class.

Further important question is how do commodities correlate with other asset classes? Anson (2000) mentions three arguments why commodity prices should be negatively correlated with prices of U.S. stocks and fixed income: "First, the inflation has a positive effect on commodity prices but a negative impact on stocks and bonds. Second, commodity prices are impacted by a different set of expectations than that for stocks and bonds. Last, in the production process there is a tradeoff between the returns to capital and the returns to raw materials." Kat and Oomen (2007b) mention the same arguments and add that commodities tend to react positively to event shock. They mention an example of decrease in oil production leading to higher oil prices but lower stock prices. They find that overall the prices of commodity futures are not correlated to prices of stocks and bonds. My results comprised in Table 5 show that commodities do not correlate with other asset classes as well. The correlation coefficients between commodities and other asset classes are almost zero in most cases. Leibowitz et al. (2010) report even slightly negative correlation to U.S. stocks (-0.25). An exception is the correlation coefficient between real estate and commodities - commodities seem to be slightly positively correlated with real estate 0.24.

Beta-analysis shows that commodities have a structural beta of 0.13 and structural alpha of 2.34% (Table 4 Panel B). Regarding the behavior of commodities during crises, a unique statement cannot be made. Although Figure 4 Panel H shows a negative curved trend line, the R-squared is very small. The stressed structural betas stated in Table 4 Panel A shows that the relationship between commodities and U.S. stocks changed during both recent crises. In the dot-com crash, the structural beta and correlation coefficient took even more negative values. During the recent financial crises, the structural beta rose from -0.11 to 0.41 and the correlation coefficient from -0.08 to 0.23 (Table 4 Panel A). In other words, the diversification potential of commodities increased during the Dot-com crisis, but decreased during the financial crises. Kat and Oomen (2007b) show that the correlation of the particular commodities, especially energy and metals, with equity and bonds, may change in dependence on the phase of business cycle, monetary regime and volatility of commodities, bonds and stocks. For instance, the correlation of metals with equity increases by 8% during start of recession and

[27] They based the calculation on daily future returns, but the results for monthly returns reveal mostly the same pattern.

decreases by approximately 15% during the end of expansion[28]. At the same time, the correlation increases by approximately 6% when the volatility of commodity prices is high, and decreases when the volatility is low. In contrast, quite reverse pattern was observed by energy commodities.

Regarding the returns, Kat and Oomen (2007a) show that except for energy commodities do not generate any significant risk premium. The exception of energy, which generates high risk premium, causes that commodity indices with large share of energy evoke that commodities as a whole provide risk premium[29]. As in case of correlation, the return of some commodities tends to be different in different monetary and inflationary environments and during different phases of business cycle.

Furthermore, Kat and Oomen (2007a) show that the skewness in the commodity returns is minimal and insignificant and the kurtosis excessive, but not very different from U.S. large stocks. Anson (2000) looks at the return distribution of The Goldman Sachs Commodity Index® over the period from 1990 to 2000 and finds positive skewness of 0.82, suggesting upside potential, and large positive kurtosis of 2.31. This leptokurtosis would mean higher frequency of outlier returns suggesting that commodities are exposed to shocks of the global demand and supply of commodities. My calculations indicate only fat tails but not skewness (see Table 4 Panel B).

There is an important distinction between commodities and other alternative asset classes. In the case of commodities, it is possible to apply ‘passive’ investment strategy. There are a number of ETFs covering both broad commodity market and individual subsections, e.g. agricultural products. Therefore, investors are able to achieve diversification across the commodity market easily and bear ‘only’ the systematic risk of commodities. As a consequence, the need for additional skills and active management is significantly lower.

In summary, commodities are a very heterogeneous asset class, that exhibit high volatility. They provide a substantial diversification potential, but the changes in their behavior with respect to U.S. equities do not follow a unique pattern and depend on the type of the commodity. The distribution of commodities’ return seems to be not skewed but has fat tails. Consequently, commodities may be included in a portfolio in order to diversify and achieve higher returns. An advantage of commodities is the possibility to invest in commodity ETFs. This makes investing in commodities more open for broad range of investors.

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[28] Kat and Oomen (2007b) use Pearson’s linear correlation. Stocks are represented by DJIA

[29] Goldman Sachs Commodity Index S&P GSCI® consists almost 80% of energy.

3. Portfolio Analysis

3.1. General

In the previous section, I described the main asset classes, identified the main characteristics and 'determined' the possible role of each asset class in a portfolio. In this section, I am going to create a number of portfolios using the asset classes described in the previous section and to simulate the portfolio performance of these portfolios over the time period from Q2 1990 to Q2 2010. As it was mentioned above, the portfolio construction is usually affected by a number of factors such as volatility of the non-endowment revenue, relative importance of the endowment revenue for the university, etc. Therefore, even among university endowments, the portfolios may pursue various goals depending on the associated university. As stated at the beginning of this thesis, the main point is to examine whether alternative asset classes are beneficial for portfolio construction and lead to a better return-risk profile. Therefore, the central point is the portfolio return from asset allocation and the corresponding risk. It is important to stress that this return component may contain the structural alpha. Therefore, the potential for generating structural alpha has to be taken into account in the course of asset allocation decisions. In contrast, the potential for generating active alpha may not necessarily be affected by asset allocation policy. Leibowitz et al. (2010) distinguish between active portable alphas and bound-active alphas. Active portable alphas are theoretically independent of the asset allocation policy. If the entire asset class can be shorted and there is no need for a cash reserve, the portable alphas may be simply added at the top of the portfolio, without any exposure to the asset class. In contrast the bound-active alphas depend on the exposure to the particular asset class. Leibowitz et al. (2010): "There are various asset classes that are not fully hedgeable and the pursuit of the active incremental return is intimately bound to having some allocation weight assigned to the underlying asset class. One example of such a bound-alpha might be a university endowment that believes it has the network to better access and evaluates high-tech venture capital opportunities, thereby garnering an excess active return of about 2 percent (even though that incremental return would carry with it a high 10 percent level of added volatility risk). However, if there is no way to shorten the venture capital as an asset class, this active alpha could not be pursued without having a direct exposure in the venture capital."

3.2. Portfolios

The asset allocations of the portfolios I analyze are defined in Table 6. The portfolios are listed in the first column. The following columns denote the allocation to the particular asset classes in per cent and the total allocation to all alternative asset classes is summed up in the last column (see the notes below Table 6). The basic portfolio is the conventional 60/40 portfolio. This portfolio represents not only a conventional asset allocation policy, which was also mainly applied by endowments approximately 20 years ago, but also an allocation policy, which does not require any special knowledge and skills. As the 60/40 portfolio consists of the two most liquid asset classes with 'investable' benchmark, such portfolio can easily by managed by any investor.

Table 6: Asset Allocation - Portfolios

(Values in %)	Equity	Fixed Income	Real Estate	Cash	Hedge Funds	Private Equity	Venture Capital	Natural Res.	Other	Altern. assets
60/40	60.0	40.0								0
Large Uni	39.40	10.80	6.40	1.40	22.60	10.00	3.60	5.30	0.50	47.90
Average Uni	51.90	19.20	4.10	3.90	12.90	3.30	1.00	2.20	1.50	23.50
Small Uni	55.90	27.10	2.20	8.10	3.30	0.60	0.30	0.40	2.10	6.80
Markowitz (ex post)	-2.04	57.26	19.40	0.00	17.35	9.42	0.42	-1.81	0.00	44.78
Harvard	Domestic Equities	Foreign Equities	Emerging markets	Private Equity	Hedge Funds	Natural Res.	Real Estate	Bonds	Cash	Altern. assets
	11.0	11.0	11.0	13.0	16.0	14.0	9.0	13.0	2.0	63.0
Yale	Absolute Return	Domestic Equity	Fixed Income	Foreign Equity	Private Equity	Real Estate	Cash	Altern. assets		
	21.0	7.0	4.0	9.9	30.3	27.5	0.4	88.7		

This table shows the asset allocation of seven portfolios in per cent. The basis portfolio is the 60/40 portfolio in the first row. Large Uni, Average Uni, and Small Uni refer to the asset allocation of the biggest endowments (over 1billion USD), average asset allocation of all endowments and asset allocation of the smallest endowments (less than 25 million USD), respectively, which are covered in the NACUBO Endowment Study 2008. Markowitz (ex post) is the optimized Markowitz tangency portfolio, based on the real data over the simulated period. Harvard and Yale portfolios correspond to the asset allocation of these two endowments in 2010. The particular columns denote the allocation to the relevant asset class (stated in the first row). The last column of each portfolio summarizes the total percental allocation to all alternative asset classes. In case of the first four portfolios the last column is the sum of allocation to real estate, hedge funds, private equity, venture capital, and natural resources. In case of Harvard portfolio, the last column is the sum of emerging markets, private equity, hedge funds, natural resources, and real estate. In case of Yale portfolio the alternative assets correspond to the sum of absolute return, private equity, and real estate. Source: NACUBO Endowment Study 2008, Annual Report Harvard Management Company 2010, and The Yale Endowment Report 2010.

Harvard and Yale portfolios represent very alternative asset allocation policies. Both university endowments are pioneers in the alternative asset allocation policies Harvard invested 63% in alternative assets and Yale almost 79% (see table 6) (Appendix A). At the same time, both universities achieved great success. It is important to mention that these university endowments try to exploit the alternative asset classes' potential for a successful active management. Yale Endowment report 2010: "The heavy allocation to non-traditional asset classes stems from their return potential and diversifying power. […] Alternative assets, by their very nature, tend to be less efficiently priced than traditional marketable securities, providing an opportunity to exploit market inefficiencies through active management. The Endowment's long time horizon is well suited to exploiting illiquid, less efficient markets such as venture capital, leveraged buyouts, oil and gas, timber, and real estate." Similar statement is in the Endowment Report from Harvard Management Company 2010: "Most importantly, we strive to add value relative to the Policy Portfolio which is specifically constructed to generate strong, long-term risk-adjusted returns."

Further three portfolios (Large Uni, Small Uni, and Average Uni) represent average asset allocation of university endowments covered by NACUBO endowment study in fiscal year 2008. Large Uni corresponds to endowments with more than $1 billion assets under management, which invests approximately 48% in alternative asset classes, Small Uni to endowments with less than $25 million asset under management with about 7% in alternative assets and Average Uni represents average allocation of all endowments covered by the study. All average allocations are equally weighted. Therefore, the average captures the applied asset allocation policy of individual endowments without being biased by the asset under management.

Furthermore, I applied the concept of the Modern Portfolio Theory by Markowitz and calculated the optimal asset allocation. However, there are important differences between the Modern Portfolio Theory by Markowitz and the way how I calculated the optimal asset allocation. I used the arithmetic average, standard deviation, and variance-covariance matrix of the returns from Q2 1990 to Q3 2010 in order to calculate the optimal asset allocation for that time period ex post. In other words, this asset allocation would have been the optimal one at the beginning of the fiscal year 1990 if the investor had known the characteristics of the asset classes over the period from 1990 to 2010. The ex-post Markowitz portfolio in this thesis is a theoretical tangency portfolio at the efficient frontier. Accordingly, I name this portfolio theoretical ex-post Markowitz portfolio. The optimization is based on the quarterly data. No restrictions on short sales or maximal allocation to particular asset classes were made. As shown in Table 6, this portfolio allocates almost the same capital to alternative assets as Large Uni does, but the allocation to individual asset classes is different.

3.2.a. Simulation - Calculation

All portfolios are rebalanced to the original asset allocation mentioned in the previous section at the beginning of every fiscal year i.e. beginning of the third quarter. The performance of the portfolios is calculated from the actual historical quarterly returns on benchmarks of the individual asset classes represented by following indices: Venture capital: Cambridge Associates U.S. Venture Capital Index®, Private equity: Cambridge Associates U.S. Private Equity Index®, Hedge funds: Hedge Fund Research Index, International stocks: MSCI EAFE, Emerging markets: S&P/IFCI, U.S. stocks: S&P500, Real estate: NCREIF, Fixed income: Barclays Capital U.S. Aggregate Bond Index and Natural resources: Goldman Sachs Commodity Index S&P GSCI®. (In the case of 'Other', I use equally weighted average of the returns on all other asset classes.) (Appendix B). The portfolio return is the weighted average of the returns on individual asset classes each quarter (see Formula 6). The time period of the simulation is from 1990 to 2010.

$$\text{Policy return} = \sum_i Wp_i * Rp_i$$

Formula 6

Wp_i= weight for asset class i

Rp_i= (passive) return on asset class i

This approach has two essential limitations compared with the reality: First, only the asset allocation from 2008 (for Uni portfolios) and 2010 (for Harvard and Yale portfolios) are applied for the whole time period from 1990 to 2010. The real development of the asset allocation strategies over the time period is not taken into account. Second, only return from asset allocation (i.e. passive return) is analyzed.

The analysis of the portfolio performance is conceptually based on the same measurements as the analysis of the individual asset classes in the chapter '2.1. Data and Methodology' and the used formulas are continuously explained in the following section.

3.2.b. Results

Table 7 shows the overall portfolio statistic of all seven portfolios. First of all, I calculated the common quantitative measures such as portfolio value at the end of the period, average return, excess return, the corresponding volatilities and Sharpe ratio. The basic 60/40 portfolio achieved an average yearly return of 8.21% with volatility of 9.67%. Of course, this result is placed between S&P500 and U.S. Aggregate Bond index. The mixture of U.S. stocks and fixed income instruments obviously provided good diversification effect and a still 'good' average return. It is important to mention that this result could be achieved by simply investing in the most liquid markets without any active portfolio management (except the rebalancing at the beginning of every fiscal year). The excess return on 60/40 portfolio is lower by 4.49% than the average excess return on stocks, but the corresponding systematic risk (beta volatility) of 60/40 portfolio is lower as well – 9.52% compared to the S&P500 volatility of 16.55%. The Sharpe ratio of the 60/40 portfolio (0.47) was the lowest one among the simulated portfolios, but still higher than the Sharpe ratio of S&P500 (0.35).

Table 7: Portfolio Characteristics

	60/40	Large Uni	Average Uni	Small Uni	Harvard	Yale	Markowitz (ex post)
% alternative assets	0	48	24	7	63	79	45
Portfolio Value	473.43	688.25	548.54	470.53	591.81	869.41	557.01
Average excess return (%)	4.49	6.36	5.23	4.43	5.61	7.49	4.89
Average total return (%)	8.21	10.08	8.96	8.16	9.33	11.22	8.61
Volatility (excess return)(%)	9.55	9.29	9.52	9.27	9.52	8.88	2.70
Volatility (total return)(%)	9.67	9.43	9.65	9.40	9.58	9.02	2.90
Sharpe ratio	0.47	0.68	0.55	0.48	0.59	0.84	1.81
Rank of the Sharpe ratio	7	3	5	6	4	2	1
Structural beta	0.58	0.54	0.58	0.56	0.48	0.41	0.07
Beta Vola. (sys. risk) (%)	9.52	8.87	9.51	9.31	7.90	6.85	1.14
Alpha Vola. (unsys. Risk) (%)	1.71	3.21	1.63	1.26	5.42	5.87	2.66
Beta sigma/total sigma (%)	98	94	99	99	82	76	39
Beta excess return (%)	3.06	2.85	3.06	3.00	2.54	2.20	0.37
Alpha return (%)	1.47	3.55	2.22	1.48	3.11	5.33	4.57
Skewness	-0.353*	-1.012***	-0.746***	-0.501**	-0.838***	0.142	-0.376*
Kurtosis	0.082	2.323***	0.977**	0.363	3.448***	4.516***	1.282***

Table summarizes the characteristics of the seven simulated portfolios. The first row indicates the total allocation to alternative assets. Portfolio value is the portfolio value at the end of the simulated period (Q2 2010) – the starting value is 100. The average excess return is the arithmetic annualized average of the excess return - return over the risk free rate. Average total return is arithmetic annualized average. Volatility of excess return and total return is the corresponding standard deviation. Rank of the Sharpe ratio indicates the relative position of each portfolio. Beta volatility (systematic risk) refers to the U.S. stocks volatility contained in each portfolio and can be calculated according to Formula 7. Alpha volatility (unsystematic risk) is the remaining volatility according to Formula 8. Beta sigma/total sigma is the proportion of the beta volatility relative to the total volatility. Beta excess return is calculated according to CAPM. Alpha return refers to structural alpha. The last two rows show the skewness and the kurtosis of the return distributions. ***,**,* denote significance at the 1 per cent, 5 per cent, and 10 per cent levels, respectively.

The three portfolios representing the three section averages among university endowments have quite different results. The portfolio Large Uni has an average exposure to alternative asset classes 48% of the total portfolio value, while the Average Uni had only 24% and the Small Uni mere 7%. Over the 80 quarters (from 1990 to 2010), the Large Uni portfolio multiplied the portfolio value almost seven times, the Average Uni more than five times and the Small Uni more than four times. Accordingly, the average returns are different as well. The average return on the Large Uni is almost 2 percentage points higher than the return on Small Uni portfolio. In contrast, the total volatility of these three portfolios does not change and is placed close to 9.50%. Due to the high excess return (6.36%) and constant correspondent volatility (9.29%), the Large Uni portfolio has the largest Sharpe ratio among these three portfolios, namely 0.68 (see Table 7).

The further two portfolios are representatives of alternative asset allocation strategies and should demonstrate how the alternative assets can affect the portfolio performance. Harvard portfolio is exposed to alternative assets by 63% and Yale portfolio even by 79%. The value of Harvard portfolio multiplied its value approximately six times and Yale portfolio more than eight times. Both portfolios have high average return of 9.33% and 11.22%, respectively. It is very interesting that both portfolios exhibit no excessive volatility. Harvard portfolio's volatility is 9.58%, which is in line with the 60/40 and the Unis portfolios, and Yale portfolio's volatility is even lower, namely 9.02%. This may suggest that the alternative asset classes enable both high returns and diversification. Especially the Sharpe ratio of Yale portfolio is very high (0.84) – the highest value except for the theoretical ex-post Markowitz portfolio.

The last portfolio is the theoretical optimal ex-post Markowitz Tangency portfolio with the exposure to alternative asset classes of 45%. The U.S. stocks and commodities are sold short. As already the title suggests, the portfolio should provide the optimal result. As mentioned above, the optimization of the theoretical ex-post Markowitz portfolio is not based on expectations but on the real data from the same period in which the performance is analyzed. Therefore, the portfolio achieve performance that is hardly achievable in the real world. In order to stress this fact, the portfolio is marked with the label "ex-post". The portfolio value increased by 419%. The average return is almost the same as that of Average Uni, but the volatility is unrivalled 2.9%. Consequently, the Sharpe ratio is in extreme value of 1.81. The results are clearly the best ones among the examined portfolios. It is important to mention that this portfolio is only a theoretical one and many university endowments would not be allowed to allocate the capital in this way, especially to take short positions. It is, however, interesting to compare the composition of the theoretical ex-post Markowitz portfolio with the Large Uni portfolio, which has approximately the same exposure to alternative assets. The greatest differences in the composition between these two portfolios are in allocation to U.S. stocks, the fixed income and real estate. Theoretical ex-post Markowitz portfolio has short position in U.S stocks of 2.04%, while the Large Uni invests almost 40% long in U.S. stocks. In the case of fixed income, the theoretical ex-post Markowitz portfolio allocates about 57% to U.S. bonds, while the Large Uni portfolio only 10.8%. The large exposure to fixed income seems to be unusual, but it can be ascribed to the fixed income performance over the examined period – high return and low risk. As mentioned above, the exposure to alternative assets is the same, but the allocation to the individual alternative asset classes is different. Therefore, it is interesting that not the total exposure to alternative asset classes but rather the allocation of capital between U.S. stocks and fixed income and among the individual alternative asset classes changes the portfolio characteristics, in this case the portfolio risk.

As Table 8 shows, the correlation coefficients S&P500 and 60/40, Large Uni, Average Uni, and Small Uni are very high – more than 0.9. The two alternative portfolios (Harvard and Yale) exhibit lower correlation with U.S. stocks, showing that Harvard and Yale portfolios are exposed to other risk factors as well. The weakest correlation is between the theoretical ex-post Markowitz portfolio and S&P500. This is quite logical, as the theoretical ex-post Markowitz portfolio exhibits very low volatility and brief look at Figure 10 shows that the theoretical ex-post Markowitz portfolio has an almost constant movement. Furthermore, the 60/40 portfolio and the three Uni portfolios are strongly correlated to each other. The Yale, Harvard and 'Large Uni' also have strong correlation to each other, but Yale and Harvard portfolios have considerably lower correlation to 60/40 and 'Small Uni' portfolios. The theoretical ex-post Markowitz portfolio has the weakest correlation to other portfolios. As a result, the following pattern can be recognized. The theoretical ex-post Markowitz portfolio is optimally diversified. Yale and 'Large Uni' portfolios resemble this optimally diversified portfolio by correlation coefficient of 0.56 and 0.54, respectively. Other portfolios correlate to the theoretical ex-post Markowitz portfolio as well, but more weakly than Yale and Large Uni.

Table 8: Correlations - Portfolios

	S&P500	60/40	Large Uni	Average Uni	Small Uni	Harvard	Yale	Markowitz (ex post)
S&P500	1.00							
60/40	0.98	1.00						
Large Uni	0.94	0.92	1.00					
Average Uni	0.99	0.98	0.98	1.00				
Small Uni	0.99	1.00	0.95	0.99	1.00			
Harvard	0.82	0.81	0.93	0.88	0.84	1.00		
Yale	0.76	0.72	0.90	0.82	0.77	0.88	1.00	
Markowitz	0.39	0.49	0.54	0.51	0.49	0.48	0.56	1.00

This table is intended to show the correlation coefficients among the examined portfolios and S&P500 index. The calculation is based on quarterly portfolio returns in the time period from Q2 1990 to Q2 2010.

In the course of 'beta-based' analysis, I use the measures suggested by Leibowitz et al. (2010), namely the systematic risk (beta volatility) and unsystematic risk (alpha volatility). The systematic risk (beta volatility) is the portion of the total volatility captured by the structural beta of the portfolio with respect to U.S. stocks (S&P500). I calculated the structural beta for every examined portfolio and then the systematic risk (beta volatility) according to the Formula 7.

Systematic risk: $$\sigma_\beta = \beta_P * \sigma_{U.S.Stocks}$$ **Formula 7**

Then the unsystematic risk (alpha volatility) can be calculated as well. The alpha volatility is the risk that is required to take the systematic risk (beta volatility) to the total risk under the assumption of no correlation between alpha component and beta component. See Formula 8.

Unsystematic risk: $$\sigma_\alpha = \sqrt{\sigma_{total}^2 - \sigma_\beta^2}$$ **Formula 8**

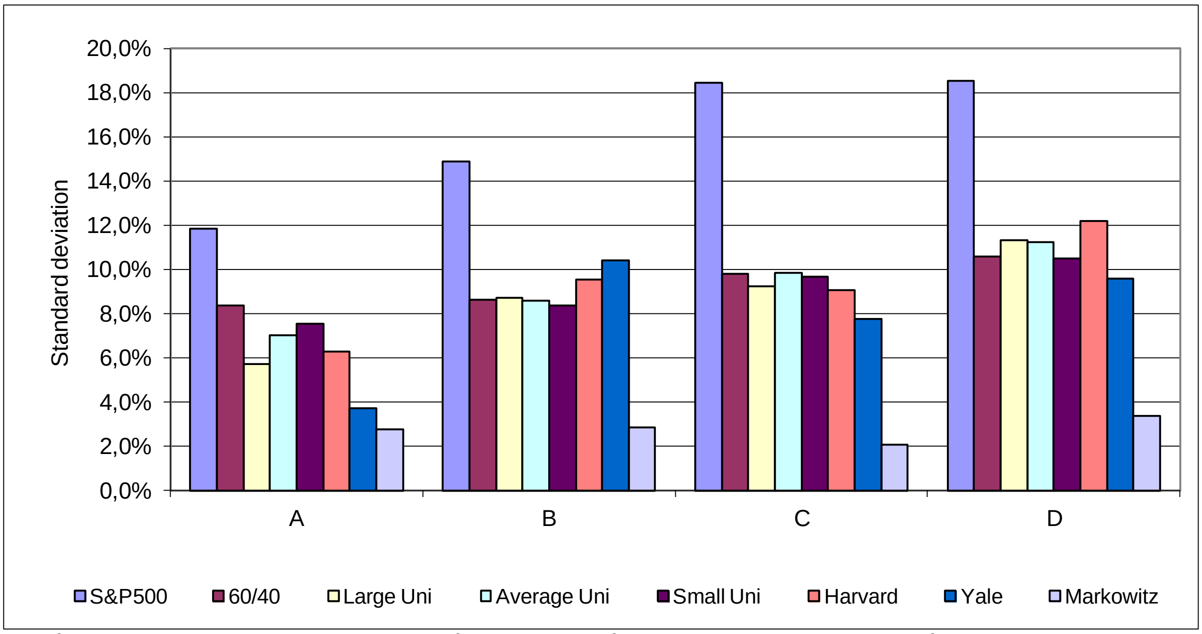
According to Table 7, the structural beta of the 60/40 portfolio is 0.58[30]. However, the further three portfolios exhibit structural betas, which are close to 0.6 as well. Therefore, the mixture of asset classes applied by the Large Uni, Average Uni and Small Uni portfolios lead to approximately the same structural beta as 60/40 portfolio and to the same exposure to systematic risk (the risk of S&P500). In other words, the investment in alternative asset classes within these portfolios does not lead to such strong diversification and lets the portfolio correlate with U.S. stocks in the same way. The three 'Unis' portfolio simply take the same S&P500 risk as 60/40 portfolio. The difference is that it happens (partially) indirectly – not through a direct investment in S&P500 but through investments in other asset classes. Harvard and Yale portfolios exhibit some structural beta as well. Their structural betas are, however, smaller than the betas of the Large, Average, and Small Uni portfolios. In contrast, the theoretical ex-post Markowitz portfolio does not seem to be exposed to systematic risk at all – its structural beta is close to zero. These results are, of course, reflected in the systematic risk (beta volatility) of the portfolios. 94-99% of the total volatility of 60/40, Large, Average, and Small Uni portfolios is made by the systematic risk. Only Harvard, Yale, and the theoretical ex-post Markowitz portfolios contain a lot of unsystematic risk. The systematic risk accounts 'only' for 82% of the total risk of Harvard portfolio and for 76% of the risk of Yale portfolio. These result are consistent with Leibowitz et al. (2010): "What follows from this notion is that beta sensitivity to equities is the parameter that captures about 90 percent or more of the volatility risk for most allocations seen in the U.S. institutional market. This single parameter is a value that lurks hidden within virtually every asset class, and that, in aggregate, accumulates to become the portfolio's overall exposure to the equity market. Once these underlying beta values are uncovered, it becomes clear that while the traditional 60/40 appears quite different from the highly diversified endowment model, they in fact share certain common risk characteristics."

When comparing the absolute value of portfolio volatility, it is obvious that except for the theoretical ex-post Markowitz portfolio, all portfolios have total volatility between 9% and 10%. Therefore, it seems that university endowments seek, on average, a common level of portfolio volatility, regardless of the composition of the portfolio. This finding is consistent with the finding in Leibowitz et al. (2010) who examined five theoretical portfolios with different asset allocation policies: "The total

[30] Actually, the structural beta of the 60/40 portfolio should be 0.6 per definition. The difference between 0.6 and 0.58 is caused, by the fact that the portfolio returns are based on quarterly returns and the rebalancing takes place only once a year. Therefore, during three quarters of each year the portfolio is driven by the performance of both asset classes away from the 60/40 allocation .

volatilities all range between 10 and 11 percent, the ratios of portfolio volatility to USE[31] volatility all lie within 60 to 70 percent and the correlations with USE are all above 90 percent."[32]

Figure 5: Volatility of Portfolios – Various Time Periods



This figure is intended to show the volatility of individual portfolios and index S&P500 during four time periods A, B, C, and D. The x-axis shows the time periods and the y-axis measures the standard deviation of the portfolios and S&P500. Period A lasts from Q2 1990 to Q2 1995, period B from Q3 1995 to Q2 2000, period C from Q3 2000 to Q2 2005, and period D from Q3 2005 to Q2 2010. The calculation is based on quarterly return on the individual periods. The columns are defined by the color legend below the diagram.

Leibowitz et al. (2010, 273) also examine how the portfolio volatilities are related to the volatility of U.S. stocks across time and look at three five-year periods from 1993 to 2007. "The primary driver of the level of portfolio volatility is the magnitude of the equity volatility. The higher equity volatility from 1998 to 2002 led to higher portfolio volatilities, while lower portfolio volatilities occurred in the 1993 to 1997 and the 2003 to 2007 periods when the equity volatility was much lower." I have conducted similar calculations and divided the whole time period into four sections called A (Q2 1990 – Q2 1995), B (Q3 1995 – Q2 2000), C (Q3 2000 – Q2 2005), and D (Q3 2005 – Q2 2010), calculated the standard deviation of each portfolio and S&P500 during each time section and summarized the results in Figure 5. The volatility of S&P500 increase from 11.85% in time section A to 18.53% in time section D. A similar increase can be observed only by 60/40 and the three Uni portfolios. In the

[31] USE stands for U.S. Equity

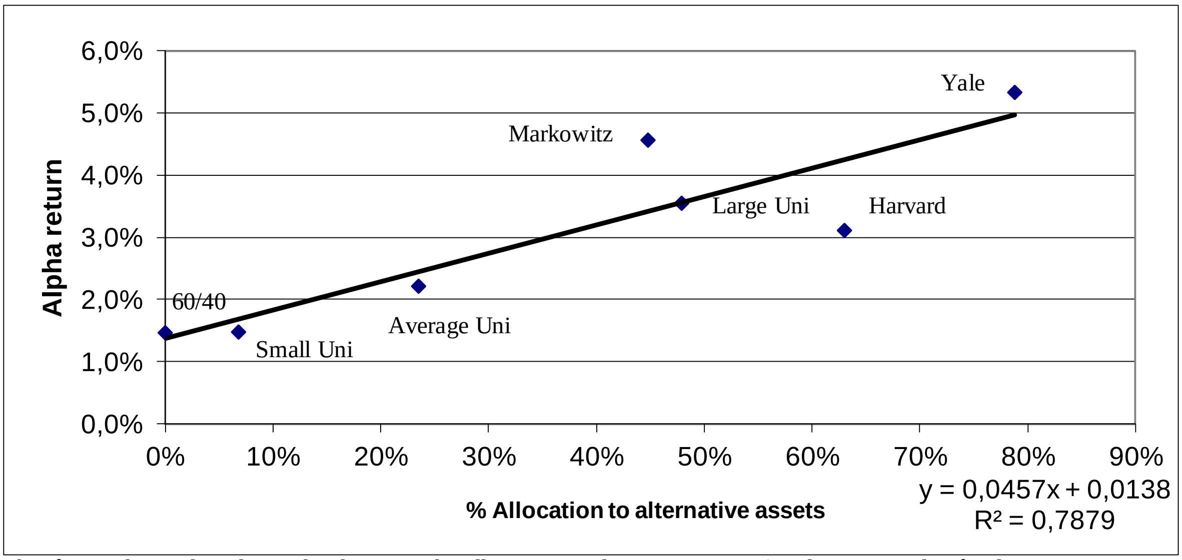
[32] The ratio of portfolio volatility to U.S. stocks volatility is not reported in this thesis. However, as the portfolio volatility of each portfolio (except for Markowitz) is about 9.5% and the U.S. stocks volatility about 16.5%, this ratio accounts for approximately 0.58.

case of Harvard, Yale and the theoretical ex-post Markowitz portfolio, no similar pattern is present. Of course, this is in line with their very alternative asset allocation strategies.

As the first four portfolios have similar structural beta, the beta excess returns are similar as well – close to 3%. Only Harvard, Yale and the theoretical ex-post Markowitz portfolios differentiate significantly from the beta excess return of 3% and have lower beta excess return. The second important component within the 'beta-based' analysis is structural alpha and the corresponding alpha risk. According to Table 4, the venture capital contains the highest structural alpha. The remaining alternative asset classes (hedge funds, private equity, real estate and commodities) exhibit lower but still high structural alpha. Consequently, the structural alpha of portfolio strongly depends on the allocation to alternative asset classes – especially venture capital, private equity, and hedge funds. According to Table 7, the 60/40 portfolio exhibits the lowest alpha of 1.47%, while Yale portfolio exhibits the highest structural alpha of 5.33%. Figure 6 shows the relationship between allocation to alternative asset classes and structural alpha return. It is obvious that the higher the allocation to alternative assets, the higher the structural alpha return. In contrast, there is no clear relationship between the alpha return and the total portfolio volatility. Figure 7 indicates that (except for the theoretical ex-post Markowitz portfolio) the total volatility of all portfolios lies between 9% and 10%, but the alpha return is very different. Therefore, the high alpha return does not increase the total portfolio volatility – finding that is already mentioned in Leibowitz et al. (2010): "It is interesting to note, however, that these higher alpha returns lead to only minimal increases in portfolio volatility." Therefore, it seems that the true benefit of investment in alternative assets is not risk reduction, but generating alpha returns. Leibowitz et al. (2010): "The true advantage gained by the typical diversification, therefore, is not risk reduction. Rather, the primary benefit of the endowment model is the accumulation of alpha returns over time." The theoretical ex- post Markowitz portfolio, however, shows that the alternative assets can be used for reduction of the portfolio volatility as well. (Of course, in this thesis the ex-post Markowitz portfolio is only a theoretical portfolio based on information that is not (or not in that high quality[33]) available in real life.) Therefore, the university endowments seem to have certain 'volatility targets' (9%-10%) which are targeted without regard to the use of the particular asset classes. Consequently, the investing in alternative assets is reflected in higher returns. Figure 8 is intended to show an almost linear relationship between the total return and the allocation to alternative assets.

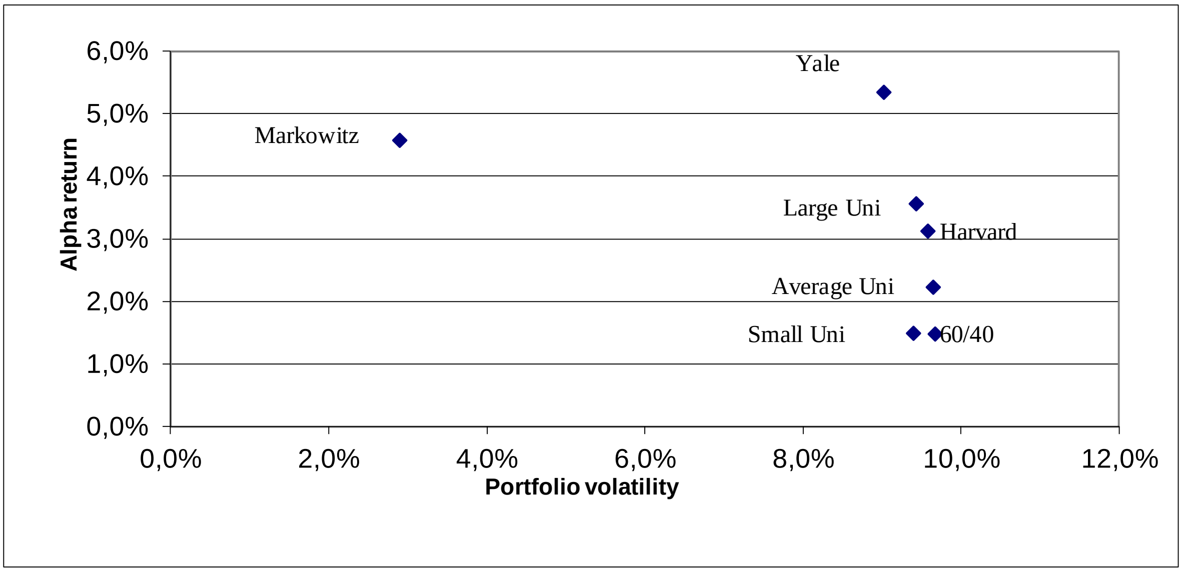
[33] The quality of the information refers here to the fact that the inputs to the optimization are not expected values but real values that the investor cannot know in advance in the real world.

Figure 6: Relationship between Alpha Return and Allocation to Alternative Assets



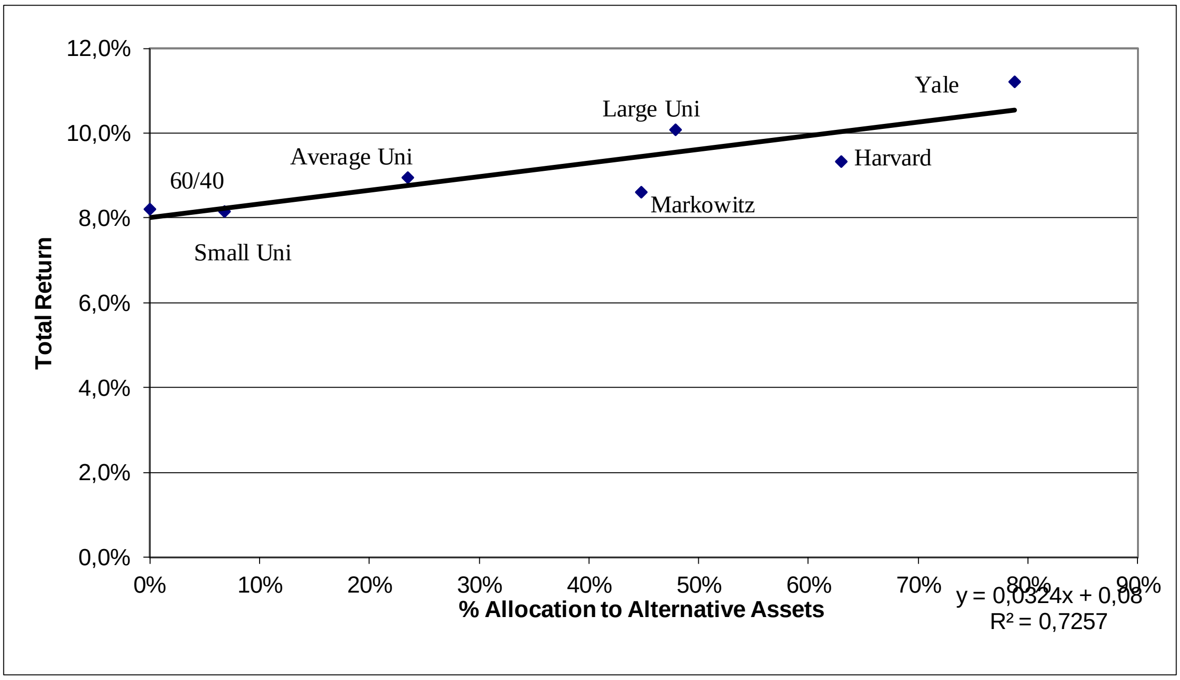
This figure shows the relationship between the allocation to alternative assets (Real estate, Hedge fund, Private equity, Venture capital, and Natural resources) and alpha return. The points in the diagram represent the individual portfolios, namely 60/40, Large Uni, Average Uni, Small Uni, Harvard, Yale, and Markowitz. The relation between the allocation to alternative assets and alpha return is illustrated by the linear regression line. The regression equation (including R-squared) is in the right-hand bottom corner of the diagram.

Figure 7: Alpha Return and Portfolio Volatility



This figure shows the relationship between the portfolio volatility and the alpha return. The points in the diagram represent the individual portfolios, namely 60/40, Large Uni, Average Uni, Small Uni, Harvard, Yale, and Markowitz. No regression line is drawn here, because the 'relationship' is obvious from the plotted points. Moreover, the regression line would be strongly biased by the outlier – theoretical Markowitz portfolio.

Figure 8: Total Return and Allocation to Alternative Assets



This diagram plots the allocation to alternative assets of each portfolio (x-axis) and the total return on each portfolio (y-axis). The equation and R-squared of the regression line is in the right-hand bottom corner.

Further important characteristic of each portfolio is how it behaves during crises. As in the case of individual asset classes, I have calculated structural betas and correlation coefficients during the last two U.S. stocks crises and plotted the portfolio returns in a graph with quadratic regression line. In Figure 9 Panels A-G, you can see the relationship between the portfolios return and S&P500 return and the corresponding quadratic regression line. When looking at all these diagrams, some patterns can be observed. In the case of the first four portfolios (Figure 9 Panel A-D), there are almost straight regression lines showing that the portfolio responds to the movements in S&P500 always in the same way and magnitude. The points are concentrated very close to the regression line. Accordingly, the regression models (the regression equation is stated in the right-hand bottom corner in each diagram) show very high R-squared. Further two portfolios – Harvard and Yale – have slightly downward sloping regression lines on the left-hand side of the diagram, suggesting that the portfolios tend to respond more sensitively to negative S&P500 returns. Moreover, the points in the diagrams are more dispersed. Accordingly, the R-squared of the regression line is 0.715 in the case of Harvard portfolio and 0.605 in the case of Yale portfolio. The theoretical ex-post Markowitz portfolio has even a more curved regression line (but most of the returns are still positive) and the regression line has only a 0.171 R-squared. Consequently, the last three portfolios seem to present an increasing sensitivity to negative S&P500 returns. At the same time, their returns are less related to S&P return – a finding already captured by the correlation coefficient.

Figure 9: Quadratic Regression Lines - Portfolios

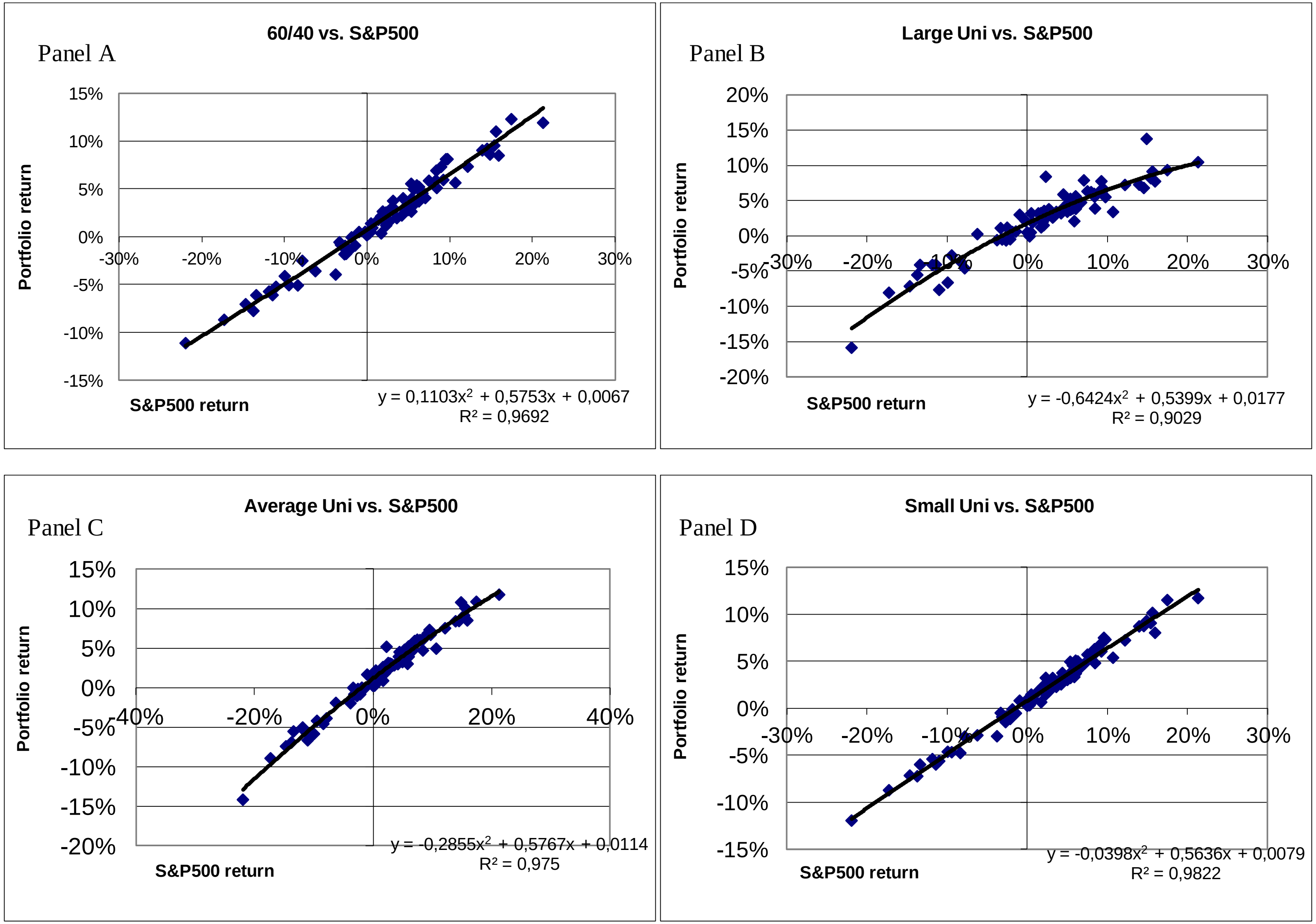
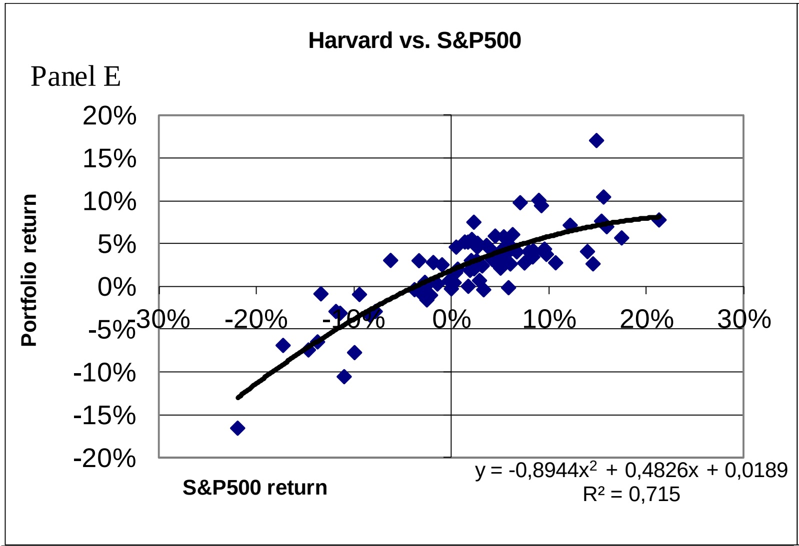
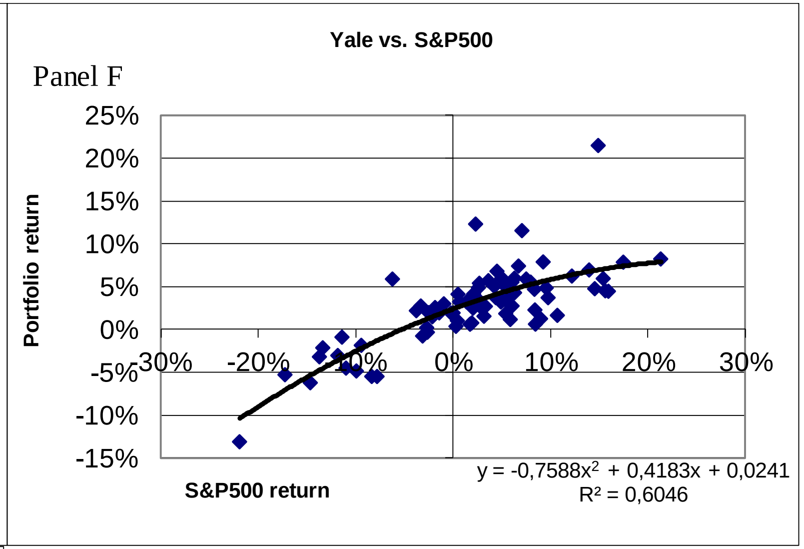


Figure 9 (cont.)





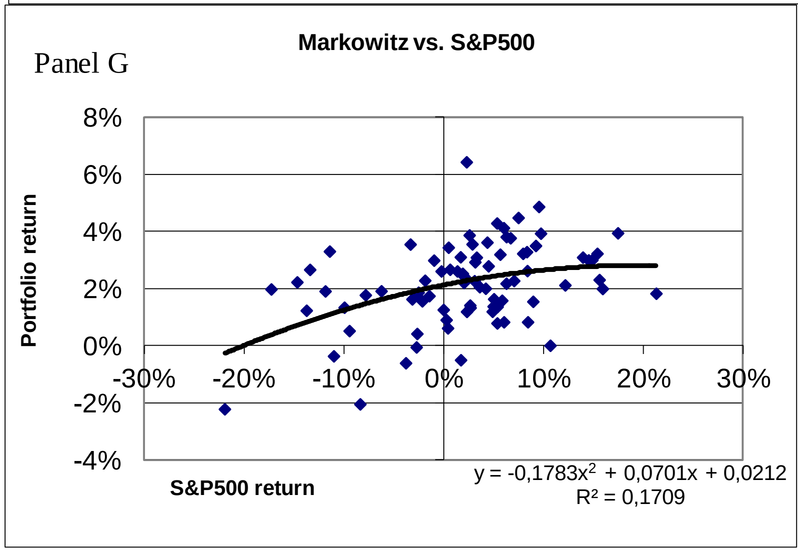


Figure 9 shows diagrams, where the x- axis are the monthly or quarterly returns on S&P500 and the y-axis are the monthly or quarterly returns on the particular portfolios. In each diagram, there is a quadratic regression line, which indicates how the relation between the S&P500 return and the returns on the particular asset class changes. The regression equation (including R-squared) is in the right-hand bottom corner of each diagram. The increased downward sloping on the left-hand side of the regression line indicates increased sensitivity of the returns on the particular asset class to the S&P500 returns.

Table 9: Correlations and Structural Betas during Crises

	60/40	Large Uni	Average Uni	Small Uni	Harvard	Yale	Markowitz (ex-post)
Correlation	0.98	0.94	0.99	0.99	0.82	0.76	0.39
Correlation 1	1.00	0.95	0.99	1.00	0.86	0.82	-0.68
Correlation 2	0.99	0.96	0.99	0.99	0.92	0.89	0.71
Beta	0.58	0.54	0.58	0.56	0.48	0.41	0.07
Beta 1	0.51	0.42	0.49	0.50	0.33	0.27	-0.06
Beta 2	0.57	0.60	0.60	0.56	0.63	0.42	0.12

This table shows the correlation coefficients and structural betas calculated over various time periods. The correlation coefficients illustrate the correlation between the individual portfolios and index S&P500 and structural betas are related to S&P500 as well. The rows 'Correlation' and 'Beta' are calculated over the whole examined time period from Q2 1990 to Q2 2010. Correlation 1 and Beta 1 refer to the period of the Dot-com crisis (Q3 2000 – Q4 200) and Correlation 2 and Beta 2 refers to the recent financial crisis (Q3 2007 – Q3 2009)

Table 9 shows the correlation coefficients and structural betas during the whole period and over both recent U.S. stock crises. The first four portfolios show basically no change in correlation coefficient. Structural beta of these portfolios declined slightly during the first crisis, but return to its total value during the second crisis. This means that these portfolios are not subject to correlation tightening during stressed times. In the case of Harvard portfolio, the correlation coefficients and structural betas increased during the financial crisis. This is basically consistent with the downward sloping regression line in Figure 9 Panel E. Yale portfolio presents an increased correlation with S&P500 during the financial crisis, but the same structural betas. Even though the changes are not too large, it is interesting to take a closer look at this situation. First of all, it is important to remember the formula for beta (see Formula 9).

$$\beta_{port} = \rho_{port,U.S.stocks} * \frac{\sigma_{port}}{\sigma_{U.S.stocks}}$$

Formula 9

$\beta_{portfolio}$= structural beta of the relevant portfolio

$\rho_{port,\ U.S.\ stocks}$= correlation coefficient between the portfolio and U.S. stocks

$\sigma_{portfolio}$= volatility of the portfolio

$\sigma_{portfolio}$= volatility of U.S. stocks

According to the Formula 9, when correlation increases the structural beta can remain unchanged only when the ratio of the two standard deviations decreases. The standard deviations and the ratios of them are shown in Table 10. It is obvious that the ratio of these two risks declined during the U.S. stocks crises. Although the Yale portfolio correlated more strongly with U.S. stocks during the crises, the portfolio volatility decreased more or increased less than the volatility of S&P500. In this way, the Yale portfolio provided some degree of ‘stability’. The theoretical ex-post Markowitz portfolio presents quite different behavior during crises. This optimally diversified portfolio has very weak correlation during the whole period. During the first crisis, however, the correlation with U.S. stocks decreased to -0.68 and structural beta to -0.06 (see Table 9). In contrast, during the second crisis, the correlation and structural beta increased slightly. As both crises are incorporated in the optimization, the portfolio is constructed so that it provides best mean-variance combination. Therefore, it is quite possible that the portfolio optimization results in portfolio composition which is not adversely affected by the crises.

Table 10: Standard Deviation - Yale

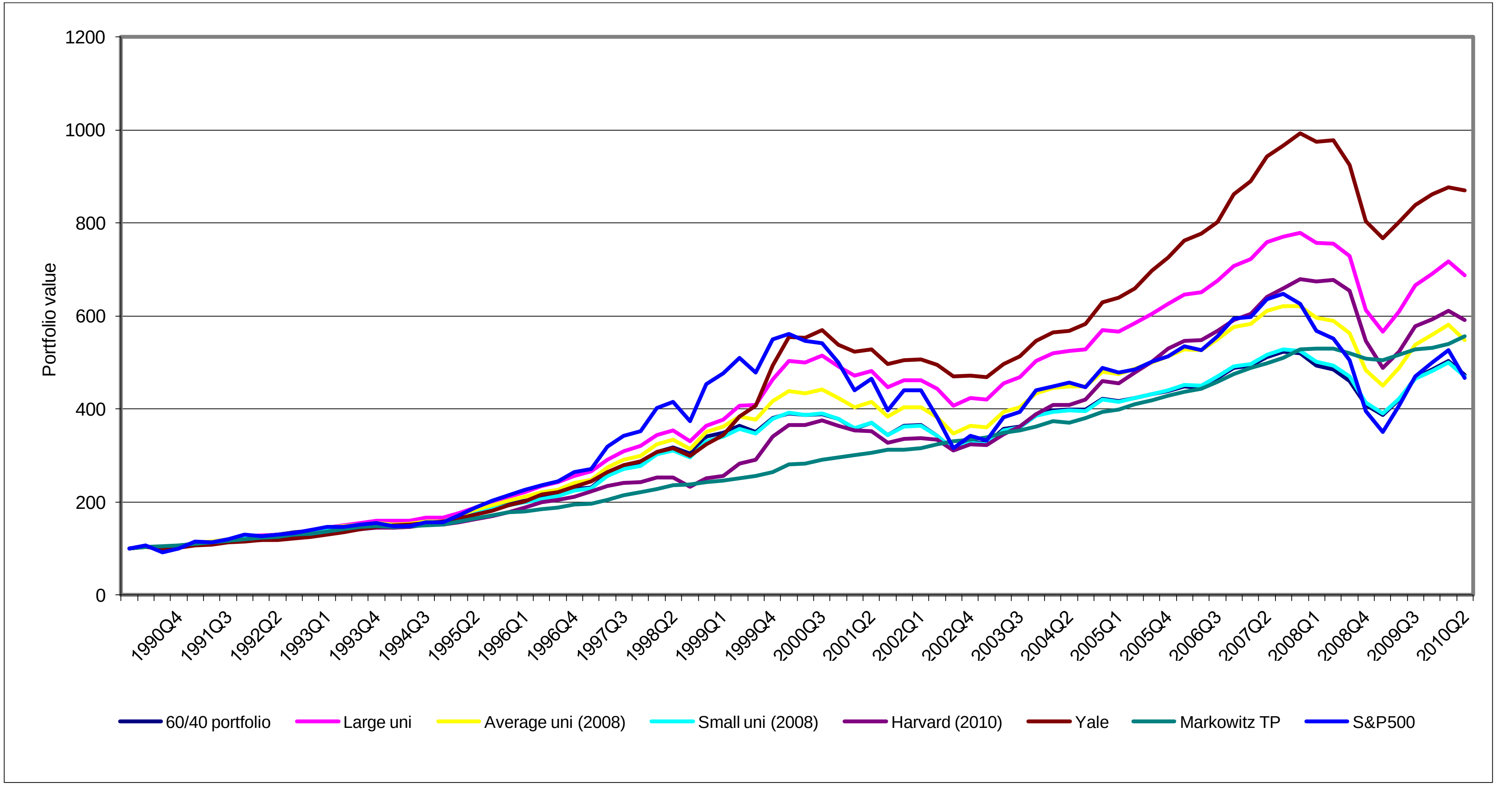
	S&P500	Yale	Ratio
Standard deviation (%)	16.5	9.0	0.55
Standard deviation 1 (%)	20.5	6.7	0.33
Standard deviation 2 (%)	24.7	11.6	0.47

This table shows the standard deviation of S&P500 index and Yale portfolio over three time periods. The first row refers to the period from Q2 1990 to Q2 2010, the second row to the period from Q3 2000 to Q4 2002 (Dot-com crisis) and the third row to period from Q3 2007 to Q3 2009 (financial crisis). In the last column there is the ratio of the standard deviation of Yale portfolio and S&P500.

One thing is the portfolio performance related to U.S stocks and the other thing is the absolute portfolio performance. Figure 10 is intended to illustrate the total performance of the seven portfolios and S&P500 during the whole examined time period. It is obvious from Figure 10 that basically all portfolios except for the theoretical ex-post Markowitz portfolio were adversely affected by both crises and their market value declined. The only portfolio which seems to be unaffected by the stressed situations on U.S. stock markets is the theoretical ex-postMarkowitz portfolio and its almost unchangeable development signalizes the optimized portfolio structure.

The distributions of returns on the seven portfolios vary considerably (see Table 7). Regarding the skewness, the return distribution of 60/40 portfolio is slightly negatively skewed. The return distribution of the Large Uni portfolio has the largest negative skewness of -1.012. and the other two Uni portfolios have negatively skewed return distribution as well. Interesting is that the Harvard and Yale portfolios – representatives of very alternative asset allocation – have different distribution of returns. In case of Harvard, the distribution has a significant negative skewness. On the contrary, the Yale portfolio is obviously mixed in such a way that the positively and negatively skewed return distributions of individual asset classes are balanced and result in a symmetric distribution. Regarding the kurtosis, the portfolios with large allocation to alternative assets – Large Uni, Harvard, Yale, and ex-post Markowitz – have high kurtosis. This is an expectable result, as the alternative asset classes have distributions with fat tails. In sum, on the one hand the alternative asset classes enable to construct a portfolio whose return distribution is expected to be symmetric. On the other hand, investing in these assets lets expect extreme returns.

Figure 10: Portfolio Performance – without Spending



This figure shows the performance of seven portfolios (60/40, Large Uni, Average Uni, Small Uni, Harvard, Yale, and Markowitz) and S&P500 index over the total examined time period from Q21990 to Q2 2010.The starting value of each portfolio is 100. The performance is based on the real historical quarterly returns of the asset classes, which the portfolios consist of.

How successful are the examined portfolios when compared with the real performance of university endowments? According to Table 11, the equally weighted average yearly return among the university endowments, contained in the NACUBO Endowment studies over the last twenty years, is 8.31%. Large Uni, Average Uni, Harvard, Yale and theoretical ex-post Markowitz portfolio have higher average returns, while 60/40 and Small Uni have lower returns. This is reflected in the compounded yearly return during the last twenty years. Yale achieved compounded yearly return of 11.18%, while Small Uni 'only' 7.79% - compared with real average result of 7.85%. Table 11 also shows that Large Uni portfolio outperformed the equally weighted average of real endowment in 16 of 20 years. In contrast, Small Uni portfolio was better than the real endowments only in 7 years. It is difficult to draw any conclusion from this numbers, as it is a comparison of theoretical policy portfolios based on unrealistic assumptions with total[34] average performance of real endowments. It could be said – with great caution and keeping in mind all the unrealistic assumptions (e.g. non-investable indices) - that endowments would have been better off if they had applied only the average asset allocation policy (according to NACUBO Endowment Study 2008) and forego any active portfolio management activities.

The alternative asset classes offer great potential for active portfolio management. As mentioned above the alternative asset classes offer both high structural alpha and the potential for generating active alpha, as the markets for these asset classes exhibit a not as high efficiency as the markets for U.S. stocks and bonds. Therefore, the portfolios with large allocation to the alternative assets (i.e. Large Uni, Harvard, Yale, and ex-post Markowitz) have the greatest potential for generating risk adjusted returns. Of course, the potential is only one prerequisite. In order to realize risk adjusted returns, skills and knowledge of active portfolio management, especially market timing skills and security selection skills are necessary. Accordingly, all the problems associated with most of the alternative asset classes (little information, no investable indices, etc.) may be considered (and in fact they are) advantages rather than disadvantages. Of course, how the alternative assets are perceived by the endowments depends on the endowments' ability to exploit the potential for generating risk-adjusted returns.

[34] 'total' refers to the fact that not only the return from asset allocation but also the return from market timing and return from security selection are contained in the real numbers of endowment performance.

Table 11: Years of Outperformance

	60/40	Large Uni	Average Uni	Small Uni	Harvard	Yale	Markowitz (ex post)	Real results
Mean (%)	8.29	10.47	9.15	8.26	9.66	11.96	8.83	8.31
Years of outperformance	10	16	13	7	12	12	7	
Compounded return (%)	7.81	9.86	8.61	7.79	9.06	11.18	8.76	7.85

This table compares the results of the portfolio simulation (without spending) with the real performance of the endowments covered by the NACUBO Endowment Studies. Columns 2-8 report the simulation results and the last column shows the real performance - source of the data are Brown et al. (2008) and NACUBO Endowment Studies. The numbers in this column refer to equally weighted average of the covered endowments. 'Mean' refers to arithmetic average of the yearly returns – the calculation is based on yearly (not quarterly) returns – over the time period from 1990 to 2010. 'Years of outperformance' indicates in how many years the theoretical portfolios outperformed the real equally weighted average of the endowments covered by the NACUBO Endowment Studies. The last row 'compounded return' is the yearly compounded return over the twenty fiscal years from 1990 to 2010.

3.2.c. Spending

Up to now, I have dealt only with portfolio composition, portfolio performance and other common portfolio characteristics. However, portfolio composition and portfolio performance are 'only' means to the main purpose of university endowments, namely to support the university budget. Therefore, I focus on the payout from the examined portfolios in this section.

The spending policy of a university endowment is affected by a number of factors, such as relative importance of the endowment revenue, endowment performance, etc. and has a direct impact on the strategic purposes of the endowments, preservation of the endowment value and purchasing power, and ensuring the intergenerational equity. Acharya and Dimson (2007): "One of the major challenges for endowed institutions is how best to maintain the level of spending in the long term, particularly during adverse market conditions. The risk for the institution lies not necessarily in the changes in the capital value of its endowment but ability of the endowment to provide the level of spending the institution is accustomed to. Therefore, spending rules minimizing the volatility of spending are favoured by institutions that depend on the endowment for sustaining their operational activities. Sensitivity of the institution to such a shortfall inevitably influences spending policy." Moreover, the spending rule may directly affect the handling area for the portfolio management. As Acharya and Dimson (2007) state: "A clearly defined spending policy also frees up the asset allocation decision and enables the fund manager to focus on investment issues." Therefore, spending policy is not a mere way how to pay out the money, but one of the key aspects of the endowment management.

Spending policies may pursue various goals and thereby be very different. According to Acharya and Dimson (2007), spending policies may be divided into three categories: (i) spending all income, (ii) spending a fixed percentage of the moving average market value of the endowment, and (iii) spending a constant amount each year that is adjusted for inflation. As stated at the beginning of this thesis, the spending policies changed in the past. The change was mainly the shift from the 'income-only' spending to the 'total return' spending. However, even today there are some differences in the applied spending policies. For instance, according to Swensen (2000): "Under Yale's rule, spending for a given year equals 70 percent of spending in the previous year, adjusted for inflation, plus 30 percent of the long-term spending rate applied to the endowment's current market level." According to Brown et al. (2010)*: "The typical endowment spending policy specifies a payout rate that is applied to a multi-year moving average of endowment values. According to the 2008 NACUBO Endowment Study, 73% of universities have such a rule. For example, an endowment might specify that it spends 5% of the average endowment balance over the prior three years." Therefore, I apply following spending policy in my calculations: the payout is 5% of the average of portfolio value from the last three years. This amount is paid out once a year at the end of the second quarter – end of the fiscal year. When looking at the payouts from university endowments following points are important: (i) Does spending enable to preserve the purchasing power of the endowment fund and is capital accumulated? (ii) What is the absolute cumulative amount paid out? (iii) How volatile is the payout?

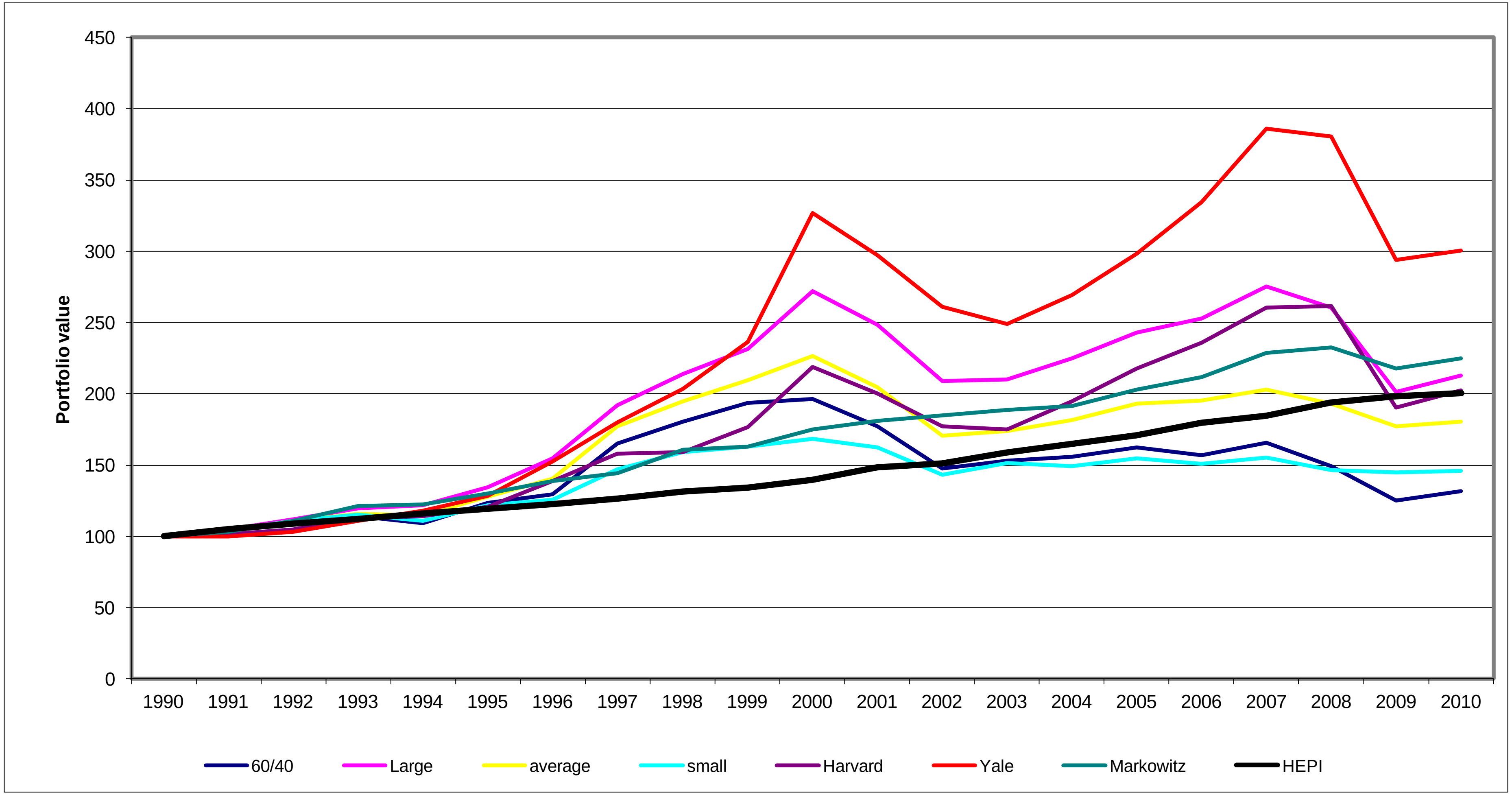
Figure 11 shows the market values of the examined portfolios and HEPI over the period from Q2 1990 to Q2 2010. The corresponding market value of each portfolio at the end of fiscal year 2010 can be found in Table 12. It is obvious that despite the above described spending policy Large Uni, Average Uni, Harvard, Yale, and theoretical ex-post Markowitz portfolios retained their purchasing power and even were able to accumulate additional capital – their portfolio value is higher than the value of HEPI. The most successful was the Yale portfolio which supplied the university with 244.44 'units' in sum over the twenty years – average yearly payout is 12.22 units - and more than tripled the portfolio value. The purchasing power of the portfolio increased by more than 66%[35]. During the examined period from 1990 to 2010, Yale portfolio market value was only three times below the value of HEPI (the purchasing power decreased). Furthermore, I calculated the maximal possible spending rate that preserves the portfolio purchasing value at the end of the 2010. Yale portfolio performance allows to payout up to 7.09% of the last-three-year portfolio average market value, in order to preserve the purchasing power. Large Uni, Average Uni, Harvard, and the theoretical ex-post Markowitz portfolios were also able to retain their purchasing power and accumulate further capital. Although the Large Uni and Average Uni portfolios did not achieve such a great performance as Yale portfolio did, the purchasing power of Large Uni and Average Uni decreased only in one year. This means that these

[35] The value of Yale portfolio is 332.48 at the end of 2010. The value of HEPI is 200.24. Therefore, the increase of purchasing power is: (332.48/200.24 – 1)*100= 66.04%

two portfolios were able to provide more stable protection against inflation. 60/40 and Small Uni were not able to retain their purchasing power when distributing 5% of the average of the last three-year portfolio market value. While the 60/40 portfolio spent a larger total sum and has higher average spending, the Small Uni portfolio ended with higher portfolio value and enables a higher maximal possible spending (4.33%), which still preserves the initial purchasing power. The difference between the maximal possible spending rate of Yale and 60/40 portfolio is about 3%. If we consider that the three-year average of real Yale endowment market value is about 18.7 billions USD[36], the three-percent difference in spending accounts for 0.56 billion USD – an amount which is significant for the university. In the last column of Table 12, there is a coefficient of variation, which should capture the relative volatility of the distributed amounts. Yale portfolio exhibits the largest coefficient of variation, namely 43%. As a result, this portfolio distributes high amounts but the payouts are quite volatile. This can be very inconvenient for the university, as the university cannot rely on a constant or constantly growing contribution from the associated endowment. Furthermore, it is interesting that the Large Uni portfolio achieved better performance and ended with higher portfolio value than the theoretical ex-post Markowitz portfolio, although both portfolios have similar total exposure to alternative asset classes. In contrast, the coefficient of variation of Large Uni is higher than that of the theoretical ex-post Markowitz portfolio. Although the ex-post Markowitz portfolio is only a theoretical optimal portfolio, the example of these two portfolios should illustrate that the alternative assets enable both portfolios with high growth and total spending, and portfolios that provide the university with nonvolatile 'constantly' growing cash flow. However, as stated above, according to Acharya and Dimson (2007): "A clearly defined spending policy also frees up the asset allocation decisions and enables the fund managers to focus on investment issues." Therefore, if the spending policy secures a 'constant' payout from the endowment, the portfolio managers are less forced to worry about the volatility of the spending and can concentrate more on portfolio performance.

[36] The market value of the Yale endowment in years 2010, 2009, and 2008 was 16.652 billion USD, 16.327 billion USD, and 22,869 billion USD.

Figure 11: Portfolio Performance – with Spending



This figure shows the market value of the examined portfolios and HEPI (Higher Education Price Index) over the period from the fiscal year 1990 to the fiscal year 2010. The HEPI is illustrated by the bold black line and should indicate the limit over which the purchasing power of the particular portfolio is preserved. The starting value of each portfolio and HEPI is 100 and the calculation is based on year returns of each portfolio and yearly growth of HEPI. This figure illustrates the yearly market values and HEPI at the end of each fiscal year.

Table 12

	60/40	Large Uni	Average Uni	Small Uni	Harvard	Yale	Markowitz (ex post)	HEPI
% alternative	0	48	24	7	63	79	45	
Portfolio Value	173.56	258.07	220.68	183.73	233.73	332.48	209.20	200.24
Total spending	177.17	224.55	197.23	163.60	188.86	244.44	164.15	
Average spending	8.86	11.23	9.86	8.18	9.44	12.22	8.21	
in % of market value	4.90	4.82	4.84	4.86	4.83	4.76	4.83	
Maximum possible spending (%)	4.08	5.93	5.20	4.33	5.49	7.09	4.96	
# of years below HEPI	5	1	1	5	3	3	3	
standard deviation	2.11	3.72	2.74	1.76	2.99	5.21	1.88	
Coefficient of variation (%)	24	33	28	21	32	43	23	

Table shows the results of the portfolio simulation including spending over the period from 1990 to 2010. The first row reports the allocation to alternative assets. Portfolio value is the value of each portfolio and HEPI – Higher Education Price Index – at the end of fiscal year 2010 (Q2 2010). Total spending is the total amount paid out by the portfolio over twenty years. Average spending refers to the average yearly spending over twenty years. 'in % of market value' denotes the amount paid out in relation to the actual portfolio market value. Maximal possible spending is the maximal theoretical spending rate (based on the last-three-year average portfolio market value) that secure the preservation of the portfolios purchasing power. '# of years below HEPI' indicates how many years the portfolio's purchasing power was under the initial purchasing power. The last row shows the coefficient of variation - standard deviation in relation to mean (=average spending)

4. Conclusion and Discussion

The asset allocation of university endowments has changed considerably over the last two decades and today endowments allocate more capital to alternative asset classes. There are, however, big differences in the asset allocation among the endowments. The most 'innovative' endowments with regard to the asset allocation are the endowments with large asset under management, especially Harvard and Yale endowments. Smaller endowments allocate also more capital to alternative asset classes than two decades ago, but their allocation to these assets is still smaller than that of large endowments. These differences may arise from the absence of investable benchmarks of alternative asset classes, need for active portfolio management, and some characteristics of the endowments and the associated universities such as endowment size, volatility of non-endowment revenue, donations, and student body. The analysis of the individual asset classes shows that the alternative assets offer great range of return-risk profiles, various diversification potential, and diverse shapes of return distributions.

The previous chapter '3. Portfolio Analysis' describes the characteristics and performance of various asset allocation policies. From the information above it is obvious that alternative asset classes are able to change the portfolio in a considerable way. When recalling the characteristics of the alternative asset classes described above, the following conclusions are quite intuitive. The increased allocation of capital to alternative asset classes basically increases the total return, decreases the beta excess return and considerably raises the alpha return. As illustrated in Figure 6, there is an almost linear positive relationship between portfolio's structural alpha and allocation to alternative asset classes. Systematic risk is decreasing and unsystematic risk is increasing with higher alternative assets allocation. These effects result in almost constant total portfolio volatility. Consequently the examined portfolios, which try to capture the university investment policy, are constructed in the way that the alternative asset classes do not lower the total portfolio risk by diversification effects but rather increase the total portfolio return, which enables higher (and more volatile) spending rates. However, the theoretical ex-post Markowitz portfolio shows that reduction in the portfolio total risk by holding the total return high is possible. The theoretical ex-post Markowitz portfolio presents less than the third of the risk of 60/40 portfolio. Figure 12 shows is designed to show the efficient frontier and the position of these portfolios and S&P500. In essence, this figure summarizes the detailed description given above. The variation in the total portfolio risk is low. The total risk is between 9% and 10%. The variation in total return is high. The total portfolio return ranges between 8.16% and 11.22%

Consequently, the answer on the central question whether the increased allocation to alternative asset classes leads to superior returns is YES, the portfolios, which consist considerably of alternative asset classes according to the recent trend among university endowments, generate superior return-risk profiles compared with 60/40 portfolio. However, the investor has to be aware of the pitfalls and anomalies of these alternative assets. Consequently, I would like to mention these pitfalls and further questions.

It must be stressed again that the calculations are partially based on non-investable indices and thereby the replication of the same mean-variance profile of these indices by the single investment vehicles from the relevant asset classes may be very complicated, or even impossible, and require excessive research activity, which exceeds the framework of allocation policy decisions.

The discussion about the allocation to alternative assets has been driven by the great success of the top endowments, especially Yale's and Harvard's ones. Of course, it is tempting to try to mimic the asset allocation of the top endowments and to hope for the same results. However, this procedure resembles the looking for a simple and universal cook-book for an excellent performance. In contrast, Lerner et al. (2008) search for the 'real' drivers of the performance of university endowments and find that, for instance, in the case of private equity the success of this asset class in the university endowment correlates strongly with SAT scores of the student body and the rate of alumni giving. In other words, the asset class performs better for one endowment and worse for the other. Lerner et al. (2008) state that probably the access to the top performing funds, the ability to select the funds with the best outlook, the experience and the timing are the key factors for success. Accordingly, it is advisable to look at the asset allocation to alternative asset classes from a different point of view. We know that the success of the top endowments results from their superior skills and the active management – something more than mere asset allocation – and that these endowments have the ability to find out superior investment opportunities. Therefore, these asset allocations to alternative asset classes may not necessarily be considered the only key factor, and the universal cook-book for great performance but rather an opportunity for profitable investments. This opportunity arose from the changing situation on capital markets, and there is no certainty that this opportunity will last forever. It is the fact that from the whole-market point of view the active alphas are zero-sum[37]. If the market participants become more informed and skilled, the active alpha will diminish (or it will be more costly to find investment opportunities with risk-adjusted return). I presume to claim that if this situation happens, the top endowments will find other opportunities how to achieve superior performance. At the same time, it is important to mention that based on the information in the reports of Harvard Management Company, Yale Investment Office and Swensen (2000), the largest endowments try to apply more 'knowledge-based' way of investing and have the necessary skills and knowledge.

Therefore, yes, the alternative asset allocation offers further opportunities for better return-risk portfolio profile, and it was a good decision to allocate capital to these asset classes. However, the power of this asset allocation should not be exaggerated and it may not necessarily last forever. Universal cook-book for superior performance seems to be the skills and knowledge rather than the only asset allocation.

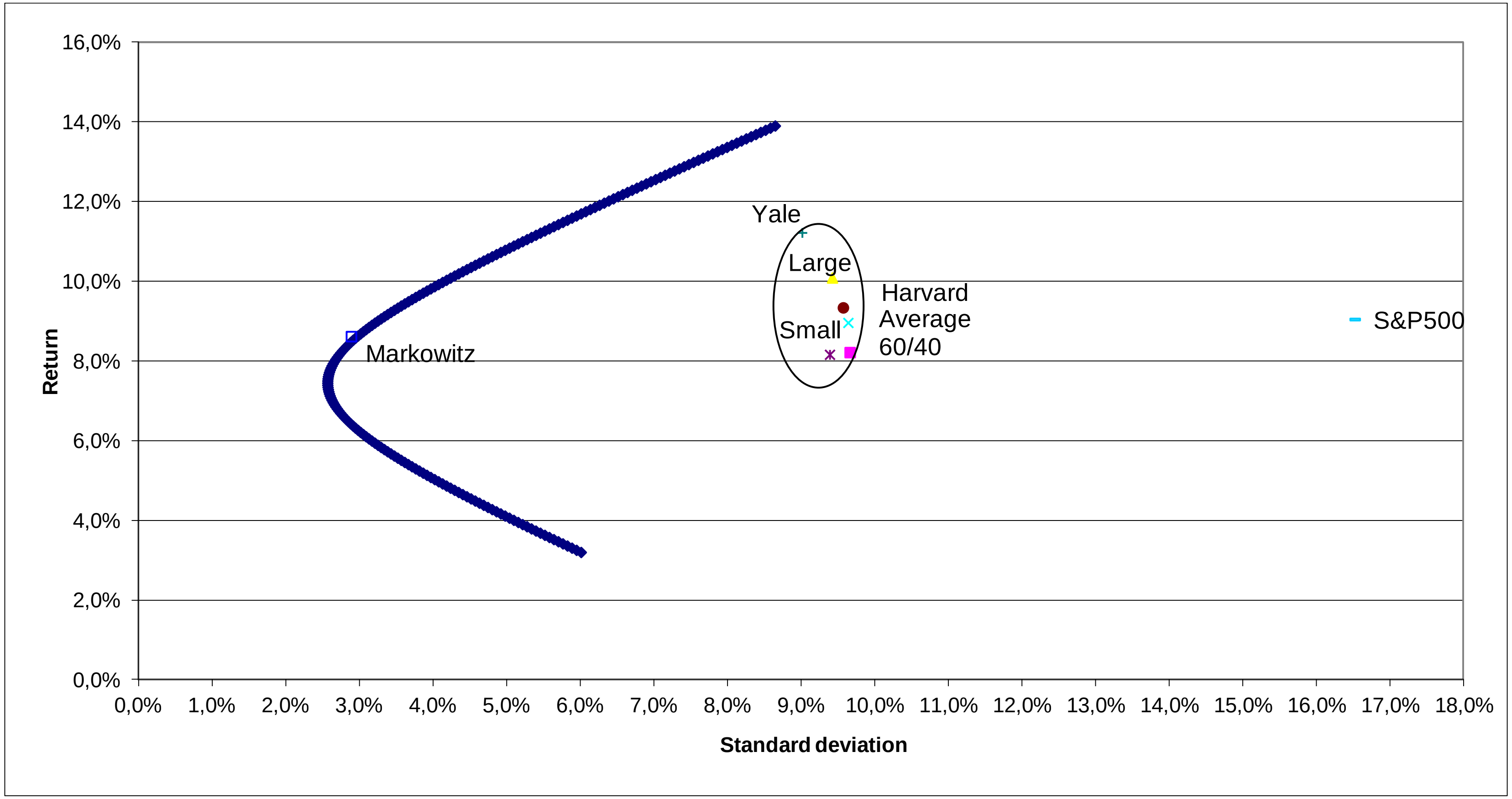
Further point is why university endowments should be 'defined' as a homogenous class of investors. Of course, the endowments have the same goal, namely to support the higher education. Nevertheless, there are considerable differences between both the endowments and the associated universities. According to Lerner et al. (2008) Ivy League universities have the largest endowments. These universities also levy much higher tuition fees. Therefore, their funding structure seems to be different from other universities, especially the public ones. The SAT score of the student body is higher as well and Lerner et al. (2008) mention that this score correlates with the successful investing in alternative assets. An older study by Davidson (1971) states that larger endowments tend to employ external managers. At the same time, he mentions that the endowments with external managers achieve

[37] If we take the transaction cost into account then active alphas are less than zero-sum.

significantly higher capital appreciation. According to Brown et al. (2010)*, the endowments and the associated universities are a heterogeneous group with respect to further characteristics such as number of employees or student financial aid, as well. Brown et al. (2008) show that the endowments in the highest AUM quartile generate by 1.63 percentage point higher active return than endowments in the lowest AUM quartile. Therefore, why an asset allocation policy of some endowments which have the necessary intellectual capacity, enough capital, and associated university with different funding structure should be mimicked by an endowment with little capital, no professionals in the managing body, and other type of associated university. In this case, it seems that the only common thing is the title ‘university endowment’.

Therefore, yes, the alternative asset classes may improve the return-risk profile of the portfolio even in the case of smaller endowments, which usually apply 60/40 asset allocation policy. However, these endowments cannot expect the same results as the large endowments.

Figure 12: Portfolios Frontier



This diagram shows the portfolios frontier and the position of seven simulated portfolios and index S&P500. The portfolio frontier is calculated from ex post data for the simulated period. It means that for the optimization over the period from 1990 to 2010, the real data from the same period were used. Therefore, no expectation is included in the optimization. This procedure does not capture the real conditions under which the portfolio managers can optimize the portfolio, but it is a backward look that shows what would have been the optimum, if the portfolio had known the exact characteristics of the future. The Markowitz portfolio lies on the efficient frontier as the portfolio is the optimal one. The seven portfolios are away from the efficient frontier, but their risk is between 9% and 10% - this area is market by the ellipse. S&P500 is even more far away from the portfolio frontier.

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8. Appendix

Appendix A:

Harvard Management Company mentions in the Endowment report 2010 an allocation to private equity but no allocation to venture capital. Therefore, I use an average of the returns on private equity and venture capital as a base for calculating the return on the allocation to private equity in the Harvard Portfolio. The column ‘Alternative Assets-sum’ in Table 6 includes the allocation to Emerging markets. Although emerging markets stocks are mentioned in the section 2.3. Conventional Asset Classes under the head line 2.3.b. International Stocks, they are considered alternative assets in the analysis of the portfolios, as they are ‘alternative’ to U.S. stocks and fixed income. In contrast, allocation to ‘Foreign equity’ is not included in the ‘Alternative Assets-sum’ in Table 6, as the ‘Foreign equity’ investments – investments in developed markets seems to be more conventional. The performance of ‘Absolute return’ is covered by HFRI index. The real Harvard bond policy portfolio consists of allocation to domestic bonds, foreign bonds, high-yield bonds, and inflation-indexed bonds. In this analysis, all these weights are aggregated to allocation to ‘Bonds’ and their performance is represented by Barclays Capital U.S. Aggregate Bond Index, for simplicity reasons.

Yale portfolio is constructed according the information from the Yale Investment Office Report 2010. There is mentioned the allocation to Private equity, which reportedly consists of venture capital and levered buyouts. In this thesis, the Yale portfolio’s position in private equity consist 50% of private equity represented by Cambridge Associates U.S. Private Equity Index®, and 50% of venture capital represented by Cambridge Associates U.S. Venture Capital Index®. Similarly the position ‘Foreign equity’ consists 50% of foreign developed equity represented by MSCI EAFE and 50% of emerging markets equity represented by S&P/IFCI (prior 1995 by mixture of S&P500 and MSCI EAFE as mentioned in Appendix B). In fact, according to the reports of Yale Investment Office from 2000 to 2010, the benchmarks for policy-portfolio position ‘Foreign equity’ was 50% MSCI EAFE and 50% MSCI EM in the years from 2000 to 2006, 40% MSCI EAFE, 40% MSCI EM, and 20% HEPI+8% in 2007 and 2008. Since 2009 the benchmark has consisted of 44% MSCI EAFE, 28% MSCI EM, and 28% MSCI China. In contrast to Harvard portfolio, the column ‘Alternative Assets-sum’ in Table 6 does not include the position ‘Foreign equity’, as Yale’s foreign equity consists considerably of developed equity market stocks.

Appendix B:

The analysis of both the individual asset classes and the constructed portfolio is based on a number of benchmarks. As there is no consistent use of indices for benchmarking among the individual endowments, research papers, books and studies, it is quite complicated to find out the most appropriate indices. For instance, Yale Investment Office uses The Wilshire 5000 Index as portfolio benchmark for domestic equity, while NACUBO uses S&P500 and Russell 3000. Moreover, the characteristics of U.S. stocks are commonly calculated from CRSP data. I selected those indices, which are commonly used by broad financial world and are easily accessible for common investor. These indices are: following Venture capital: Cambridge Associates U.S. Venture Capital Index®, Private equity: Cambridge Associates U.S. Private Equity Index®, Hedge funds: Hedge Fund Research Index, International stocks: MSCI EAFE, Emerging markets: S&P/IFCI, U.S. stocks: S&P500, Real estate: NCREIF, Fixed income: Barclays Capital U.S. Aggregate Bond Index and Natural resources: Goldman Sachs Commodity Index S&P GSCI®.

Emerging Markets: S&P/IFCI, a benchmark for exposure to emerging market stocks, has been calculated only since 1995. However, the Harvard and Yale portfolios contain this asset class over the whole period from 1990 to 2010 in this thesis. Therefore, in the time period before 1995 average of returns on S&P500 and MSCI EAFE is used. I admit that this procedure seems to be arbitrary and may not necessarily capture the real exposure, but the correlation coefficient between S&P500 and S&P/IFCI is 0.744 and between MSCI EAFE and S&P/IFCI is 0.83. Therefore, the mixture of S&P500 and MSCI EAFE may, at least partially, capture the virtual return on emerging market stocks.

In case of the asset classes which are not covered by an 'investable' benchmark (hedge funds, private equity, venture capital, and real estate) an investor will not be able to make an investment easily with such quantitative characteristics in those asset classes as mentioned in the chapter '2.4. Alternative Asset Classes' and Table 4 and 5. The quantitative characteristics presented in that chapter are already 'biased' by diversification effects. An investor, who will – randomly or purposely – pick an investment vehicle in such asset class, will bear the total risk, namely both systematic and idiosyncratic risk. As this thesis focuses on the asset allocation policy, the use of an average return on such asset class is intended to represent the return an investor can expect to gain when randomly (without any skills and knowledge) selecting an investment in such asset class. Admittedly, this concept may not necessarily supply the real expected average return, as the indices may be subject to selection bias and the distributions of the returns may be skewed. Moreover, some hedge funds, private equity, and venture capital firm are closed for new or unknown investors, or they set a minimal limit for investment. When the most successful hedge funds, private equity funds and venture capital funds are available only for few (largest) endowments, then the average historical return overestimates the real expected return accessible by average unskilled investor.