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Faculty of Social Sciences
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RIGOROUS THESIS

Specifics in investment structure of private pension funds in the Czech Republic

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Signature

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Abstract

The objective of the thesis is to investigate the efficiency of pension funds' investment strategy in the Czech Republic and the adequacy of the current level of real estate investments in their portfolios. We employ Markowitz portfolio theory and construct the optimal market investment portfolio. The optimal portfolio is then compared with the portfolio of Czech pension funds and the loss arising from asset class misallocation is estimated. Besides, the comparison of portfolio structures of all current pension funds in the Czech Republic is done with the intention to detect whether they follow significantly different investment strategies or not. The analysis is done on quarterly data over the period 2000 – 2011. In the last chapter of the thesis, other sources of market inefficiency of the Czech pension funds are discussed.

JEL Classification	G11, G18, G23
Keywords	portfolio theory, real estate investments, pension funds

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Abstrakt

Autor rigorózní práce si klade za cíl analyzovat efektivnost investiční strategie penzijních fondů v České Republice a prošetřit přiměřenost současné míry investic do nemovitostí v jejich investičních portfoliích. S využitím Markowitzovy teorie je sestaveno optimální investiční portfolio pro český trh. Porovnáním optimálního portfolia s portfoliem penzijních fondů je odhadnuta ztráta výnosnosti způsobená neefektivitou v investiční struktuře. V rigorózní práci je též porovnán vývoj portfolií všech penzijních fondů aktuálně působících v České Republice se záměrem prozkoumat, zda se jejich investiční strategie výrazně liší. Analýza je provedena na čtvrtletních datech z období mezi lety 2000 a 2011. V poslední kapitole rigorózní práce jsou diskutovány další možné příčiny neefektivnosti českých penzijních fondů.

Klasifikace JEL	G11, G18, G23
Klíčová slova	teorie portfolia, investice do nemovitostí, penzijní fondy

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Contents

List of Tables

List of Figures

Chapter 1

Introduction

Previous work which has analyzed pension systems has pointed toward the specificity of private pension funds in the Czech case. Czech investment portfolios are very conservative compared to private pension funds in other countries and their returns are very low and stable. What has been rarely discussed in regard to Czech pension funds is the tiny share of real estate investments in their portfolios. Czech pension funds invest, on average, in real estate less than pension funds in the United Kingdom (UK) or the United States (US), which are criticized for poor real estate investments. Economic research concurs that real estate investments, although illiquid, have enough favorable attributes beneficial for investors especially with long investment horizon. Prices of real estate follow different cycles than prices of shares and bonds and therefore their returns are considered to have little correlation. Also from the risk-return perspective, real estate investments offer interesting investment opportunity. Why is it that Czech funds, especially, do not invest in real estate?

Recently, two master theses dealing with the topic of the Czech private pension system were written in the Institutes of Economic Studies at Charles University. Hlaváč (2011) described the current system in detail and used the Sharpe ratio to show that Czech pension funds achieve the poorest results among countries from the Central-Eastern-European region. Součková (2011) estimated the potential impact of the future reform of the pension system on the Czech real estate market. She found that if investments in private pension funds become mandatory the consequent increase of demand

in the real estate market could be remarkable. However, the total effect is extremely sensitive to the proportion of real estate investments in funds' portfolios. This parameter was exogenous in the model and it was expected to be similar to levels observed in other countries in the region where investments in private pension funds became mandatory in previous years. This thesis attempts to estimate what should be the optimal share of real estate investments in portfolios of pension funds with respect to the current market conditions. For this purpose we employ reasonable methods that have been introduced in economic journals by economists who analyzed portfolios of private pension funds in the UK and in the US. And our analysis goes even further. We investigate whether there is enough heterogeneity in portfolio strategies among Czech pension funds and we try to examine probable causes of inefficiency in the Czech market.

The thesis consists of three chapters. In the first chapter, we describe the characteristics of real estate investments and we also provide some evidence related to the key characteristics of Czech pension funds. The second chapter is focused on the detailed analysis of the portfolio management performed by Czech pension funds. First, we demonstrate that changes in portfolio structure between 2000 and 2011 were driven almost exclusively by active redistribution investments and that the conservative portfolio was even strengthened during the observed period by shifting to bonds from other assets. Second, we show that the conservative trend in portfolio change is followed by all pension funds and that there is no real choice of different portfolio strategies for pension funds' participants. Third, we estimate the optimal portfolio structure for the chosen level of portfolio risk and conclude that the asset class misallocation is given mainly by undervaluation of real estate investments. Finally, the third chapter discusses the possible sources of extreme investment conservatism. We argue that the current conservatism is determined by the strict regulation of pension funds in the Czech Republic.

Chapter 2

Real estate investments and its use in portfolios of pension funds

2.1 Real estate

The real estate is an important specific segment of investments in the global financial market. Real estate assets are considered very illiquid because of the low number of real estate transactions. There is not any organized market focused on real estate direct trading, so finding buyer or seller may be difficult. Real estate assets do not typically have enough close substitutes in the market and information about their price is often difficult to access. However, trading on insider information is possible and legal. Various methods providing unequal results were introduced to estimate the pattern of price trace in the aggregated real estate market (see Gyourko and Keim, 1993 or Giliberto, 1993). However, the literature investigating characteristics of real estate usually offers the following arguments for real estate investments:

1. Real estate investments are useful because of their diversification potential. Their returns are just a little dependent on returns of bonds and shares. The price of properties, economic factors aside, depends on some non-economic factors like population expansion or development of technology dealing with information quality and accessibility. It follows that by adding some real estate the diversification effect can

eventually reduce the portfolio volatility without significant loose in expected returns. Due to the problems with access to relevant information about actual changes in real estate prices, this statement is difficult to defend or refute empirically. Contrary to usual reasoning, Ennis and Burik (1991) argue that it is plausible to expect correlation between returns of real estate and other asset classes. Real estate as well as stock and bond prices represent future cash flows and therefore they are influenced by changes in interest rates. They also offer another argument to support the potential correlation. Price of real estate may be affected by the performance of companies. The demand for real estate can increase because of the excess earnings of shareholders.

2. Risk-return profile of real estate returns is remarkable. Ross and Zisler (1991) show that volatility of real estate returns lies between the volatility of bonds and stocks. Compared to shares, real estate can achieve quite similar returns with significantly lower volatility. We demonstrate later in chapter 3 that this evidence is supported by historical data from the Czech market too. This statement contradicts the common capital asset price model which postulates that higher returns can be earned only with additional increase of risk.

3. Real estate investments hedge against inflation. Neither shares nor bonds have such features. Prices of real estate are not quickly adjustable to the situation in the market. In contrast to shares, property value is influenced by specific factors like long term written rental contracts which impose more rigidity in the real estate market. It also follows that real estate prices are likely to be more predictable than other market prices.

Chun, Sa-Aadu and Shilling (2004) examined these arguments with the intention to find serious counter-arguments and explain the source of the undervaluation of real estate in portfolios of institutional investors detected by economists (for example Ennis and Burik, 1991). Actually, they failed to find suitable explanation for it, instead realizing the situation to be even more complicated. In their analysis of the US market they found the following favorable real estate features:

1. Unlike bonds and capital stocks, real estate investments pay off at the time when consumption growth opportunities are low.

2. Real estate performs well in the asset-liability framework. The optimal share of real estate in portfolios of institutional investors was estimated to lie between 6 and 12% while the current investment share in real estate was between 2 and 3% in 2004 in the US.

3. The chance of experiencing large losses over the long horizon is quite small when investing in real estate.

Not surprisingly, larger real estate portfolios, on average, tend to be less risky as showed by Byrne and Lee (2001). He (2002) went even further and showed that the volatility of optimally constructed real estate portfolio represents a systematic risk in the market.

Pension funds seem to be appropriate candidates for real estate investments. Their investment horizon is long so they can just buy and hold real estate assets and gain returns with acceptable volatility.

2.2 Cross-country analysis limitations

Before analyzing pension funds' investments it is necessary to mention some complications which problematize, to some extent, cross-country analyses of pension fund performance. Pension fund performance should be interpreted with regard to differences in pension systems. Savings in private pension funds may be optional or mandatory. Pension systems are either defined-benefits or defined-contributions which may impose crucial differences in pension funds' investment strategy. Finally, differences in market regulation can set completely different investment opportunities and affect significantly the pension funds' motivation.

Actually, only supranational organizations such as Organization for Economic Co-operation and Development (OECD) or World Bank provide broad cross-country research dealing with pension systems. A very detailed description of pension systems and market regulation in OECD countries has

been carried out by Tapia (2008b). He found, for example, that national supervisors may use different methodologies when measuring funds' returns or operating costs. Antolin (2008) named other limitations of data reported by pension funds and regulators as problems of "lagged aggregate weights", "weighted average share values", "clear portfolio composition separation between different asset classes" and "survival bias".

The problem of "lagged aggregate weights" arises when various weights from the end of the period are used for the description of the aggregated performance in the whole period. The issue of "weighted average share values" is related to the performance bias. This bias stems from using constant weights to calculate returns. A serious problem for undertaking an investment performance comparison across pension funds in different countries is the unclear portfolio separation among equivalently named asset classes. The last found bias of pension funds data is "survival bias", which arises from the fact that the averages of portfolios are constructed only by funds which survived until the end of the period. Funds which did not survive during the examined period are excluded and therefore the aggregated performance is shifted upwards.

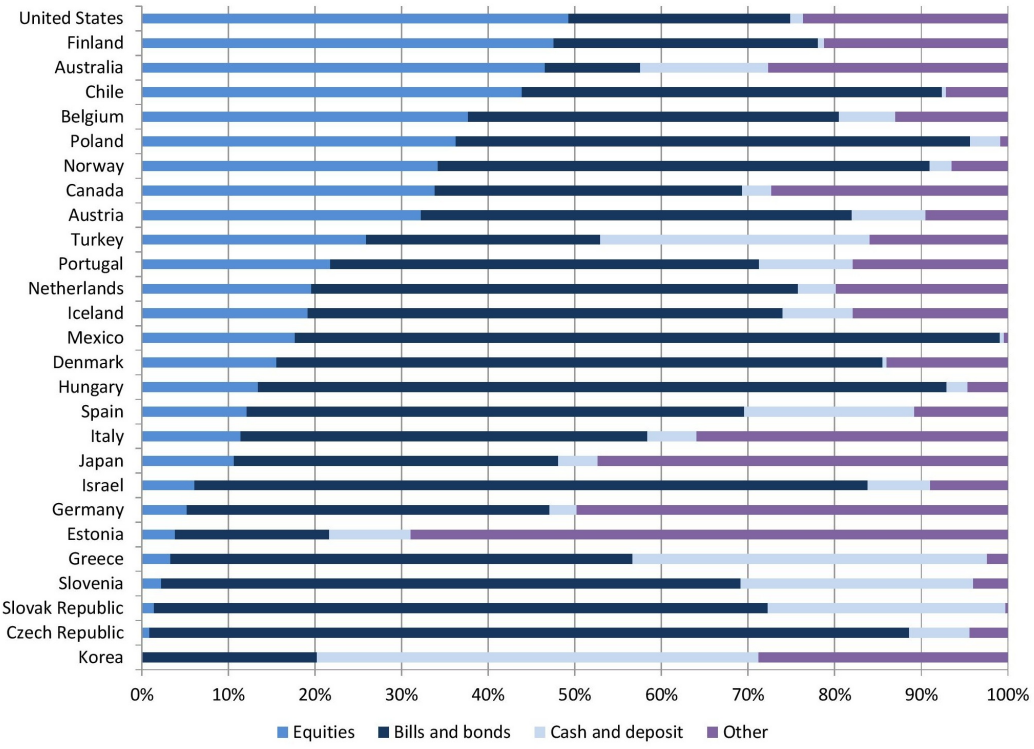
2.3 Structure of pension funds

Data reported by the OECD suggests that bonds are the most important asset class in most countries and they account for approximately 50% of total investments. Figure 2.1 demonstrates the structure of aggregated pension funds' portfolios in selected OECD countries sorted by the portion invested in equities. Countries with the most conservative portfolios are included at the bottom. The data does not allow the complete comparison of portfolio structures because of the share of investments classified as "other".[1] Nevertheless, it seems to be evident that not all OECD countries follow a conservative portfolio strategy. The United States, Finland, Australia and Chile allocated more than 40% of total investments to equities in 2010. The data

[1]The "other" category includes loans, land and buildings, unallocated insurance contracts, private investment funds, other mutual funds (i.e. not invested in cash, bills and bonds or shares) and other investments.

also shows that portfolios of pension funds in the Czech Republic were very conservative in 2010.

Figure 2.1: Pension funds' asset allocation in selected OECD countries in 2010



Source: Pension Markets in Focus, OECD 2011

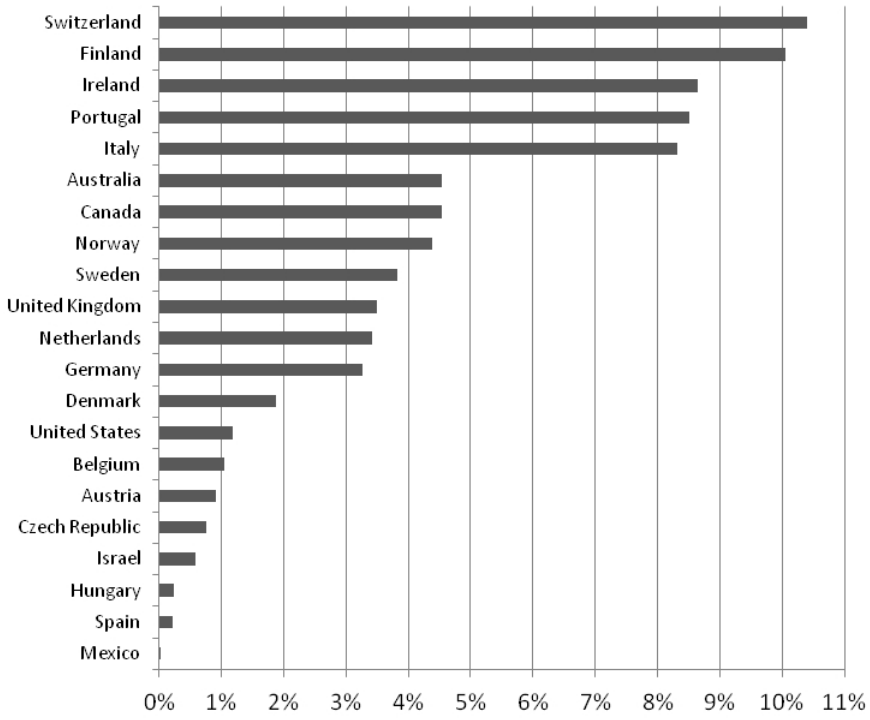
The comparison of the asset allocation in 2010 with the same evidence from the previous year, OECD stated that shares of equity and bonds remained relatively stable in most countries. Austrian, Finnish, Polish and Dutch pension funds even increased the share of equity from 2009 to 2010 by 6-7% while investments in bonds decreased by a similar amount. Bonds also have a dominant role in most non-OECD countries monitored by the OECD. On average, 55% of total assets were invested in bonds in selected non-OECD countries in 2010.[2]

The role of real estate investments is usually not discussed in OECD reports. However, the OECD database includes data of real estate investments of pension funds in some countries. Figure 2.2 shows the 10 year average share of real estate investments in aggregated portfolios of pension funds in OECD

[2]Source: Pension Markets in Focus, OECD 2011

countries with accessible data. Clearly, the share of real estate differs significantly among countries. While funds in Switzerland, Finland, Ireland, Portugal and Italy invested on average more than 8% in real estate, Austria, Czech Republic, Israel, Hungary, Spain and Mexico invested less than 1% of their assets in real estate. Czech pension funds invested in real estate most 1.07% in 2006. The overall simple average ranged between 3% and 5% in that period.[3]

Figure 2.2: The share of real estate in pension funds' portfolios 2001-2010 (10 year average)



Source: OECD, Pensions Indicators

The conservative orientation of the portfolio strategy could be a possible reason for limited real estate investments in Czech pension funds. However, there is still the possibility that slightly more real estate investments would improve the performance of Czech pension funds without destabilizing the current strategy. In the next chapter, we investigate the situation in the Czech market in more detail and we also examine whether additional real estate investments would be beneficial for pension funds or not.

[3]Data table is attached in appendix A.

Chapter 3

Czech private pension funds modeling

3.1 Data description

We used the quarterly data of Czech private pension funds' portfolio structure from the last quarter of 2000 to the last quarter of 2011 as reported by The Association of Pension Funds of the Czech Republic. The massive concentration of pension funds' assets can be observed in the last eleven years. The total value of assets in pension funds increased from 41.7 to 246.4 bil. CZK, which corresponds to the growth from 1.8% to 6.5% of GDP.[4] The number of pension funds in the market decreased from 18 in 2000 to 9 in 2011. This decrease in pension funds was mainly a result of increased market concentration due to the merging of funds. However, one fund, Thalia, became bankrupt. To avoid the "survival bias", we omit pension fund Thalia from our analysis. All other pension funds are included in the aggregated market portfolio.

8 out of 9 pension funds operated in 2011, although some, renamed or modified by multiple mergers, had been operating over the whole period. Only Aegon pension fund emerged as a new subject in the market in the third

[4]Our calculations are based on data supplied by The Association of Pension Funds of the Czech Republic and Czech Statistical Office. GDP in 2011 was calculated as the sum of quarterly estimates.

quarter of 2007. One can argue that we should remove this pension fund from the dataset because of the possible bias of the market portfolio at the end of the period. However, we decided to include this pension fund in our sample for the following reasons. First, the scale of Aegon's assets accounts for only about 2% of the market assets between 2007 and 2011. Second, Aegon's portfolio structure and its changes are not significantly different from the common trend in the Czech market. We provide some evidence for this assertion later in this chapter where fixed effect model is applied.

For each pension fund, we organize data to create a portfolio structure composed of five asset classes.

1. Bonds
2. Shares and Unit certificates
3. Cash and cash equivalents (CCE)
4. Real estate
5. Sundry

Although aggregated values of shares and unit certificates are reported separately today, they were, until 2006, reported as one asset class. Their risk-return profile is expected to be very similar and the taxation of both is susceptible to the same principles.[5] CCE are the most liquid assets in the market and therefore they play an important role in portfolio management. Real estate assets, since their share in the pension funds' portfolios is regulated by law in the Czech Republic, are clearly reported as a specific asset class. All remaining assets in portfolio, sometimes also called "non-traded securities", are classified as sundry assets. This asset class does not play an important role in the portfolio management or in our analysis. The share of sundry in portfolio structures is usually quite stable and very small.

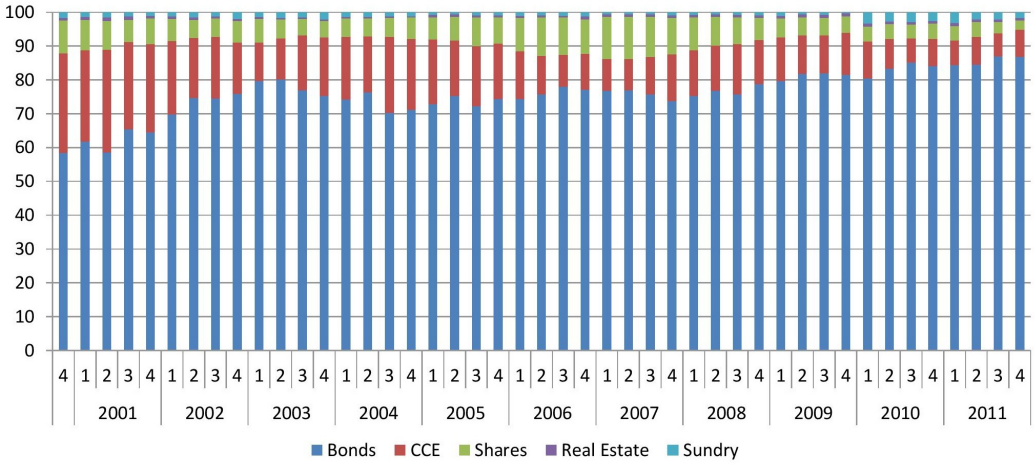
Unfortunately, Czech pension funds do not report the redistribution of asset class' investments between local and foreign markets. The only information available is the proportion of total foreign investments regardless of their structure. Unlike research dealing with portfolios of pension funds in

[5]For simplicity, we call the asset class "shares and unit certificates" only "shares".

the US (Ennis and Burik, 1991) and in the UK (Blake et al., 1999) where the structure of foreign investments is reported, we have to assume that foreign investments have a similar return profile as those in the Czech market. Since massive investments in foreign markets are not typical for Czech pension funds, so it is unlikely that this simplification will cause seriously our analysis.[6]

The visualization of quarterly data in figure 3.1 demonstrates changes in aggregated portfolio structure from 2000 to 2011.[7] Bonds were clearly the most important component of aggregated portfolios in each quarter. Conservative portfolio management was even strengthened during the observed period as shown by a shift to bonds from other assets. The share of bonds accounted for 58% of the aggregated portfolio in 4/2000 and it had been increasing to 87% in 4/2011. The significance of the most liquid asset class declined from 29% to 8% over the sample period. Proportion of shares decreased dramatically from 10% in 4/2000 to 3% in 4/2011. The importance of real estate had been very low. Actually, the share of real estate was even lower than the share of sundry in most quarters. The share of real estate and sundry in overall portfolio did not exceed 1.02% and 3.35% respectively in any single quarter.

Figure 3.1: Structure of aggregated Czech pension funds' portfolio (2000-2011)



Source: The Association of Pension Funds of the Czech Republic

[6]The share of foreign investments in aggregated portfolio ranged from 0.7% (Q1/2001) to 13.8% (Q2/2007) with the average of 8.4%.

[7]Data is attached in appendix B.

3.1.1 Returns approximation

In all models dealing with optimal asset allocation the cardinal issue arises from the requirement of suitable market returns estimation. We utilize the following benchmarks (below) to approximate the market returns of asset classes as defined above.

1. Bonds: Czech Republic Government Bond 5-year note yield
2. Shares: Prague Stock Exchange (PX) index
3. CCE: Prague Inter-Bank Bid Rate (PRIBID) 7-day deposit rate
4. Real estate: RE index

Quarterly historical data for yields of 5-year Czech Republic Government Bond and 7-day PRIBID are both published by Czech National Bank (CNB). PX index is monitored daily by Prague Stock Exchange. RE index is calculated quarterly by Czech Statistical Office. Unfortunately, RE index is not currently available for the last year. Thus, we approximate the RE index in 2011 by the index of flat prices.[8]

We use 5-year Czech Republic Government Bond as a benchmark for returns of bonds. CNB publishes bonds annualized yield calculated from the formula recommended by International Securities Market Association as:

$$P = \sum_{i=1}^{n} (CF_i V^{L_i}) \tag{3.1}$$

Here P is gross price, i.e. clean price plus accrued interest, n is number of future cash flows, CF_i is ith cash flow, L_i is time in years to the ith cash flow and V is annualized discounting factor, i.e. $\frac{1}{(1+y)}$, where y is the annualized yield. Quarterly averages of annualized yields are simple arithmetic averages of annualized yields computed in each working day in the quarter. For purposes of our analysis, quarterly returns are calculated as:

$$1 + y_q = \sqrt[4]{1+y} \tag{3.2}$$

[8]Index of price flats has been constructed by Czech Statistical Office since 2005, data are also quarterly and the covariance between trends of both indices is 0,899 in the period from 2005 to 2010.

In this instance index q stands for quarterly yield y.

In an article investigating the performance of British pension funds (Blake et al., 1999), 7-day LIBID (London Inter-Bank Bid Rate) was used as an approximation for cash returns. We use 7-day PRIBID as a benchmark for CCE returns in the Czech market. To be consistent with the calculation of quarterly yields of 5-year Czech Republic Government Bonds, we employed the simple average method to get quarterly 7-day PRIBID from monthly averages reported by CNB. To compute quarterly yields, the same method as for bonds is used.

PX index is the official index of Prague Stock Exchange.[9] It includes all major stocks traded in the Czech market. PX index is calculated daily. In our analysis, we investigate the managers' decisions on a quarterly basis. As we expect both the holding of shares for the whole quarter and the reinvestment of the income from shares in the same asset class, we therefore utilize the continuous compounding method to calculate quarterly returns.

Real estate returns are usually subject to a substantive measurement problem. Therefore, below, we explain the construction of RE index in greater detail. The source of data for the RE index constructed by Czech Statistical Office are statements for property transfer tax, which have to be handed in by sellers of properties to the financial office. The data has been collected and monitored since February 1999.

The administrative source is a remarkable specificity of the data. Prices admitted by sellers probably suffer from systematic bias. The prices of the property handed in to the financial office may be lower than true prices paid despite the fact that the price should be named by the valuation authority for tax purposes in case the admitted price is low. However, this bias is systematic and contaminates only the nominal price level of traded properties. Since RE index is constructed as a relative price change in time, it does not suffer from this bias.

[9] PX index was constructed in March 2006 and replaced previous indices PX 50 and PX-D. The methodology used complies with the IFC (International Finance Corporation) methodology recommended for the creation of indices in emerging markets. The formed PX index took over their historical values. Hence the data of PX index in last eleven years are continuous and we can use them for our analysis without any additional adjustments.

Significant advantages of the RE index is the amount of data included for its construction. Data of all real estate transactions are sent monthly from all regional financial offices in the country to the statistical office and they therefore reflect the prices of transactions in the nationwide real estate market. On this basis the Czech Statistical Office computes overall real estate index for each quarter.

The data used for calculation of real estate index include only types of real estate, for which there is enough sample size traded in the market such as family houses, flats, cottages, garden huts, garages, non-dwelling areas, halls, construction plots, agricultural land, forest land, forest stands etc. Each property included must not be an outlier in sense that it has to be describable by various combinations of explaining factors. The real problem of the real estate returns measurement therefore arises from the insufficient size of Czech real estate market. Occasionally traded big commerce buildings, which could be also a target group of institutional investors such as pension funds, are not included in the index calculation.

3.1.2 Historical returns of assets

Risk return profile of all four asset classes measured by means of quarterly returns from 2000 to 2011 and their standard deviations are summarized in table 3.1. The most stable returns were generated by bonds. Their standard deviation of quarterly returns was only 0.23%. The average return was equal to 0.86%. Similarly, the high stability of low returns was a property of most liquid asset class. The average of CCE returns was only 0.58% with standard deviation 0.31%. These two asset classes are highly correlated, the corresponding coefficient is equal to 0.85.

Unsurprisingly, the other two asset classes have quite different risk-return profile from bonds and CCE. Typical characteristics of both shares and real estate are generally high risk and high return. Our data provides us sufficient evidence to support this assertion. Investments in both risky asset classes generated much higher returns over the last eleven years than both bonds and CCE. This data also highlights another interesting finding. While means of quarterly returns of shares and real estate were very similar, at

1.36% and 1.46% respectively, standard deviation of real estate 2.24% was much lower than standard deviation of shares equals 12.63%.

As mentioned, correlation between returns of bonds and CCE was high. Real estate returns were more correlated with CCE than with bonds. The correlation coefficient between real estate returns and bond returns was only 0.37 and returns of shares were even negatively correlated with bond returns. The correlation coefficient -0.16 suggests the potential importance of bonds in the portfolio from the perspective of portfolio risk diversification. Inclusion of real estate as the second lowest correlated asset with bond returns could also diversify the portfolio. We will investigate these potential diversification effects by constructing an optimal portfolio through Markowitz's theory later in the thesis.

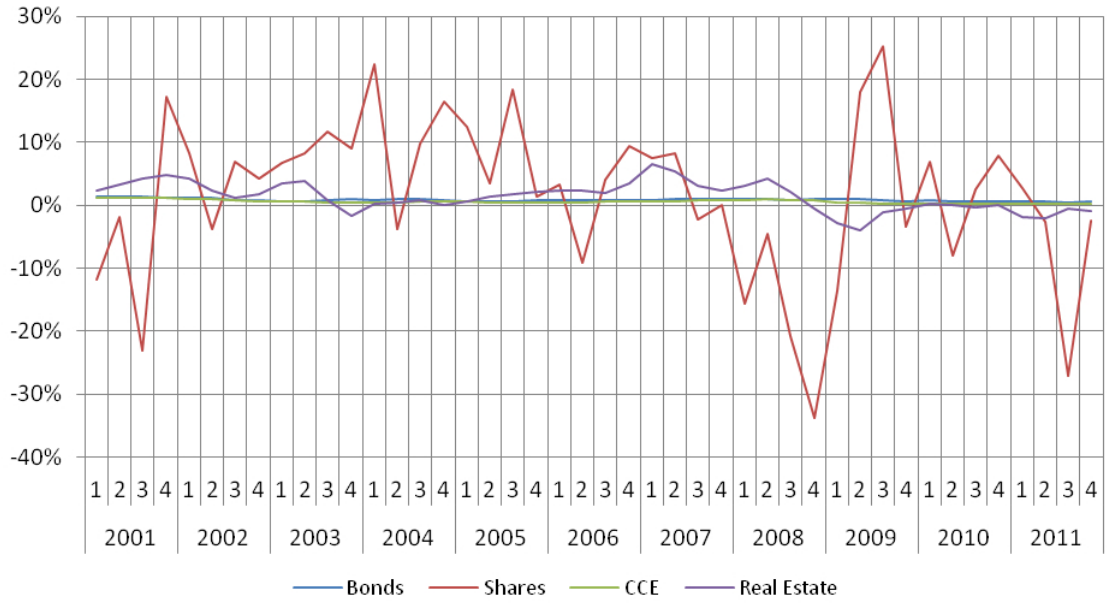
Table 3.1: Correlations, means and standard deviation of quarterly returns

Asset class	Correlation coefficients				Mean	Standard deviation
	Bonds	CCE	Shares	Real Estate		
Bonds	1.00000	0.84997	-0.15683	0.37852	0.86%	0.23%
CCE		1.00000	-0.18278	0.65161	0.58%	0.31%
Shares			1.00000	-0.00402	1.46%	12.63%
Real Estate				1.00000	1.36%	2.24%

The key performance characteristics of the two most risky asset classes also differ over time. From figure 3.2 we can see that excepting 4/2003, real estate provided unstable but strictly positive returns from 1/2001 to 3/2008. After this, returns became mostly negative with minimum -3.99% in 2/2009. Unlike real estate, returns of shares were very unstable and dropped below zero at least in one quarter in each year except 2003 and 2005. Quarterly return fell even below -20% four times in total during the observed period.

The performance of shares worsened dramatically with the financial crisis from 3/2007. Real estate returns reflected the crisis by slowly decreasing from around one year later. We split the period into the one before crisis 1/2001-2/2007 and the second one 3/2007-4/2011, when the crisis already affected the finance market performance. Means of shares quarterly returns in these periods were 5.22% and -3.96% with standard deviations 9.7% and -3.96%. Average return of real estate decreased in the same time from 2.29% to 0.02% and corresponding standard deviations enlarged from 1.8% to 2.1%.

Figure 3.2: Quarterly returns (2001-2011)



3.2 Dynamics of asset allocation in aggregated portfolio structure

As we mentioned in the previous section, the portfolio structure of Czech pension funds was not stable over the sample period. The deepening of prudent portfolio management strategy over the sample period seems to reflect the market performance. Without further analysis, we are not able to conclude to what extent those changes were driven by decisions of portfolio managers to shift some of the assets to less risky assets. Changes in portfolio weights were partially determined by variation of market returns. We investigate the origin of these changes more precisely here. As an analytical tool we use the model derived originally for analyzing pension funds in the UK (Blake et al., 1999).

3.2.1 Portfolio management strategy decomposition

We have already described changes in aggregated portfolio structure over the sample period. Those changes are not necessarily driven solely by intentional asset management. The second and possibly significant source of

portfolio weight changes is the relative increase or decrease of revenues of particular asset classes. Therefore it is important to distinguish between active portfolio management, i.e. changes in portfolio structures as a result of ex ante decisions of portfolio managers and passive portfolio management, i.e. changes coming from a "buy and hold" strategy, when benefits or loses causing changes in the portfolio structure are actually just outcomes turned out ex post. The question we would like to answer by the model constructed here is the significance of both of these strategies on changes in portfolio structure in the last eleven years. For asset allocation dynamics modeling we use the following aggregate portfolio decomposition proposed by Blake et al. (1999), slightly adjusted to our data set structure.

Let W_{iq} be an aggregated value of asset class i at the end of the quarter q held by all pension funds in the sample, and let W_i be the total holding of all asset classes. Then these weights must satisfy the accounting identity

$$W_{iq} = W_{iq-1}(1 + r_{iq} + NCF_{iq}) \tag{3.3}$$

where r_{iq} is the rate of return of the asset class i over the quarter q and NCF_{iq} is the rate of net cash flow into the asset class i over the quarter q. Moreover, let ω_{iq} denote the portfolio weight of asset class i defined as

$$\omega_{iq} = \frac{W_{iq}}{W_q} = \frac{\frac{W_{iq-1}}{W_{q-1}}(\frac{W_{iq}}{W_{iq-1}})}{\frac{W_q}{W_{q-1}}} = \omega_{iq-1}\frac{\frac{W_{iq}}{W_{iq-1}}}{\frac{W_q}{W_{q-1}}} \tag{3.4}$$

$$\frac{\omega_{iq}}{\omega_{iq-1}} = \frac{1 + r_{iq} + NCF_{iq}}{1 + \sum_{k=1}^{M} \omega_{kq}(r_{kq} + NCF_{kq})} \tag{3.5}$$

where M is a number of all asset classes in the portfolio. Taking log-differences, it follows that

$$\triangle\, log(\omega_{iq}) = log(1 + r_{iq} + NCF_{iq}) - log(1 + \sum_{k=1}^{M} \omega_{kq}(r_{kq} + NCF_{kq})) \tag{3.6}$$

and so for both $r_i q + NCF_{iq}$ and $\sum_{k=1}^{M} \omega_{kq}(r_{kq} + NCF_{kq})$ close to zero, equation (3.6) can be approximated as

$$\triangle\, log(\omega_{iq}) \approx (r_{iq} - r_{pq}) + (NCF_{iq} - NCF_{pq}) \tag{3.7}$$

where r_{pq} is the value-weighted total return of the portfolio and NCF_{iq} is the value-weighted net cash flow into the total portfolio during quarter q. Derived decomposition of relative changes in portfolio weights (3.7) can be extended by appropriate variance decomposition

$$var\lfloor \triangle\ log(\omega_{iq})\rfloor \approx var(r_{iq} - r_{pq}) + var(NCF_{iq} - NCF_{pq}) \\ +2cov(r_{iq} - r_{pq}, NCF_{iq} - NCF_{pq}) \tag{3.8}$$

Equality represented by equation (3.7) enables us to quantify the effect of two key factors on changes in portfolio structure. The first component $(r_{iq} - r_{pq})$ stands for changes in portfolio caused by differential returns across asset classes. The change is positive when the return of asset class i in quarter q is higher than the weighted return of the overall portfolio and negative otherwise. Shifts in the portfolio structure caused by this component are understood as outcomes of the passive management (buy and hold strategy). Besides, this strategy is associated with reinvestment of return in the asset category where it was generated. The second component $(NCF_{iq} - NCF_{pq})$ reflects net shifts across asset classes resulting from active portfolio rebalancing. The positive value represents shifting funds in the portfolio from other asset classes to asset class i in quarter q or disproportional distribution of new assets towards asset class i. The expansion of Czech pension funds in the last eleven years does not affect this component unless it is disproportional. In our analysis, we consider any cash flow redirection as active portfolio management though shifting to long term bonds could be in economic literature sometimes viewed as a passive management strategy.

3.2.2 Results

Sample means of $(\triangle\ log(\omega_{iq}))$ computed from our data and both their components are presented in the first panel of table 3.2. The results highlight the significant role of active portfolio management over the sample period. Cash flow redirection accounts for portfolio changes much more than differences in returns of particular asset classes in the aggregated portfolio. The only asset class with positive mean of net cash flow is bonds. Out of 0.90% of positive mean percentage change in aggregated portfolio weight, the whole

0.89% was caused by net cash inflow and only 0.01% came from positive net mean return. The impact of active management on the other three asset classes was also significant but in the opposite direction. Mean percentage changes in portfolio weights caused by net cash flow differentials were negative.

Mean percentage changes in portfolio weight arising from differential returns was negative only for CCE. Thus this is the only asset class with mean relative return lower than the mean of the total portfolio. The mean of bonds returns differentials equals 0.01% and almost matches the trend of the aggregated portfolio. Return differentials accounted positively to portfolio weights of shares and real estate.

The evidence shows that the impact both factors is in favor of increasing the share of bonds in aggregated portfolio on one side and decreasing the portfolio weight of CCE on the other side. Negative mean percentage change in the portfolio weight of shares and real estate was caused entirely by significant intentional cash outflow, while returns of these asset classes contributed to positive change of the overall portfolio weight.

The second panel of table 3.2 summarizes percentage decomposition of quarterly variance in aggregated portfolio weights between variation of return differentials, variation of net cash flow differentials and the covariance between them. Required equality is expressed as equation 3.8 above. Results show that variance of net cash flow differentials largely account for variance in portfolio weights of each asset class. Variance of differential returns seems to explain much less variation in the quarterly asset allocation. Return differentials appear to be important only as a significant explanatory factor of variances in shares' portfolio weights.

Table 3.2: Identification of the sources of changes to aggregate portfolio weights across asset classes

	Bonds	CCE	Shares	Real Estate
Mean percentage change in portfolio weight	0.90%	-2.93%	-2.80%	-0.32%
- due to different returns (passive)	0.01%	-0.27%	0.61%	0.51%
- due to net cash flow differentials (active)	0.89%	-2.66%	-3.41%	-0.83%
Percentage of quarterly variance in portfolio weights				
- due to variance of differential returns	6.13%	0.36%	90.10%	1.75%
- due to variance of net cash flow differentials	87.87%	102.30%	90.57%	102.89%
- due to covariance between these two factors	6.00%	-2.65%	-80.68%	-4.64%

3.3 Individual pension funds' asset allocation

So far, we have analyzed the aggregated portfolio composed of all pension funds operating in the Czech Republic. In this section, we try to answer the question whether portfolio managers in Czech private pension funds followed a similar strategy or whether at least some pension funds offer different investment opportunities to their participants.

As mentioned earlier, the number of pension funds in the Czech Republic declined from 18 to 9 from 2000 to 2011. In the following analysis, we are interested only in the performance of 9 pension funds registered at the end of the period. 8 of them have been operating continuously in the market for the last 11 years. The last one, Aegon pension fund, appeared in the market in the third quarter of 2007.

3.3.1 Fixed effect model construction

We introduce the fixed effect model proposed by Blake et al. (1999) to analyze cross sectional aspects of the asset allocation. Consider the fund specific version of equation (3.7):

$$\triangle\, log(\omega_{fiq}) \approx (r_{fiq} - r_{fpq}) + (NCF_{fiq} - NCF_{fpq}) \tag{3.9}$$

where the index f stands for specific pension fund. Then subtracting equation (3.7) from (3.9) we get

$$\begin{aligned} \triangle\, log(\omega_{fiq}) - \triangle\, log(\omega_{iq}) \approx [(r_{fiq} - r_{fpq}) - (r_{iq} - r_{pq})] \\ +[(NCF_{fiq} - NCF_{fpq}) - (NCF_{iq} - NCF_{pq})] \equiv \Psi_{fiq} \end{aligned} \tag{3.10}$$

The term Ψ_{fiq} represents the fund-specific relative change in ω_{iq}. Equation (3.10) can be further rewritten as

$$\triangle\, log(\omega_{fiq}) = \triangle\, log(\omega_{iq}) + \Psi_{fiq} \tag{3.11}$$

This decomposition enables us to measure the extent of the fund-specific changes in portfolio structure. The relative changes in weight in the portfo-

lio of the particular fund $\triangle\ log(\omega_{fiq})$ are comprised of the change in weight common across funds $\triangle\ log(\omega_{iq})$ and the fund-specific relative change Ψ_{fiq}.[10]

The classical fixed effect model presumes two features of data. First, the fixed effect is time invariant. In our case, the correlation between both components $\triangle\ log(\omega_{iq})$ and Ψ_{fiq} should be zero. However, Green (2002) found, that this assumption is usually relaxed in research done with economic data, which is likely to be time variant as in our case. Second, zero cross-sectional correlation is postulated. Following an aim similar to Blake et al (1999), who investigated UK pension funds, we state that such a requirement does not need to be a feature of our data. We consider the decomposition (3.11) to be a useful baseline for our analysis.

3.3.2 Correlations of individual weight changes with the common trend

Correlations between common trends in portfolio weight changes $\triangle\ log(\omega_{iq})$ and the fund-specific relative change Ψ_{fiq} are presented in Table 3.3. Only four pension funds invested in real estate. Construction of the "common trend" and the investigation of the consequent correlation for this asset class is not very useful. The other three asset classes are included in the portfolios of all pension funds in the sample. Large positive correlations are attributed to the Aegon pension fund. The specific contribution of this small pension fund to changes in portfolio weights of bonds and CCE in last four years seemed to strengthen the common trend. Far from zero is also the correlation between the common trend in portfolio weight changes of bonds and the fund-specific component of the relative change of Generali PF, which is also very small with assets accounting for only 1% of the overall portfolio. Correlation coefficients are more frequently close to zero, especially for large pension funds.

This correlation analysis with similar results was done by Blake et al (1999),

[10]When computing $\triangle\ log(\omega_{fiq})$, we had to omit values in cases where the weight of some asset dropped to zero. The model by its construction does not allow such changes in portfolio weights. However, since this happened only in a few cases in our sample, corresponding slight modification of data does not affect significantly computed means and correlations computed.

Table 3.3: Correlations between the fund-specific relative changes in portfolio weights and the common trend

Pension Fund	Bonds	CCE	Shares	Real Estate	Market share*
Aegon PF	0.64	0.58	-0.03		2%
Allianz PF	-0.12	-0.12	-0.20		5%
AXA PF	0.16	-0.08	0.34	0.77	14%
ČSOB PF Satbilita	0.21	-0.14	-0.37		13%
Generali PF	-0.59	-0.24	0.00	-0.90	1%
ING PF	0.29	0.18	-0.25		11%
PF České pojišťovny	0.04	0.06	0.26		24%
PF České spořitelny	0.02	0.05	-0.06	-0.89	16%
PF Komerční banky	-0.09	-0.03	0.06	-0.91	13%

**Market share of the pension fund in 4Q/2011*

who analyzed information from more than 300 UK pension funds. Unlike the UK case, our data includes only 9 pension funds. There is a question, whether pension funds in the Czech Republic offer different management strategies in such a concentrated market.

3.3.3 Examination of diversity in portfolio strategies

Mean percentage changes in portfolio weight of all investigated pension funds $\triangle\ log(\omega_{fiq})$ are presented in table 3.4. Fund-specific relative changes in portfolio weights Ψ_{fiq} are by construction equal to the difference of $\triangle\ log(\omega_{fiq})$ and aggregated portfolio changes $\triangle\ log(\omega_{iq})$ presented in the last line of the table. Different mean changes of pension funds suggest possible differences in portfolio management across pension funds. Means of weight changes vary more or less from the aggregated changes and from each other. Aegon PF has negative mean change of bonds, Generali PF has positive mean change of CCE and Axa PF seems to perform differently from all others by investing in risky assets. Other pension funds are subjected to negative mean relative changes of all assets except bonds.

However, it is difficult to draw conclusions about the differences in speed of portfolio changes because we measure asset weight changes relative to the share of asset classes in the portfolio. In fact, the significant information observable from table 3.4 is the positive or negative sign of mean changes related to the increasing or decreasing trend of portfolio weights. To be

able to conclude whether there were significant differences between the performed management strategies of Czech pension funds in the last eleven years, we must combine our obtained information concerning relative portfolio changes with the portfolio structures.

Table 3.4: Mean percentage changes in fund portfolio weights

	Bonds	CCE	Shares	Real Estate
Aegon PF	-0.22%	6.43%	-10.57%	
Allianz PF	1.00%	-5.87%	-17.13%	
AXA PF	0.25%	-3.30%	1.52%	11.71%
ČSOB PF Satbilita	1.56%	-7.46%	-5.85%	
Generali PF	0.12%	0.70%	-3.18%	-2.68%
ING PF	0.88%	-2.56%	-2.54%	
PF České pojišťovny	1.03%	-4.57%	-3.40%	
PF České spořitelny	1.47%	-2.38%	-2.08%	-4.61%
PF Komerční banky	1.52%	-2.38%	-0.72%	-5.43%
Market portfolio	0.90%	-2.93%	-2.80%	-0.32%

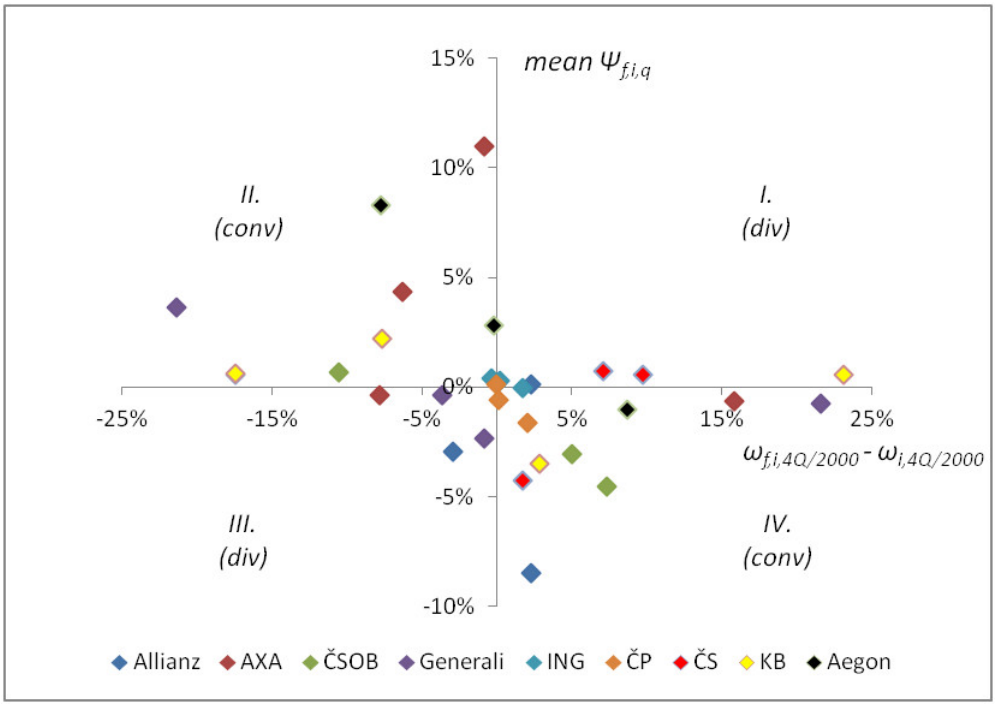
We have already shown that quarterly fund-specific relative changes in portfolio weights Ψ_{fiq} are independent from common trend for most funds. However, there is still not sufficient evidence to conclude that pension funds offer their participants different portfolio strategies. Differences in portfolio changes across funds may arise out of different initial portfolio structures. Higher or lower specific changes in portfolio weights could be determined exclusively by different starting points and portfolios still could converge to the common trend at different rates. To draw conclusions about the convergence or divergence of Czech pension funds and the common trend in the market, we investigate the conditionality of fund-specific trends given by differences in initial fund-specific portfolio structures.

We computed means of fund-specific relative changes in portfolio weights Ψ_{fiq} and also differences of initial fund-specific portfolio weights from the aggregated weight for each asset of each fund in the fourth quarter of 2000 and plotted these two variables.[11] Then we plotted the means of Ψ_{fiq} on the vertical axis and the differences of initial portfolio weights from the initial means on the horizontal axis in figure 3.3 and figure 3.4. Both figures show the same set of points where each point stands for the weight of one particular asset class of one particular pension fund. Asset classes are structured by

[11] In the case of Aegon PF, the difference references 3Q/2007.

pension funds in figure 3.3, while they are sorted by the type of asset class in figure 3.4. Hence these two categories belonging to each point are easily detected.

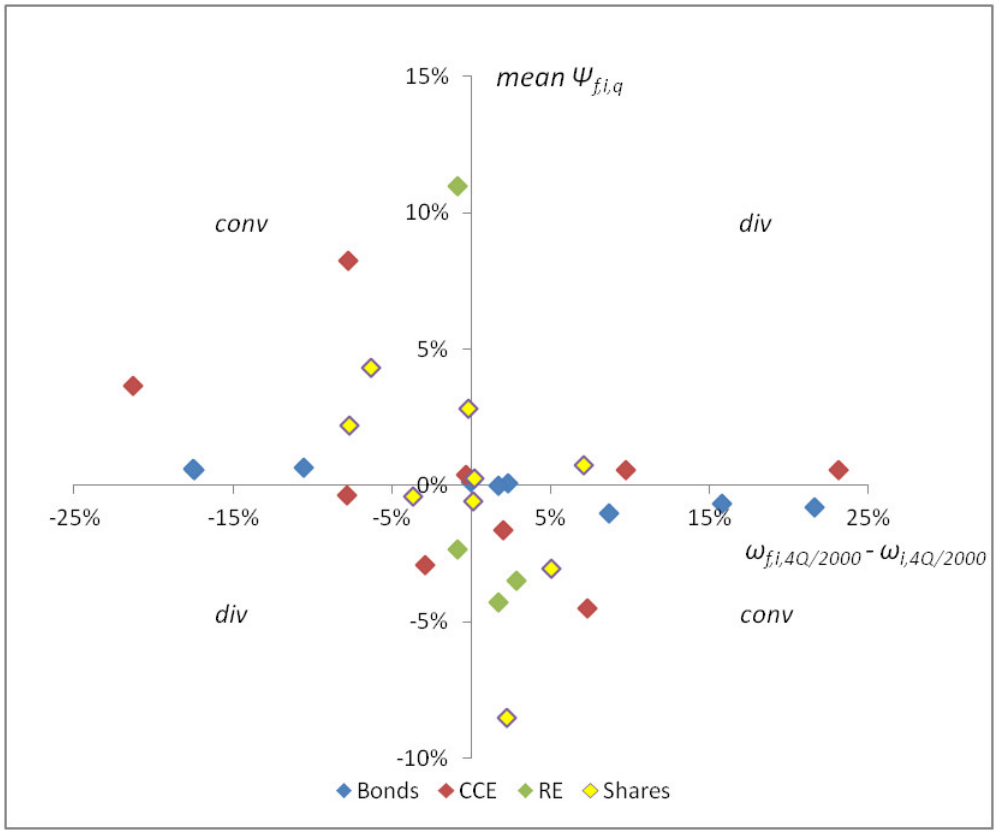
Figure 3.3: Convergence plot (fund structured)



In the first quadrant, there are asset classes whose weights were higher in fund portfolios in 4Q/2000 than the in the aggregated portfolio and whose share in funds portfolios increased more than the market portfolio on average, i.e. they diverged. Asset classes in the second quadrant were underweighted in 4Q/2000, however their weights increased more than the corresponding weights in the aggregated portfolio on average. The fourth quadrant contains assets with the characteristics opposing the characteristics of second quadrant assets. All asset classes in the second and fourth quadrant converge either from above or below to the aggregated portfolio weights. Third quadrant represents asset classes underweighted in the initial portfolios whose weights were weakened more than the benchmark, hence they clearly diverge from the common trend.

The proposed interpretation fits well for description of divergence from the common trend. However, the term convergence is not necessarily suitable enough. An asset class underweighted (overweighted) at the beginning which had been strengthening (weakening) in the next eleven years towards

Figure 3.4: Convergence plot (asset class structured)



the trend strongly enough, could have crossed the average weight in a particular time and then started moving away from the trend. The term convergence is understood as the convergence of asset class's share that had started in 4Q/2000 and lasted to the end of the observed period or shorter. Portfolios composed of assets indicating convergence do not show different portfolio strategy in the last eleven years, which is clearly attribute of portfolios composed by diverging assets' weights. We introduce such benchmark to detect pension funds, which clearly follow strictly different portfolio management from the average and their strategy has been significantly invariable over last eleven years.

Our sample contains 31 observations.[12] 9 asset classes are plotted in quadrants denoting divergence and remaining 22 indicate convergence pattern. In the minority of diverging samples, only one represents bonds and indicates stronger increase of the share of this asset class on average in the

[12] Out of 9 pension funds in the sample, four had the full portfolio composed of four asset classes for at least some quarters, five remaining pension funds did not have real estate in their portfolios in any single quarter.

portfolio. Only four pension funds have real estate in their portfolios. One of them diverges downwards. Remaining divergences in shares and CCE follow both directions from the trend depending on specific pension funds.

Table 3.5 shows pension funds and divergence indicators of asset classes in their portfolios. Changes in portfolios of three pension funds (Aegon PF, ČSOB PF Stabilita and PF České pojišťovny) with respect to initial portfolio structures indicate no divergence in any single asset class. They also do not invest in real estate at all. Pension funds Allianz and Axa reduced the portion of CCE on average more than the decrease of CCE common in the market. While Axa PF spread the gained assets between other asset classes following the trend, Allianz PF even strengthened the common tendency of prudent strategy and increased the portion of already overweighted bonds. Generalli PF also followed low-risk strategy and lowered shares of underweighted risky assets on average more than the decrease common across all funds. ING PF and PF České spořitelny are only two pension funds which weights of shares suggest divergence upwards. Finally, data of PF Komerční banky show tendency to invest more in short term money instruments.

Table 3.5: Divergence indicators

Pension fund	Bonds	CCE	Shares	RE
Aegon PF	conv	conv	conv	
Allianz PF	div (up)	div (down)	conv	
AXA PF	conv	div (down)	conv	conv
ČSOB PF Satbilita	conv	conv	conv	
Generali PF	conv	conv	div (down)	div (down)
ING PF	conv	conv	div (up)	
PF České pojišťovny	conv	conv	conv	
PF České spořitelny	conv	div (up)	div (up)	conv
PF Komerční banky	conv	div (up)	conv	conv

It is worth to mention that the detected divergence from the trend itself is not sufficient evidence to decide whether strategic asset allocation of pension funds differs significantly because the divergence attribute still allows the asset class to follow the same direction of change in portfolio weights with changes of the market portfolio. Divergence only states that the weight of the asset moves away from the corresponding asset weight in the aggregated portfolio on average.

3.3.4 Results

Although it is challenging to make reliable statements about different or indifferent portfolio management strategies of pension funds, we believe that the combination of evidence demonstrated in tables 3.4 and 3.5 provides helpful indicators for few clear statements.

First, the evidence shows, that real estate is rarely used as an asset by Czech pension funds. Three out of four pension funds which included real estate in their portfolios in the past had negative mean weight change of this asset class. On the contrary, AXA PF started to invest in real estate and had positive mean weight change in the observed period. The mean of weight change of shares decreased on average in portfolios of all pension funds except AXA PF. Investments in this asset class were the second lowest across all pension funds in the fourth quarter of 2000. It is therefore not adequate to say that the shift of this pension fund to risky assets represent clearly different portfolio management principles.

None of pension funds resisted the market trend of massive investments in bonds. The most popular asset class during the eleven years has became even more important in portfolios of all pension funds operating from 2000 to 2011 in the Czech market. Aegon PF, which appeared in the market in the third quarter of 2007, had negative mean percentage change in fund portfolio weight, but its initial portfolio in the first period was already composed of 84% of bonds and therefore this pension fund cannot be considered as exception from the rule. Huge investments in bonds absorbed the initial popularity of short term money instruments. The role of CCE weakened rapidly in all funds except Generali PF, which preferred investments in bonds instead of CCE holdings for the whole period.

3.4 Optimal portfolio construction

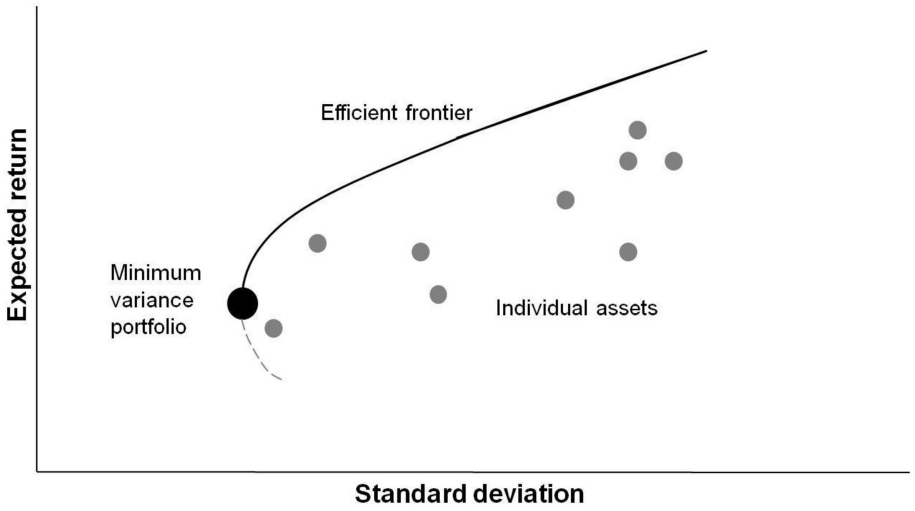
Using historical data we investigated the performance of Czech private pension funds. We would also like to see to what extend the structure chosen by portfolio managers match the efficient market portfolio. First attempts dealing with the issue of efficiency measurement were done by Hlaváč (2011)

who used aggregated data of Czech private pension funds and calculated the Sharpe ratio. He concluded that Czech private pension system provides very poor results. Czech private pension funds achieved the lowest returns relative to the risk among six countries from the Central-Eastern-European region included in the study. We go more into details of the Markowitz portfolio theory focusing on portfolio structure chosen by Czech pension funds managers. We compare the actual structure with the efficient portfolio structure suggested by this famous theoretical framework. The concept of efficient frontier is employed.

3.4.1 Efficient frontier

Efficient frontier is a set of portfolios that offers highest expected return for given level of risk among all possible portfolios. These portfolios plotted in a risk-return space form a positively sloped curve bounded at the bottom by global minimum variance portfolio. All portfolios on the efficient frontier provide best risk-return combinations that could be constructed from assets included in the portfolio.

Figure 3.5: Efficient frontier



Standard deviation of portfolio returns is generally accepted measure of risk. Expected portfolio return is computed as a weighted expected return of all assets in the portfolio. Let Ω be a vector of portfolio weights of all assets

included in the portfolio p and let μ be a vector of expected returns of these assets. Expected return of the portfolio $E(r_p)$ and variance of portfolio returns $var(r_p)$ are equal given by formulas

$$E(r_p) = \mu^T \Omega \tag{3.12}$$

$$var(r_p) = \Omega^T \Sigma \Omega \tag{3.13}$$

where Σ is a covariance matrix for returns of assets in the portfolio p. Standard deviation of portfolio returns is derived as square root of $var(r_p)$. For 1 being a unity vector, following condition expresses the fact, that the sum of portfolio asset weights is equal to one in matrix notation.

$$1^T \Omega = 1 \tag{3.14}$$

The parametrical approach of the optimal portfolio selection can be formulated as minimizing (3.13) for given (3.12) subject to (3.14). The solution feasibility is proved by the Lagrange multiplier theorem.

We follow the common practice of using standard deviations of historical returns as a measure of risk. This ex post assessment is understood as a good proxy of returns uncertainty. With regard to huge market erosion in the second half of investigated period, it is reasonable to raise a question whether variation of returns followed the similar pattern for the whole period. Therefore we examined test for homoscedasticity of real estate and shares quarterly returns. We tested the null hypothesis of variances being the same in the period before crisis 1/2001-2/2007 and in the second period 3/2007-4/2011. On 5% value of significance we concluded that variations of neither real estate returns nor returns of shares differed significantly in first and second period.[13]

Before figuring out the efficient frontier, we need to determine the appropriate benchmark for asset expected returns. There are two possible methods. First one is to use the mean historical returns, which is typically done in the literature dealing with portfolio issues. Another possible way was presented by Ennis and Burik (1991). When solving the problem of optimal

[13]Test statistic and other calculations are attached in Appendix C.

asset allocation of pension funds in US, they derived expected returns from capital asset pricing model (CAPM). They used indexes of asset classes and aggregated pension portfolio return to work out betas. They tied the beta of stocks with the average return of stock index and then they computed expected returns of remaining asset classes expecting the linear proportionality of expected risk premium with the beta coefficient.

Unlike the article investigating US pension funds, we detected huge gap in standard deviations of historical returns between shares and other asset classes (see table 3.1) and therefore CAPM attributes excessive expected return to assets rather than to real estate and bonds. This fact is supported by the evidence that variation of shares returns accounts for 89% of variation in value-weighted return of the aggregated portfolio. For that reason, we use mean historical returns as a benchmark of expected returns.

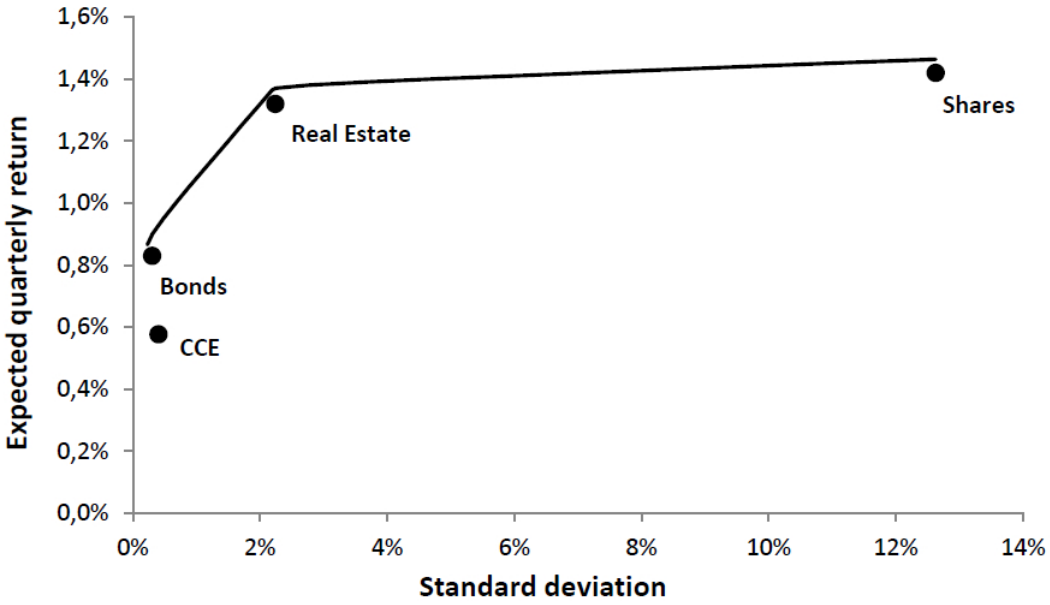
Thus, historical indicators determine risk-return characteristic of four asset classes in our model. Mean returns, standard deviations and correlations have been already discussed in section 3.1.2.

3.4.2 Optimal portfolio in the Czech market

Figure 3.6 presents the efficient frontier constructed from data of quarterly returns of bonds, CCE, shares and real estate, which have been reported in table 3.1. CCE have clearly lowest returns and their standard deviation is higher than the standard deviation of bonds returns. Returns of CCE and bonds are highly correlated, therefore CCE is likely the least attractive asset class in the portfolio. Visualization of other three asset classes in the risk-return space shows clear trade-off between risk and return. Efficient frontier leads slightly above the three points marking bonds, real estate and shares. The minimum variance portfolio consists of bonds from 99.7% and shares from 0.3%. Compared to real estate, shares bring relatively high risk to the portfolio regarding low increase in marginal expected return.

It may be worth to mention that annual expected portfolio returns are equal to the expected quarterly return multiplied by four. This comes from the construction of shares returns and real estate returns we used. The same

Figure 3.6: Efficient frontier in the Czech market



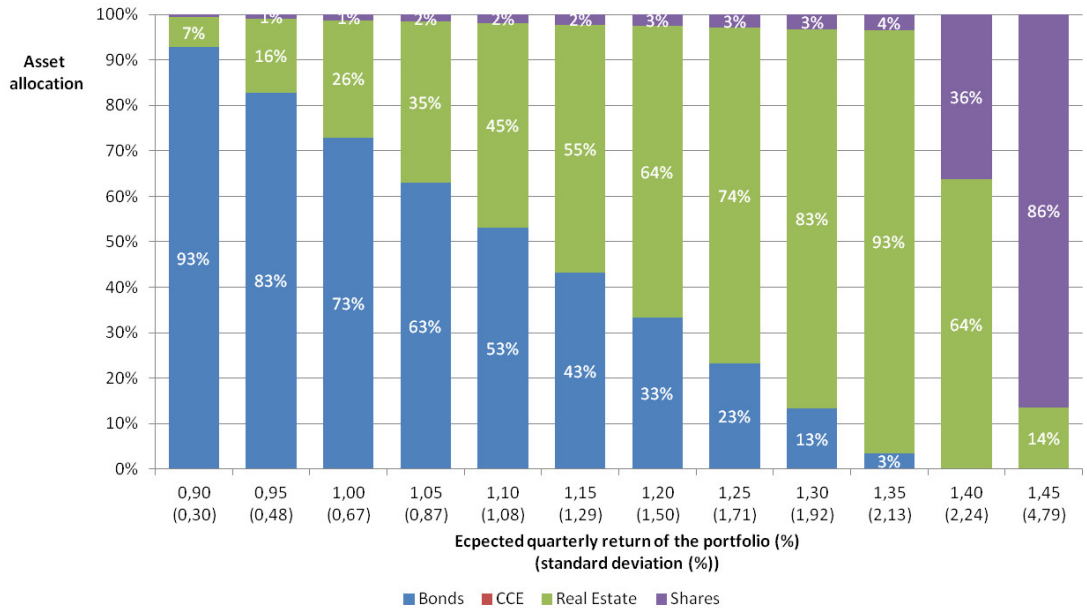
equivalence is a very close approximation of the proper computation of annual returns of bonds and CCE.

The optimal composition of portfolios on the efficient frontier is illustrated in figure 3.7. On the horizontal axis, there is an expected quarterly return of each portfolio with corresponding standard deviation. We plot portfolios from the whole range of attainable returns in 5% intervals plus three specific efficient portfolios including one asset class only.

As could be expected given the characteristics of asset classes, CCE is not included in any portfolio from the whole range. With the increasing expected return proportions of real estate and shares in the optimal portfolio increase. The first visualized portfolio with expected return only 0.03% higher than the global minimum is composed of bonds from 92.79%, of real estate from 6.57% and of shares from 0.64%. Similarly, the great amount of real estate and very little amount of shares is added to the portfolio instead of bonds to gain higher expected returns. Standard deviation of returns increases almost linearly with the increase in expected returns. With additional 0.05% of expected return, the standard deviation rises approximately by 0.2%.

This pattern holds up to the point, where the portfolio is constructed almost exclusively by real estate and offers the quarterly return of 1.35%. Since that

Figure 3.7: Asset allocation in efficient portfolios



point further, additional increase of expected return can be attained only by adding more shares in the portfolio and the corresponding risk of portfolios increases a lot. The rise of approximately 2.5% in standard deviation is required to increase the expected return by 0.05%.

Construction of efficient portfolios shows clearly, that real estate should be more used in conservative portfolios than shares. Although the portion of shares in low-risk portfolios is not zero, probably because of the negative correlation between the returns of shares and returns of bonds, they are weakly included compared to real estate. On the other hand, shares become very attractive in risky portfolios. This is not the case for Czech private pension funds that typically invested around 60-90% of their assets in bonds in last eleven years. If we subtract the amount of assets invested in CCE for liquidity purposes, which was in the last two years typically less than 10% and few per cent of shares, the remaining amount should be invested in real estate.

3.5 Cost of assets misallocation

Returns of pension funds are naturally lower than returns predicted by efficient portfolio models. There are more possible sources of this difference. The total inefficiency is somehow spread between the inefficiency given by the inadequate composition of portfolio structure, differences in returns from particular asset classes because of the unique security selection and other sources of inefficiency. These factors of portfolio performance are often subject of investigation.

3.5.1 Model construction

Brinston et al. (1986 and 1991) developed a framework to evaluate these portfolio performance determinants. They proposed the decomposition method to distinguish between profit arising from particular security selection, market timing and the long term investment policy. Unfortunately, we do not have data describing the composition of pension funds returns concerning the link between the shares of total return with investments in particular asset classes and therefore, we are not able to evaluate net extra gains or losses arising from specific allocation within asset classes. Also the proposed benchmark of long term strategy computed as a potential return from averaged portfolio structure is not suitable for modeling pension funds in the Czech market where there is a clear pattern of shift towards bonds in the long term.

Instead of estimating the success of particular portfolio managers coming from the deviation of actual portfolio from the long term mean, we estimate the annual loss arising from the asset classes' misallocation in each year of the sample period.[14] The misallocation is understood as a deviation of the actual portfolio from the optimal portfolio suggested by the portfolio theory. The optimal portfolio is always determined by the level of risk chosen or vice versa by the share of risk-free investment. In the case of pension funds'

[14]Our return analysis is strictly limited by the fact, that returns of pension funds are reported annually. Hence, we cannot construct a model on a quarterly basis as when modeling changes in portfolio structures. Data of returns of Czech pension funds used are reported by The Association of Pension Funds of the Czech Republic.

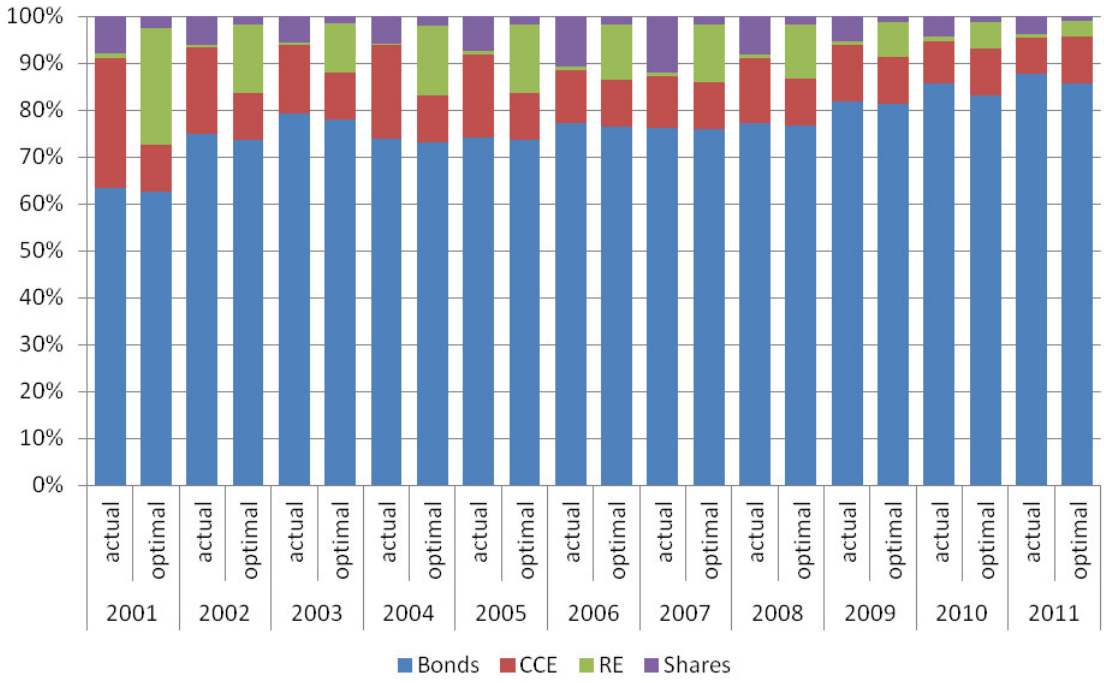
portfolios, fixed-income assets bonds and CCE could be considered as a risk free investments. Bonds are reasonable investment instruments because of their risk-return structure. The same does not hold for CCE. Their holding is rational for liquidity sufficiency of pension funds. However, the share of CCE in portfolios of pension funds is less than 10% on average in last two years of the sample. We suppose that such a low portion is enough to meet liquidity needs. The other part of assets in CCE class was likely invested in short term money market instruments, especially at the beginning of the millennium. The excess investments in CCE should be a subject to the risk-return optimal asset allocation issue.

Therefore, we convert the optimal portfolios to selected portfolios in the following way. For any actual portfolio, we fix the amount of bonds as a determinant of the risk selected by the portfolio managers. From the remaining portfolio share, we subtract 10% as a necessary liquidity security and sundry assets. Holding more CCE in portfolios is not efficient as suggested by the optimal portfolio construction in the previous section. For each portfolio with fixed portion of bonds and CCE, we finally estimate the optimal allocation of remaining investments between shares and real estate.

Consequently, compared to actual portfolios, the optimal portfolios have the same level of bonds, 10% of CCE and remaining share is optimally allocated between the two other asset classes. Figure 3.8 shows the visualization of differences between annual actual and optimal annual asset allocations from 2001 to 2011. In optimal portfolios, the excess of CCE investments and some investments in shares are transformed to the real estate. The difference is more significant at the beginning of the period when short term money instruments were used much more than in later years.

Since we would like to estimate the loss arising from the misallocation between asset classes in the market, we can just compare the average returns of actual and optimal portfolios in each year. Moreover, we are interested in comparing the modeled return of actual portfolio with the real return, which Czech pension funds pay to accounts of their participants. The Association of Pension Funds of the Czech Republic reports the average annual historical returns of existing pension funds. However, this measure is not suitable enough to describe the market situation, because it can be seriously biased for two reasons. First, recently existing pension funds accounted for

Figure 3.8: Actual versus optimal asset allocation



only 70% of the market in 2001.[15] Other pension funds, although they later merged with current pension funds, might have had quite different returns. Second, to be consistent with the structure of aggregated weights, which is computed using the weighted average method, the same method should be used to calculate equivalent aggregated returns.

We computed weighted average returns for each year in our sample period and estimated the aggregated historical returns of the rest of the market by extrapolating from historical returns of current pension funds. Finally, we estimated the return of pension funds paid to accounts of their participants in 2011 to be 85% of the total investment yield.[16]

Table 3.6 presents remarkable evidence about Czech market of pension funds. Except 2011, the simple average return of current pension funds was higher than the weighted average return in each year of the data sample. This implies that small pension funds achieved higher returns than large pension funds in general. It follows that the historical performance of pension funds

[15] Although ČSOB PF Progres was merged with ČSOB PF Stabilita in 2011, it is considered as a current pension fund here and its included in 70% market share in 2001.

[16] 85% is the legal minimum. The real values were not available when this research was done.

is overrated when the methodology of simple average return is used to describe the overall market performance.

Table 3.6: Weighted and simple average returns

	weighted average return			simple average return	difference
	current PFs return	market share of current PFs	market return	return of current PFs	weighted average return - simple average return
2001	2.84%	69.86%	4.07%	4.12%	-0.06%
2002	2.80%	76.33%	3.67%	3.76%	-0.08%
2003	2.87%	90.13%	3.18%	3.23%	-0.05%
2004	3.14%	93.14%	3.37%	3.55%	-0.18%
2005	3.82%	98.49%	3.87%	3.95%	-0.07%
2006	2.99%	99.28%	3.01%	3.04%	-0.03%
2007	2.50%	99.91%	2.50%	2.89%	-0.39%
2008	0.34%	100.00%	0.34%	0.98%	-0.64%
2009	1.20%	100.00%	1.20%	1.48%	-0.28%
2010	1.97%	100.00%	1.97%	1.99%	-0.01%
2011	1.61%	100.00%	1.61%	1.41%	0.20%

Source: The Association of Pension Funds of the Czech Republic

To estimate costs arising from asset class misallocation, we use a simple return decomposition. The idea of decomposition is described by following equalities.

$$return_{optimal} = return_{expected} + loss\ due\ to\ asset\ class\ misallocation \quad (3.15)$$

$$return_{expected} = return_{actual} + loss\ caused\ by\ remaining\ factors \quad (3.16)$$

Putting (3.15) and (3.16) together, it holds that the difference between the optimal and actual return has two different components.

$$return_{optimal} = return_{actual} + loss\ due\ to\ asset\ class\ misallocation + loss\ caused\ by\ remaining\ factors \quad (3.17)$$

The optimal annual portfolio return is calculated as the average market return of the optimally structured portfolio and expected return is the average market return of actual pension funds' portfolio. We have sufficient data to estimate both components of the overall loss on the annual basis.

$$return_{optimal_t} = \sum_{i=1}^{K} \omega_{it}^* r_{it}^* \quad (3.18)$$

$$return_{expected_t} = \sum_{i=1}^{K} \omega_{it} r_{it}^* \quad (3.19)$$

where K is number of asset classes in the portfolio, ω_{it}^* and ω_{it} are optimal and actual weights of asset class i in year t and r_{it}^* is the average annual return of asset class i in year t.

The *loss due to asset class misallocation* is a pure difference between average market returns of optimal and actual portfolios and hence it is the estimate of the inefficiency of actual portfolio structure. The *loss caused by remaining factors* is the difference between expected and actual return of the actual portfolio. This difference arises from different reasons such as specific security selection, management and administrative costs or taxes. *Loss due to asset class misallocation* is positive on average, which comes from the nature of optimal portfolio construction. *Loss caused by remaining factors* is expected to be mostly positive. It can be negative in case when yields of specific security selection are high enough to cover all transaction costs. Both defined losses are expected to be positive at least on average. In such case, it holds that at least on average

$$return_{optimal} > return_{expected} > return_{actual} \tag{3.20}$$

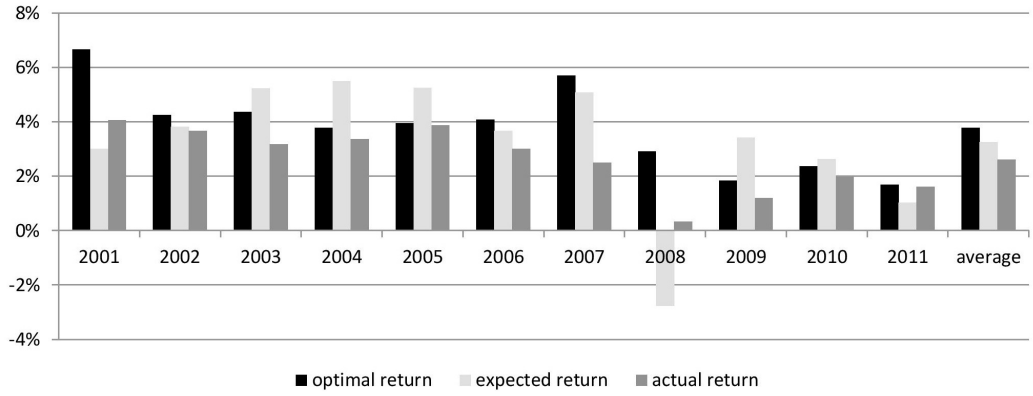
3.5.2 Results

Our results correspond with the expectation. The inequality (3.20) holds on average. However, if we focus on particular years, the inequality is not clearly observable. Optimal, expected and actual returns in each year are plotted in Figure 3.9. Optimal return is higher than actual return in each year. The expected return is extremely volatile. It reaches higher values than optimal return in five out of eleven years and falls much below actual return in 2008 when the impact of financial crisis was the strongest in the Czech market.

Standard deviations of optimal, expected and actual annual returns are 1.46%, 2.31% and 1.15%. The relative stability of optimal portfolios' returns compared to expected returns in actual portfolios is given by the construction of optimal portfolio. Real estate and shares are structured in a way to achieve the highest stability of returns. Higher volatility of expected outcomes is a natural effect of inefficient allocation of risky assets. Expected returns are

more volatile than optimal returns despite the fact that the excess of investments in CCE was spread out mostly in real estate asset class, which has a higher volatile returns.

Figure 3.9: Optimal, expected and actual returns



The lowest volatility is observable in actual returns. This evidence is highly expectable. We have already found that changes in asset structure are mainly the consequences of portfolio managers' activity. It is plausible that they adjust the portfolio to actual market fluctuations and therefore their activities contribute to the stability of returns compared to passively managed portfolio, which would achieve results similar to expected returns. Other sources of stability of the actual returns compared to the expected returns are taxes and management costs, which are higher in years when pension funds achieve higher returns. These factors lower volatility of actual returns. The correlation coefficient between the *loss caused by remaining factors* and *expected return* is equal to 0.88.

For the completeness of results, table 3.7 reports the decomposition of the total loss in two elements in order to detect the precise differences between optimal, expected and actual returns. As mentioned earlier, optimal returns were higher than actual returns in every year of the sample period despite the fact that both components varied and each of them reaches a negative value in certain years.

The average total annual loss is estimated to 1.17% by our model. The loss caused by asset class misallocation is almost as significant as a loss caused by all remaining factors. The annual return of Czech private pension funds is estimated to 0.52%. Between years 2001 and 2011, the average annual

Table 3.7: Weighted and simple average returns

	total loss	loss due to asset class misallocation	loss caused by remaining factors
2001	2,60%	3,66%	-1,05%
2002	0,59%	0,44%	0,15%
2003	1,18%	-0,88%	2,06%
2004	0,42%	-1,71%	2,13%
2005	0,07%	-1,31%	1,39%
2006	1,08%	0,43%	0,65%
2007	3,20%	0,62%	2,59%
2008	2,57%	5,69%	-3,11%
2009	0,65%	-1,58%	2,23%
2010	0,39%	-0,28%	0,67%
2011	0,09%	0,67%	-0,59%
average	1,17%	0,52%	0,65%

true return equals 2.62% hence the loss of 0.52% by inefficient misallocation among asset classes seems to be quite significant.

3.6 Limitations of the model

As in each economic model, the validity of outcomes can be affected by limitations arising from the specific model construction. Indexes of shares and real estate and averaged returns of bonds and CCE used to approximate market returns of asset classes represent averages of large amount of securities and they do not include securities form foreign markets. Specific security selections of particular pension funds can seriously affect the performance of these pension funds. However, the model should fit to the description of the aggregated portfolio of Czech pension funds since it includes wide range of investment instruments and the overall share of foreign investments in aggregated portfolio was only 8,4% on average between 2001 and 2011.

Estimation of the average returns of real estate is the most challenging issue of each analysis dealing with market returns' modeling. We use real estate index computed on the basis of changes in prices of large number of mostly small-sized properties. Pension funds apparently choose different structure for their real estate investments. They can diversify their real estate invest-

ment well by investments in Real Estate Investment Trusts (REITs) or they invest directly in a real estate.

The real estate in portfolio should be considered as a long term investment and as such the transaction costs associated with market monitoring and purchasing could be very low with respect to the period of the investment. Disadvantageous aspects of real estate investments can be minimized by considering long term investment horizon. Although returns of both direct and indirect investments of pension funds can differ from returns of RE index, it is plausible that real returns of real estate in long term horizon should be highly correlated with returns computed from RE index.

The more detailed the investigation is the more serious are its weaknesses. We try to analyze whether different pension funds follow different portfolio strategies. Fixed effect model introduced is based on description of portfolio structure changes. Investigation of the loss decomposition of particular pension funds would suffer much more for limitations of the model, because each pension fund may follow very different security selection, foreign investments may be really important and consecutively the indexes used for evaluation would be worse measures of asset class returns. The comparison of results of loss decomposition for different pension funds would be therefore seriously biased. For all these reasons, we did not provide the evidence of particular pension funds' loss decomposition.

It is worth to mention that in case of the asset allocation equal to the optimal one, the estimated loss of asset misallocation in the model is not fully achievable. The return achieved would be higher, but higher returns are usually associated with disproportional increase of other costs as described in the model. Nevertheless, it does not mean that the loss caused by asset class misallocation is not correctly estimated.

Last but not least, data used for the model contain performance of Czech market for eleven years only. Investment horizon of pension funds is longer than this period. As in all post-communistic countries in the Eastern Europe, Czech market does not provide historical data for longer period and the actual period of operation of private pension funds is still shorter than their investment horizon.

3.7 Specifics in the Czech real estate market

We mentioned already that pension funds can invest in real estate directly and indirectly. Both choices have some limitations, which are given by some particular specifics of the Czech market. The market size is quite small and therefore local investors suffer from lack of relevant market informations. Huge development project can be realized in only few biggest Czech cities. There are not many market surveys or market statistics which could be used for rational investing decisions.

In case of direct investment, the question of transaction costs appears to be apparently very important. Owning of real estate is associated with huge illiquidity, which is probably serious reason of unpopularity of such investments. On the other hand, pension funds are investors with extremely long investment horizon and they can always solve the potential problem of liquidity by quick selling of other asset classes.

In general, by indirect investments in real estate pension funds increase liquidity and lower transaction costs of real estate investments. We have already mentioned that the most common indirect real estate investments in western countries are realized by buying REITs. Different REITs have usually some specifics, for example they invest more in one particular area of real estate or they are typically focused on investments in a particular region. They are managed according to special legal arrangement with the aim of investing in property. Some REITs invest funds into loans and bonds, which are secured by real estate. The price of REITs is determined on the stock exchange. In other words, REIT can be characterized as a trading company which owned the property. The advantage is that the fund managers have clearly defined volume of money for their funding. Price is of course determined by supply and demand and does not necessarily reflect the true value of real estate.

Czech legal environment does not allow operation of REITs. However Czech investors interested in indirect real estate investments still have some opportunities. The most known Czech real estate fund REICO was found as an open-ended and retail focused. Also as a reinvestment fund it's all revenues are invested in the fund. And since the shares cannot be traded on the stock

exchange, the performance is driven by the price development in the real estate market. The potential weakness of the fund is that it's portfolio consists of only a few large buildings in big cities, mostly rented as an office space. The potential skepticism flows from insufficient diversity of such a portfolio investments. That might be a reason why the investment in the real estate might not have been such a straightforward option for Czech pension funds.

Chapter 4

Discussion on the sources of low returns

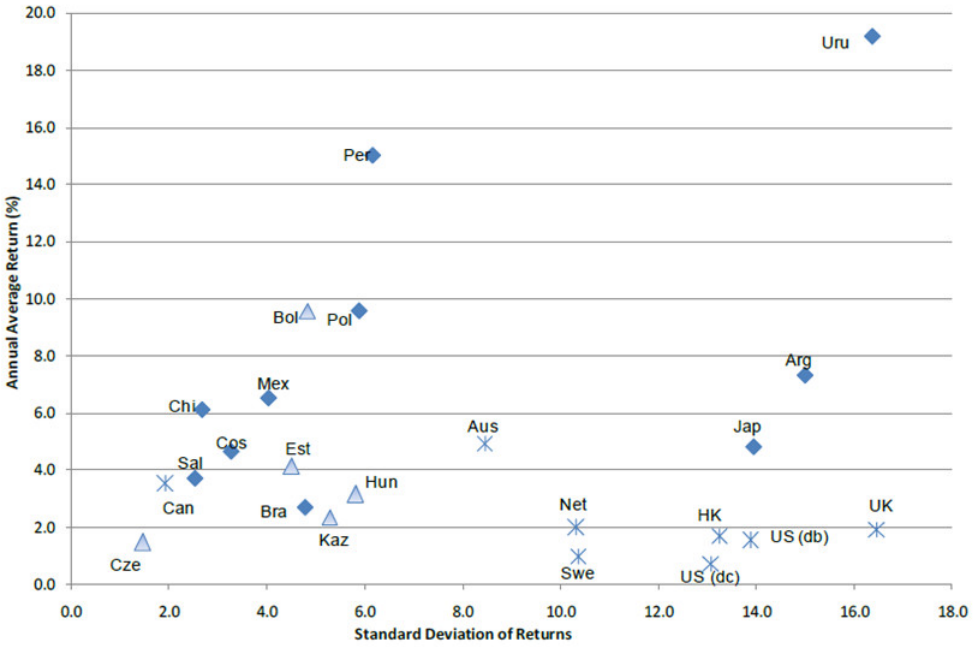
We estimated that for the chosen level of risk the loss of annual return arising from asset class misallocation in aggregated portfolio was equal to approximately 0.5% in the last eleven years. We have also shown that the chosen level of risk determined by the share of risky assets in portfolios of pension funds is quite low in the Czech Republic. Nevertheless, the gap between the higher returns in most other countries and the low returns in the Czech Republic cannot be explained by the 0.5% inefficiency in asset misallocation. To achieve the level of returns common in other countries, the share of risky assets in portfolios must be substantially increased. In this section, we provide the evidence that the low returns of the Czech private pension funds are caused by extreme conservatism of portfolio management, and we also investigate the possible impact of institutional factors on the current situation.

4.1 The evidence of low returns in the Czech Republic

In the OECD database and working papers, there is some cross-country evidence supporting the assertion of low returns of Czech private pension sys-

tem. Tapia (2008) compared aggregate investment returns of private pension funds in 23 countries from Central and Eastern Europe, Latin America and selected OECD countries. Pension funds in the Czech Republic had very low returns on average with the lowest standard deviation among all countries in the sample between years 2000 and 2005 as reported in Figure 4.1.

Figure 4.1: Annual average return and standard deviation (2000-2005)



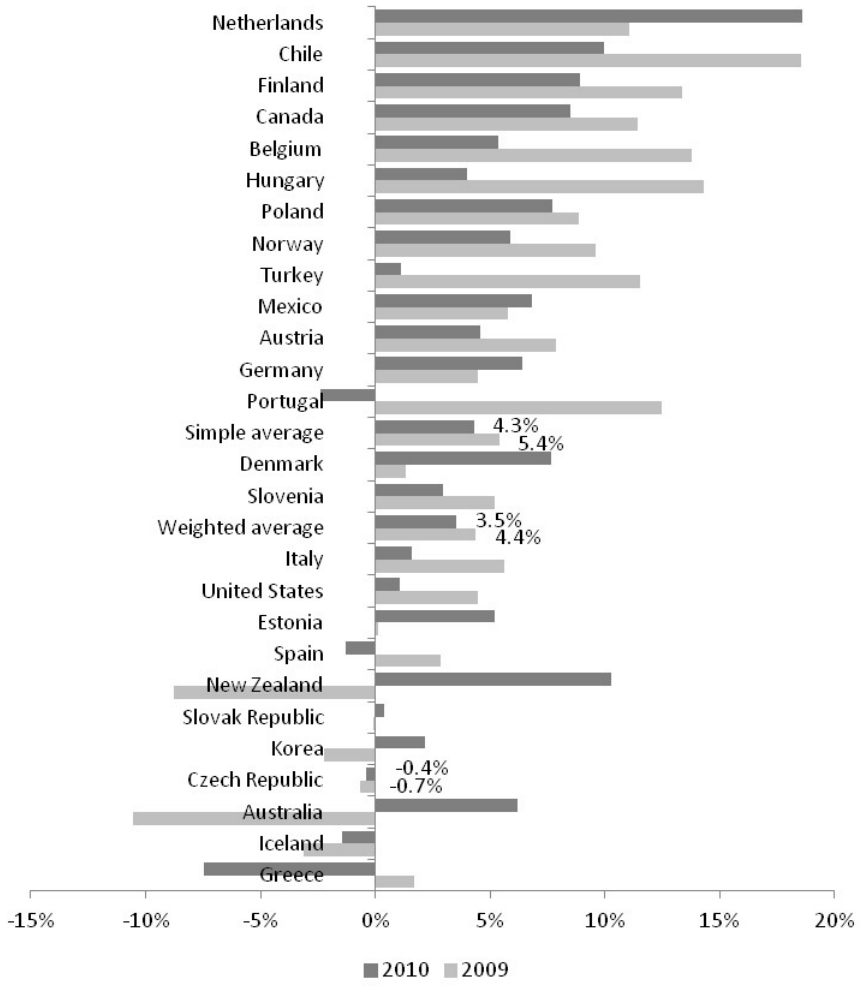
Source: Tapia 2008

The comparison is done on pre-crisis data. At that time, Czech private pension funds were obviously very conservative. Since then, the portion of risky assets in their portfolios even decreased. The worldwide evidence of private pension funds' performance covering the period of financial crisis in 2008 is not available. Hlaváč (2011) used the data from 2000 to 2010 and by using the Sharpe ratio he showed poor results of Czech pension funds in comparison with other countries from Central and Eastern Europe. Worldwide evidence of the recent performance is provided by OECD. In OECD report from 2011 (Pension Markets in Focus, OECD 2011), the comparison of private pension funds' net returns is done. Findings of the report are visualized in Figure 4.2. Countries in the figure are sorted by two-year average net rate of investment return.

Czech Republic and Iceland are the only countries in the sample where in-

flation in both years was higher than returns of pension funds. In Iceland, low net returns can be explained by extremely high inflation. The increase in consumer prices by 12.0% in 2009 was the highest among all OECD member countries. In 2010, the 5.4% inflation in Iceland was exceeded only by the inflation in Turkey. The inflation rate in the Czech Republic was 1.0% and 1.5% in 2009 and 2010 respectively, and therefore, is probably not high enough to explain the poor result of the pension funds' performance.[17]

Figure 4.2: Pension funds' real net rate of investment returns in selected OECD countries



Source: Pension Markets in Focus, OECD 2011

Although the complete information on the returns of Czech pension funds for the year 2011 have not been reported until now, the returns of most pension funds probably did not exceed 1.9% inflation rate.

[17]Source: OECD, Prices and Purchasing Power Parities (database)

Conservatism of Czech pension funds seems to be quite strong considering the world-wide evidence. First explanation provided by simple economic theory would state that customers of pension funds in the Czech Republic demand conservative investments of their pension funds. However, it is highly improbable that customers of pension funds are willing to put their savings in pension funds which provide negative yields in years when pension funds in other countries in the world are able to achieve positive returns as evident from Figure 4.2. We have a serious suspicion, that for some reasons, the market of Czech pension funds does not work properly.

Low returns of Czech private pension system are probably the outcome of more complex factors, which collectively could be referred to as the institutional environment of the market. French (2001) argues that decisions of portfolio managers are not driven by economic factors only and he put emphasis on other market determinants such as market power or motivation of portfolio managers. To understand the situation in the Czech market, we must consider other factors often ignored by the classical economic theory. Causes of market failure should be sought in the market size and in the market regulation.

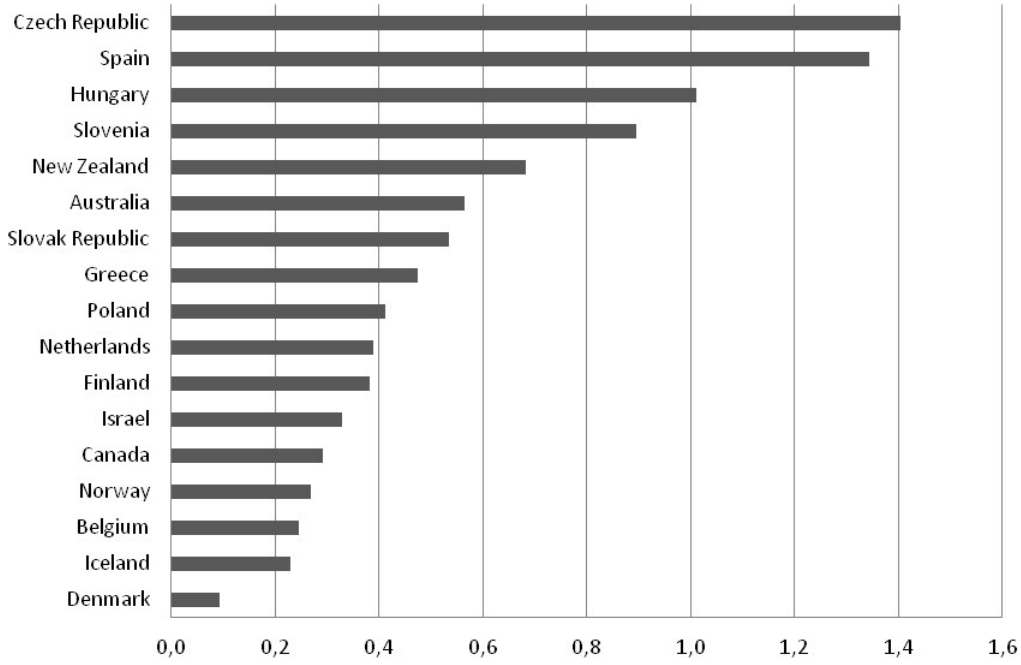
One of the measurable markets characteristics, which can be used as a signal of the market efficiency, is the level of fees charged by pension funds. OECD report Pension Markets in Focus from 2011 disclosed the level of operating costs in several OECD countries. Findings of the report are provided in Figure 4.3. Operating costs charged by private pension funds in 17 countries in 2010 are plotted there.[18] The Czech Republic, with operating costs exceeding 1.4%, is the country with the highest pension fees among all countries from the available data. The other two countries with high operating costs were Spain and Hungary. Most countries in the sample were able to reduce their operating costs below 1%. Brief look at the historical data available for more countries in previous years reveals that operating expenses of most OECD countries typically did not exceed 0.5% between 2001 and 2009.[19]

Analysts from OECD comment this evidence by the statement that "coun-

[18]Calculated operating costs include marketing the plan to potential participants, collecting contributions, sending contributions to investment fund managers, keeping records of accounts, sending reports to participants, investing the assets, converting account balances to annuities, and paying annuities. (Pension market in focus, OECD 2011)

[19]Source: OECD, Pensions Indicators (database)

Figure 4.3: Operating costs as a % of total assets in selected OECD countries (2010)



Source: Pension Markets in Focus, OECD 2011

tries with defined-contribution systems and those with large numbers of small funds appear to have higher operating costs than countries with only a few funds offering defined-benefit, hybrid, or collective defined-contribution pension arrangements." (OECD, 2011). The positive correlation between pension funds' performance and their size was already shown earlier by Ambachtsheer, Capelle, and Scheibelhut (1998). In their study, they also demonstrated the positive correlation between the pension funds' performance and the proportion of the fund passively managed.

Characteristics of the private pension system in the Czech Republic correspond highly with the description of unfavorable system attributes. There is a defined-contribution pension system with relatively small pension funds. These factors are probably important determinants of poor performance of pension funds. Moreover, there is probably another important factor which can play an important role in the insufficiency of pension funds' performance. Government of the Czech Republic implemented relatively strict regulatory framework for private pension funds. Although the analysis of market regulation and its consequent effect on the market performance is

challenging, there is some evidence which could be beneficial for revealing the possible significance of the regulation effect on the Czech pension funds' working.

4.2 The power of regulation

Two distinct approaches to regulation of private pension funds can be detected across countries. The first approach applies quantitative limits specifying restrictions in portfolio structure or boundary for risk-return performance or both. The aim of such limits is the elimination of possible imprudent portfolio management of pension funds. Portfolio and performance limits usually determine maximum allowed portfolio share invested in equity and real estate, prohibit particular investment instruments and set minimal return which must be guaranteed by pension funds' to their participants. Conversely, the second principle employs only non-quantitative rules. It focuses entirely on regulation of portfolio managers' behavior to regulate principal-agent problem between funds' participants and portfolio managers without imposing any particular investment limits.

In research paper investigating differences in private pension systems in OECD countries Tapia (2008) compared the regulation of pension funds in 23 countries. He found that most complex quantitative investment restrictions are employed in Latin American countries, where limits on portfolio structure as well as limits defining minimum returns are strictly defined. In the Central and Eastern European countries mainly investment allocation is regulated. Contrary to the major evidence, investments of pension funds in Anglo-Saxon countries are not restricted by any quantitative restrictions. Tapia (2008) explains this contrast by differences in development of capital markets. Capital markets in Latin America and Central and Eastern Europe are relatively under-developed compared to the United Kingdom and the United States. In Anglo-Saxon countries societies generally believe more in the market principle and therefore use only soft regulation tools for its control.

The strong quantitative regulation is generally motivated by lack of trust in capital markets. However, more market limitations put more responsibil-

ity on legislation creators, i.e. national governments. While in Anglo-Saxon countries managers are completely responsible for the pension fund's performance, in other countries the extent of the responsibility of pension funds' managers is questionable.

Several studies done by supranational organizations provide the cross-country evidence aimed at the effect of regulation on pension funds performance to encourage discussion about suitability of quantitative regulation. Srinivas, Whitehouse and Yermo (2000) focused mainly on the private pension systems in Latin America and Central and Eastern Europe that emerged in Nineties.[20] They state that regulation of pension funds imposed in countries in these regions seem to be more strict in terms of entry barriers and performance constraints than in other OECD countries except the portfolio limits, which are tighter in many countries than in Argentina, Chile, Colombia, Peru and Poland. Authors analyzed the effect of a tight regulation on pension funds' performance and concluded that private pension funds in countries with stringent regulation perform relatively worse. More regulated pension funds are not motivated to increase efficiency and mainly, they tend to follow the same investment strategies. People investing their savings in pension funds then do not have significant portfolio choice.

Blome et al. (2007) analyzed the impact of regulation on inefficiency of defined-benefits pension funds. In the example of differences among regulation in Germany, Japan, the Netherlands, United Kingdom and United States they showed that investment restrictions increase costs of pension funds through the limited choice of investment policy.

4.3 The effect of regulation in the Czech Republic

Regulation of private pension funds in the Czech Republic is formulated in the State-Contributory Supplementary Pension Insurance Act.[21] As the name of the act suggests, the important attribute of the private pension system is significant state contribution to participants' benefits. The detailed

[20] The countries in the Central and Eastern Europe considered were Poland, Hungary and the Czech Republic.

[21] Act No. 42/1994 Coll. and relevant amendments.

structure of the contribution system is presented in the table 4.1. The amount of state contributions clearly surpasses potential returns of pension funds investments when participants invest lower amount of money in their pension funds. Participants contributing 100 CZK monthly gain 50% return only because of government interventions. With a higher value of contribution the relative share of state contribution decreases. At least 500 CZK monthly must be deposited to get the highest possible state contribution, 150 CZK, which represent a 30% investment yield.

Table 4.1: State contribution to pension savings (in CZK)

Participant's monthly contribution	State monthly contribution
100 - 199	50 + 40% of the amount over 100
200 - 299	90 + 30% of the amount over 200
300 - 399	120 + 20% of the amount over 300
400 - 499	140 + 10% of the amount over 400
500 and more	150

Source: State-Contributory Supplementary Pension Insurance Act, Ministry of Finance

A system of generous risk-free state benefits successfully motivates people to invest in pension funds. However, to maximize their returns, participants mostly invest only small amount of their earnings to gain maximum state contributions. Since this is commonly the main point of participants' savings in private pension funds, the importance of funds investment returns significantly depreciates.

Data from OECD survey of investment regulation of pension funds (2011b) provide brief cross-country comparison of main quantitative investment restrictions applied to control pension funds' portfolio management. Among OECD and selected non-OECD countries in the survey, the regulation employed in the Czech Republic appeared to be relatively strong before 2004, when total shares of equity and real estate in the portfolio were limited by 25% and 10% respectively. Since 2004, the limit for the share of equity traded on OECD markets in portfolios was extended to 70% and the limit on share of bank deposit in the portfolio was eliminated. Remaining and relatively strict restriction is the limit of 10% on real estate investments. Most countries have higher rate for real estate investments or even no such limit.

However, quantitative portfolio limits are evidently not strong determinants for the structure of Czech pension funds' portfolios which consist of much lower shares of equity and real estate than they are allowed to invest in. Holding low-risk portfolios is more often motivated by another important regulatory directive. Czech pension funds must guarantee positive annual nominal returns. In case of loss-making performance in any calendar year, the loss has to be covered by the reduction in the owner's registered capital. The value of registered capital in the pension fund for these purposes must not fall below 50 mil. CZK.

The motivation for this rule is the protection of participants against unfavorable losses. Regarding historical data, there is no doubt that in this way the regulation works perfectly. Czech pension funds achieve low but stable positive nominal returns. Owners of pension funds are afraid of compensation the adverse market movements and hence they invest heavily in fixed-income financial instruments and construct very conservative investment portfolios. The problem of the regulation is the responsibility of the fund owners for short term returns. Risky assets offer high returns in the long term but their returns are naturally very volatile. Correctly constructed risky portfolios even if they offer high returns in the long term could bring negative returns in particular years.

The idea of protection of pension funds participants against returns' volatility is not uncommon in the world. In the working paper describing private pension systems and their regulation in OECD countries, Tapia (2008b) demonstrated that minimum rate of return is regulated in Poland and in many Latin American countries. However, the construction of the minimum rate is sharply different from the one introduced in the Czech Republic. Except Brazil, where 6% nominal rate of return must be guaranteed to ensure that pension funds' returns exceeds high inflation rate, the guaranteed minimum rate is volatile and adjustable to actual market situation. Minimal returns are usually defined to be 2-4% lower than the 36 months average return of all pension funds. Such construction of regulation in not too restrictive which allows a portion of pension funds to be invested in higher risk assets. This increases the potential of higher returns in the long run and simultaneously provides reasonable security to participants against huge losses. To avoid the lack of diversity in portfolios in the market, another

rule is introduced in some of these countries: Pension funds must offer two or more funds with different risk-return profiles to provide the suitable portfolio choice strategies for their participants.

One of the recent hot topics in the Czech Republic is the reform of pension system by implementing mandatory second pillar of the pension system. The impact of reform on pension fund management is disputable. Pension funds will have the opportunity to increase their power in the market by attracting new customers through offering unique portfolio strategy. On the other hand, more convergence than divergence was observed among pension strategies in the previous period and the continuation of the current trend seems to be highly probable. Mandatory participation in private pension system will cause some increase in number of participants for each pension fund.

Maintaining the status quo is the expectable future scenario for pension funds participating in the current scheme unless the regulation of pension funds' performance changes in the Czech Republic.

Chapter 5

Conclusion

System of voluntary savings in private pension funds in the Czech Republic was introduced in 1994 as in other countries from the Central-Eastern-European region to offer additional investment opportunities to small investors. The Czech private pension system, however, differs from most systems in other OECD countries. The evidence provided in the thesis clearly demonstrates that structure of portfolios of Czech pension funds is very conservative and also that underinvestment of real estate is extraordinary.

We showed that the conservatism in portfolio management even strengthened between 2000 and 2011 by shifting to bonds from other asset classes and that these shifts were driven almost exclusively by activity of portfolio managers. Cash flow redirection accounts for portfolio changes much more than differences in returns of particular asset classes. The only asset class with positive mean quarterly cash inflow was bonds. The portion of shares and real estate, although their returns were higher than the weighted average return of the portfolio, decreased. By highlighting the risk-return profile of CCE we pointed at the fact, that this asset class is not an attractive investment instrument and it should be included in the portfolio only to satisfy liquidity needs. Its significant share in the beginning of the period had been decreasing from 29% in 2000 to 8% in 2011.

The share of bonds in the aggregated portfolio increased from 58% in 2000 to 87% in 2011. None out of the 9 pension funds operating in the Czech market in 2011 resisted the market trend of massive investments in bonds.

We investigated individually the development of all these pension funds and concluded that any of them does not follow investment strategy significantly different from others.

Although the construction of the efficient frontier in the Czech market reveals that the efficient low-risk portfolios are mainly composed of bonds and real estate, only four pension funds include real estate in their portfolios. Shares achieved, on average, quarterly returns of approximately 1.5% with standard deviation of 12.63% while real estate gained 1.4% return with the standard deviation of only 2.24%. Still, Czech pension funds prefer investments in shares instead of investing in real estate. This puzzle could be hardly explained by usual unfavorable features of real estate investments such as low liquidity or high transaction costs since pension funds are investors with very long investment horizon.

We also estimated the loss arising from the asset class misallocation. We approximated the risk aversion of pension funds by fixing the amount invested in bonds, added 10% of cash and ran the optimization of the remaining part of the portfolio. Comparison of the optimal portfolio with the portfolio of pension funds highlighted the underinvestment of real estate in pension funds' portfolios. We calculated the cost of this inefficiency to be equal approximately 0.52% of annual returns in last eleven years on average.

The comparison of actual returns with returns which would be achieved by the pure passive management of the portfolio showed that the activity of portfolio management contributed to greater stability of returns. The higher was the expected return of the portfolio the higher were costs associated with particular security selection, management costs and taxes. The loss caused by all these factors was on average 0.65% of annual returns, which is slightly higher than the loss due to asset class misallocation.

However, the gap between the returns achieved by pension funds in the Czech Republic and in other OECD countries is too big to be fully explained by asset class misallocation or particular security selection. We argue that the share of risky assets, especially real estate, must be increased significantly to achieve the level of returns common in other OECD countries. We found the most probable source of pension funds' conservatism in the regulation of pension funds employed in the Czech Republic.

Pension funds must achieve positive nominal returns in every calendar year regardless of the current market situation conditions, regardless of the trend in returns they make in the long run. The regulation also does not dictate pension funds to offer more different investment strategies to their participants. Hence, pension funds are not motivated to change or modify the current portfolio strategy based on investing in bonds, which provides stable and slightly positive nominal returns. Shifting towards risky assets from bonds seems to be just superfluous for portfolio managers. Therefore, unlike in other OECD countries, portfolio strategy of Czech pension funds does not offer interesting returns and their participants invest their savings there primarily to gain money from the generous system of state contributions.

Soon, the current pension system will have to be somehow reformed because of the demographic change in the society. One of the discussed solutions is to make investments in private pension funds mandatory. Consequently the number of participants in the private pension funds would increase. We argue that such reform of the pension system would not reduce the inefficiency in investments of private pension funds unless it changes substantially the current market regulation.

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Data sources:

Czech National Bank

Czech Statistical Office

Prague Stock Exchange

State-Contributory Supplementary Pension Insurance Act, Ministry of finance of the Czech Republic

The Association of Pension Funds of the Czech Republic

OECD, Pensions Indicators

OECD, Prices and Purchasing Power Parities

Appendix A

Share of real estate in pension funds' portfolios (%)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10Y average
Mexico	0.00	0.00			0.01	0.01	0.01	0.01	0.01	0.01	0.01
Spain	0.24	0.25	0.26	0.23	0.21	0.14	0.12	0.23	0.22	0.24	0.21
Hungary		0.34	0.24	0.16	0.18	0.18	0.25	0.31	0.23		0.24
Israel	0.02	0.02	1.12	0.95	0.70	0.64	0.68	0.58	0.56	0.53	0.58
Czech Republic	0.74	0.61	0.40	0.33	0.92	1.07	0.72	0.88	0.96	0.86	0.75
Austria	0.49	0.43	0.71	1.05	1.32	2.13	2.00	0.33	0.35	0.34	0.91
Belgium	1.16	1.12	1.47	1.35	1.19	0.89	0.82	0.93	0.74	0.73	1.04
United States	1.25	1.29	1.12	0.98	0.88	1.00	1.22	1.53	1.28	1.22	1.18
Denmark	2.74	2.73	2.46	1.97	1.66	1.80	1.81	1.19	1.27	1.11	1.87
Germany	4.73	4.44	4.15	3.82	3.21	2.89	2.40	2.44	2.06	2.50	3.26
Netherlands	4.83	5.34	5.01	3.97	3.40	2.84	2.51	2.71	2.28	1.29	3.42
United Kingdom	4.30	5.13	4.28	3.83	3.27	3.18	2.79	2.47	2.22		3.50
Sweden	4.61	4.36	3.97	3.73	2.84	3.30	3.45	4.68	3.89	3.52	3.83
Norway	4.39	4.55	4.20	4.22	4.64	5.12	5.19	4.26	3.80	3.44	4.38
Canada	3.30	4.16	3.50	3.53	3.93	4.36	5.02	6.24	5.81	5.46	4.53
Australia		6.13	5.75	3.65	3.67	3.27	3.60	4.35	5.12	5.33	4.54
Italy	13.82	12.61	12.84	11.75	7.82	5.87	5.19	4.82	4.01	4.45	8.32
Portugal	5.87	8.64	9.78	10.79	8.15	7.81	7.15	8.77	8.57	9.58	8.51
Ireland	8.83	9.72	8.68	7.37	8.04	9.03	9.11	8.38			8.65
Finland	11.85	12.85	12.09	8.70	9.96	9.31	9.21	10.46	7.35	8.77	10.06
Switzerland	11.36	12.29	11.53	10.88	10.09	9.57	9.38	10.75	9.51	8.74	10.41
average	4.45	4.62	4.68	4.16	3.62	3.54	3.46	3.63	3.01	3.23	3.84

Source: OECD, Pensions Indicators

Appendix B

Structure of aggregated Czech pension funds' portfolio (2000-2011)

Year	Quarter	Bonds	Shares	CCE	Real Estate	Sundry
2000	4	58.4	9.7	29.4	0.9	1.6
2001	1	61.7	9.0	27.0	1.0	1.3
	2	58.5	8.6	30.4	1.0	1.5
	3	65.3	6.6	25.9	1.0	1.2
	4	64.5	7.5	26.1	0.8	1.0
2002	1	69.8	6.6	21.7	0.8	1.2
	2	74.6	5.3	17.8	0.7	1.6
	3	74.5	5.5	18.2	0.6	1.2
	4	75.9	6.5	15.1	0.6	1.9
2003	1	79.6	7.0	11.5	0.6	1.3
	2	80.1	5.6	12.1	0.5	1.6
	3	76.9	4.8	16.2	0.5	1.5
	4	75.2	4.9	17.3	0.4	2.1
2004	1	74.2	5.6	18.5	0.4	1.4
	2	76.3	5.4	16.5	0.4	1.4
	3	70.3	5.6	22.5	0.4	1.2
	4	71.2	6.3	20.9	0.3	1.2
2005	1	72.8	6.5	19.2	0.8	0.7
	2	75.3	7.1	16.3	0.7	0.6
	3	72.3	8.4	17.8	0.7	0.8
	4	74.3	7.7	16.5	0.6	0.9
2006	1	74.3	9.9	14.1	0.6	1.1
	2	75.8	11.5	11.3	0.6	0.9
	3	78.0	11.1	9.3	0.5	1.0
	4	77.2	10.2	10.6	0.9	1.2
2007	1	76.8	12.4	9.4	0.8	0.5
	2	77.0	12.5	9.2	0.8	0.5
	3	75.7	11.9	11.0	0.8	0.6
	4	73.7	10.8	13.8	0.7	0.9
2008	1	75.2	9.8	13.5	0.7	0.8
	2	76.8	8.5	13.3	0.9	0.6
	3	75.7	7.9	14.9	0.8	0.7
	4	78.8	6.5	13.0	0.8	0.9
2009	1	79.7	5.6	12.8	0.8	1.0
	2	81.8	5.3	11.4	1.0	0.5
	3	81.9	5.2	11.2	1.0	0.8
	4	81.5	4.9	12.4	0.9	0.3
2010	1	80.4	4.4	11.0	0.9	3.4
	2	83.3	4.3	8.9	0.9	2.7
	3	85.1	4.1	7.1	0.8	2.9
	4	84.0	4.5	8.1	0.8	2.6
2011	1	84.3	4.4	7.3	0.8	3.2
	2	84.5	4.4	8.2	0.8	2.1
	3	86.9	3.4	6.8	0.7	2.1
	4	86.7	2.8	8.1	0.8	1.6

Source: The Association of Pension Funds of the Czech Republic

Appendix C

Test of homoscedasticity

		Shares	Real estate	Periods
1/2001-2/2007	*var 1*	0.0094	0.0003	26
3/2007-4/2011	*var 2*	0.0204	0.0004	18
	var1/var2	0.461074	0.7375012	

Hypothesis: var 1 and var 2 are equal	
level of significance	5%
degrees of freedom	25.17
5% F lower rejection bound	0.423753
5% F higher rejection bound	2.548419

Appendix D

Fixed effect model

		Bonds	CCE	Shares	RE
	$\omega_{i,4Q/2000}$	58.44%	29.36%	9.72%	0.87%
	$\omega_{i,3Q/2007}$	75.73%	11.00%	11.89%	0.78%
	$\text{mean}\,\Delta\, log(\omega_{iq})$	0.90%	-2.93%	-2.80%	-0.32%
Aegon	$\omega_{fi,3Q/2007}$	*84.4%*	*3.2%*	*11.7%*	
	$\omega_{fi,3Q/2007} - \omega_{i,3Q/2007}$	*8.68%*	*-7.75%*	*-0.20%*	
	$mean\,\Psi_{fiq}$	-1.02%	8.26%	2.83%	
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	0.64	0.58	-0.03	
Allianz	$\omega_{fi,4Q/2000}$	60.76%	26.44%	11.99%	
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	2.32%	-2.92%	2.27%	
	$mean\,\Psi_{fiq}$	0.10%	-2.93%	-8.49%	
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	-0.12	-0.12	-0.20	
AXA	$\omega_{fi.4Q/2000}$	74.26%	21.53%	3.41%	0.00%
	$\omega_{fi.4Q/2000} - \omega_{i.4Q/2000}$	15.82%	-7.82%	-6.31%	-0.87%
	$mean\,\Psi_{fiq}$	-0.64%	-0.36%	4.32%	10.97%
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	0.16	-0.08	0.34	0.77
ČSOB	$\omega_{fi,4Q/2000}$	47.92%	36.70%	14.74%	
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	-10.52%	7.34%	5.01%	
	$mean\,\Psi_{fiq}$	0.67%	-4.52%	-3.05%	
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	0.21	-0.14	-0.37	
Generali	$\omega_{fi,4Q/2000}$	80.06%	8.03%	6.09%	0.00%
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	21.61%	-21.32%	-3.63%	-0.87%
	$mean\,\Psi_{fiq}$	-0.78%	3.64%	-0.38%	-2.36%
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	-0.59	-0.24	0.00	-0.90
ING	$\omega_{fi,4Q/2000}$	60.13%	28.99%	9.92%	
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	1.69%	-0.37%	0.20%	
	$mean\,\Psi_{fiq}$	-0.02%	0.38%	0.26%	
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	0.29	0.18	-0.25	
ČP	$\omega_{fi,4Q/2000}$	58.44%	31.40%	9.88%	
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	0.00%	2.04%	0.16%	
	$mean\,\Psi_{fiq}$	0.13%	-1.63%	-0.59%	
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	0.04	0.06	0.26	
ČS	$\omega_{fi,4Q/2000}$	41.02%	39.12%	16.83%	2.57%
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	-17.43%	9.76%	7.11%	1.70%
	$mean\,\Psi_{fiq}$	0.57%	0.56%	0.72%	-4.29%
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	0.02	0.05	-0.06	-0.89
KB	$\omega_{fi,4Q/2000}$	40.97%	52.52%	2.09%	3.74%
	$\omega_{fi,4Q/2000} - \omega_{i,4Q/2000}$	-17.47%	23.16%	-7.63%	2.87%
	$mean\,\Psi_{fiq}$	0.62%	0.56%	2.20%	-3.51%
	$corr\,(\Delta\, log(\omega_{iq}), \Psi_{fiq})$	-0.09	-0.03	0.06	-0.91

Appendix E

Thesis proposal

Institut ekonomických studií UK FSV
Teze RIGORÓZNÍ práce

Tyto teze tvoří přílohu „Přihlášky ke státní rigorózní zkoušce“

TUTO ČÁST VYPLŇUJE ŽADATEL:

Informace o žadateli:	**Razítko podatelny:**
Příjmení a jméno: Vančura Filip	
E-mail: filip.vancura@gmail.com	
Telefon (nejlépe mobilní)**:** +420 732 54 33 22	
	katedra: k rukám:

Předpokládaný název rigorózní práce v češtině:
Specifika investiční struktury privátních penzijních fondů v České Republice

Předpokládaný název rigorózní práce v angličtině:
Specifics in investment structure of private pension funds in the Czech Republic

Předpokládaný termín předložení práce:
14. 2. 2014

Pedagog, s nímž byly teze konzultovány:
PhDr. Pavel Streblov, MSc.

Charakteristika tématu a jeho dosavadní zpracování žadatelem (rozsah do 1000 znaků)**:**

Autor již v roce 2012 obhájil na FSV UK diplomovou práci, kde se zabýval analýzou efektivnosti investiční strategie privátních penzijních fondů v České Republice. Pro svoji analýzu sestrojil optimální virtuální portfolio, které by bývalo bylo sestrojeno za důsledného využití Markowitzovy teorie z agregátů základních typů aktiv. Toto portfolio je poté porovnáno s historickými daty investic českých privátních penzijních fondů. Porovnání poukázalo především na nedostatečnou míru investic do nemovitostí. Součástí diplomové práce byl odhad nákladů, které z této neefektivity pramení. Rigorózní práce navazuje na diplomovou práci autora a přináší důslednější diskusi možných příčin této neefektivity s ohledem na velikost místního trhu a investiční možnosti penzijních fondů v nastaveném institucionálním rámci.

Předpokládaný cíl rigorózní práce, původní přínos autora ke zpracování tématu, případně formulace problému, výzkumné otázky nebo hypotézy (rozsah do 1200 znaků)**:**

Cílem rigorózní práce je rozšířit autorovu diplomovou práci a představit tak ještě detailnější rozbor možných příčin neefektivního rozložení investic v portfoliích privátních penzijních fondů v České republice, které jsou příčinou aktuální neuspokojivé situace dobrovolného penzijního připojištění. Konkrétně by mělo být více rozpracován možný vliv specifického prostředí trhu s nemovitostmi na strukturu investic penzijních fondů, které jsou charakterizovány mimo jiné právě nepřiměřeně nízkým podílem investic do nemovitostí. Součástí rigorózní práce by mělo být též zhodnocení přiměřenosti uskutečněné reformy penzijního systému a její možné dopady na investiční strategie a budoucí výsledky hospodaření penzijních fondů.

Předpokládaná struktura práce (rozdělení do jednotlivých kapitol a podkapitol se stručnou charakteristikou jejich obsahu)**:**

Předpokládaná struktura rigorózní práce bude zahrnovat kromě úvodu a závěru tři kapitoly.

První kapitola – popis specifických charakteristik nemovitostí z pohledu investora

Druhá kapitola – detailní analýza struktury a vývoje agregovaného portfolia privátních penzijních fondů včetně detekce rozkladu trendu mezi jednotlivé existující fondy
Třetí kapitola – diskuse možných příčin konzervativního řízení portfolií a neochoty investic do nemovitostí v českém prostředí

Vymezení podkladového materiálu (např. analyzované tituly a období, za které budou analyzovány) **a metody (techniky) jeho zpracování:**

Autor využije dostupných dat o hospodaření všech privátních penzijních fondů v České Republice. Z těchto dat, která od roku 2000 zveřejňuje Asociace penzijních fondů, jsou nejzásadnější čtvrtletní struktury portfolií jednotlivých penzijních fondů a jejich roční investiční výnosy. Pro modelování historického vývoje jednotlivých skupin tržních aktiv je využito veřejných tržních indexů. Analytické nástroje využité ke zpracování dat jsou inspirovány analýzami penzijních fondů ve Spojených Státech Amerických a Velké Británii, kde mají penzijní fondy v porovnání s českým prostředím dlouholetou tradici. Pro znázornění specifik investování českých penzijních fondů bude použito komparace s ostatními zeměmi OECD s dostupnými daty.

Základní literatura (nejméně 10 nejdůležitějších titulů k tématu a metodě jeho zpracování; u všech titulů je nutné uvést stručnou anotaci na 2-5 řádků)**:**

Antolin, P. (2008): "Pension Fund Performance", OECD Working Papers on Insurance and Private Pensions, No. 20, OECD publishing.
Report OECD důkladně analyzuje aktuální investiční vývoj penzijních fondů v několika zemích v kontextu různých regulatorních politik jednotlivých států.

Blake, D.; Lehmann, B. N. and Timmermann A. (1999): "Asset Allocation Dynamics and Pension Fund Performance", The Journal of Business, Vol. 72, No. 4 (October 1999), pp. 429-461.
Článek předkládá důkladnou analýzu investiční strategie na datech více než 300 penzijních fondů ve Velké Británii. Analýza dokládá fakt, že pohyby mezi skupinami aktiv jsou téměř výhradně zapříčiněny aktivním zásahem manažerů.

Chun, G. H.; Sa-Aadu, J. and Shilling, J.D. (2004): "The Role of Real Estate 5. Conclusion 57 in an Institutional Investor's Portfolio Revisited", Journal of Real Estate Finance and Economics, 29:3, pp. 295-320.
Článek přednáší nové argumenty o vhodnosti investic do nemovitostí z pohledu velkých investorů. Stejně jako v mnoha jiných článcích zabývajícím se tímto tématem končí i tento argumentační rozbor podivem nad nízkou aktuální mírou investic do nemovitostí v mnoha zkoumaných zemích.

Ennis, R. M. and Burik, P. (1991): "Pension Fund Real Estate Investment under a Simple Equilibrium Pricing Model", Financial Analysts Journal, Vol. 47, No. 3 (May - Jun., 1991), pp. 20-30.
Ani v tomto článku se pomocí aplikace Markowitzovy teorie efektivního portfolia nepodařilo vysvětlit příčiny nízkých investic do nemovitostí. S využitím dat privátních penzijních fondů v USA byla odhadnuta optimální míra investic do nemovitostí 10-15% z celkových aktiv, což je více, než kolik běžně manažeři penzijních fondů na tyto investice alokují.

French, N. (2001): "Decision Theory and Real Estate Investment: An Analysis of the Decision-Making Processes of Real Estate Investment Fund Managers", Managerial and Decision Economics, Vol. 22, No. 7, Real Estate Economics and Finance (Oct. - Nov., 2001), pp. 399-410.
Autor této studie hledá příčiny neobliby investic do nemovitostí u penzijních fondů. Problematizuje nemovitosti jako investiční instrument z pohledu manažerů a poukazuje na rozdíly teoretického přístupu s reálnými obtížemi nákupu a prodeje nemovitostí na skutečném trhu.

Hlaváč, J. (2011): "The performance of the Czech Private Pension scheme: Current Design and its position within CEE countries", Master thesis, Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, 107 pages, Supervisor: Ondřej Schneider.
Diplomová práce obhájená na FSV UK přináší především překvapivé zjištění o nejhorších výsledcích zhodnocení investic privátních penzijních fondů v České republice v porovnání s výkonem fondů nejen v sousedních zemích střední Evropy.

OECD (2011): "Pension Markets in Focus", Issue 8, annual publication of the Financial Affairs Division of the OECD Directorate for Financial and Enterprise Affairs.
Studie OECD nabízí přehled vývoje penzijních fondů v mnoha světových zemích. Trend zvětšování objemu investic těchto fondů je předkládán v kontextu podobně orientovaných legislativních změn penzijních systémů v posledních letech.

OECD (2011b): "Survey of investment regulation of pension funds", OECD working paper, June 2011.
Ojedinělá studie kvantitativní investiční regulace penzijních fondů v zemích OECD a vybraných zemích mimo OECD přináší globální pohled příčin chování portfolio manažerů v jednotlivých zemích.

Tapia, W. (2008), "Comparing Aggregate Investment Returns in Privately Managed Pension Funds: An Initial Assessment", OECD Working Papers on Insurance and Private Pensions, No. 21, OECD publishing.
Porovnání investičních strategií v zemích střední Evropy, Jižní Ameriky a některých vybraných zemí OECD. Studie analyzuje, do jaké míry jsou investiční strategie determinovány právní regulací a do jaké míry jsou svobodným rozhodnutím zodpovědných osob v penzijních fondech.

Tapia, W. (2008b): "Description of Private Pension Systems", OECD Working Papers on Insurance and Private Pensions, No. 22, OECD publishing.
Další z reportů OECD se snaží přinést komparativní studii regulace investic privátních penzijních fondů v různých zemích. Zahrnuje též detailní popis penzijních systémů v jednotlivých státech.

Diplomové a disertační práce k tématu (seznam bakalářských, magisterských a doktorských prací, které byly k tématu obhájeny na UK, případně dalších oborově blízkých fakultách či vysokých školách za posledních pět let)

Hlaváč, J. (2011): "The performance of the Czech Private Pension scheme: Current Design and its position within CEE countries", Master thesis, Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies, 107 pages, Supervisor: Ondřej Schneider.

Součková, S. (2011): "Simulation of Pension Reform Impact on Czech Real Estate Market", Master thesis, Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies 85 pages, Supervisor: Tomáš Jandík, MA MSc. MRICS.

Datum / Podpis studenta

3.1.2014 **……**