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Name Tutor	: Ir. C. (Carla) Brouwer
Name student	: K.A. (Kristian) Gabriëlse
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Saxion student no.	: 414009
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THE CORRELATION BETWEEN REAL ESTATE AND OTHER ASSETS

UNIVERSITY of GREENWICH

This master thesis contains a study of the correlation between real estate and other assets in a mixed-asset portfolio of pension funds during the economic crisis of 2008.

Kristian Gabriëlse
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COLOPHON

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Author name	: K.A. (Kristian) Gabriëlse
Greenwich student no.	: 000866398
Saxion student no.	: 414009
Email	: kristiangabrielse@gmail.com
Telephone	: +31 6 30309702

PREFACE

At this moment you are reading the preface of my master thesis that I wrote to accomplish the Master of Real Estate Management study at the University of Greenwich in collaboration with the Saxion University of Applied Science. Writing this thesis was the last episode of the master study and combines the lectures, the study material and the learning process during the study with my own interest in the real estate market.

The choice for writing a thesis about this subject was triggered by the fact that my interest within the real estate market are real estate asset management, real estate portfolio management and real estate as an investment object. During the thesis process I read about the fact that the low correlations of real estate with other assets in a mixed-asset portfolio possibly were not present during an economic crisis, and decides to write my thesis about this subject. In the Netherlands, pension funds have the biggest mixed-asset portfolios, so I choose to combine this with the correlation of real estate in a mixed-asset portfolio.

Besides that this thesis is written to accomplish my master study, the investment market could possibly use the results of this thesis as well. Mixed asset investors can use this research to see the benefits of real estate in a mixed-asset portfolio during an economic crisis and to take actions on the results of correlation between different assets.

Although I collect a lot of information and worked on this thesis for a long time, I could not have done this on my own. Therefore, I would like to thank my tutor, Carla Brouwer, for helping me during the thesis process. She made me focus on the elements I needed to deliver and helped me with her knowledge and network. Besides thanking Carla for her help during the process, I would like to thank Evert Jan Nilting, Sipke Gorter and Maarten van der Spek for the interviews and the information that they shared.

I hope this thesis provides new information and a better knowledge about real estate in a mixed-asset portfolio during a crisis.

K.A. (Kristian) Gabriëlse

Utrecht, 11 september 2015

I hereby declare that this thesis is my own work and effort. Where any information from other sources has been used, they have been referenced and acknowledged.

K.A. Gabriëlse, Utrecht, 11 September 2015

SUMMARY

During the last centuries real estate became an important asset within mixed-asset investment portfolios. The importance of real estate in a mixed-asset portfolio is based on Markowitz (1959) modern portfolio theory. The important message of the modern portfolio theory was that different assets in a mixed-asset portfolio could not only be selected on the features of the different assets but rather on the movements of the different assets opposed to each other. Many studies conclude that real estate in a mixed-asset portfolio offered diversification benefits because of the low or even negative correlation with other asset classes. According to Lizieri (2013) are the diversification benefits that real estate offered before the economic crisis of 2007 not present during the economic crisis. Lizieri (2013) stated that real estate, even more than other financial products, performed extremely poorly across different types of property, different location and in many countries since the beginning of the economic crisis. In the absence of calculations about the differences in correlation of real estate with other assets, this thesis covers the gap between the assumptions that real estate has a higher correlation with other assets during the economic crisis and the actual facts about the correlation. The research question that covers the gap in knowledge and forms the basis of this research is:

To what extent are diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds present during the economic crisis (since 2007)?

To answer the research question this research contains analyses of qualitative and quantitative data. To test the correlation between real estate and other assets in a mixed-asset portfolio before and during the economic crisis a quantitative approach is used. The data sets that have been collected during the quantitative contains information about the return and invested capital of different assets of the ten biggest pension funds before and during the economic crisis. These figures are combined to an annual return per asset for the whole portfolio. With this information the correlation coefficient between real estate and other asset is calculated for the periods 2001-2007 and 2008-2014, which is used to clarify the differences in correlation between the periods before and during the economic crisis. The interviews during the qualitative research are used to gain more information about the topic and to understand the motives of real estate managers concerning their real estate portfolio. The qualitative research, quantitative data and the literature review together are used to make a final conclusion concerning the research question.

The conducted research shows that the correlation between real estate and other assets before the crisis has a low correlation with each other, which support the statements of Craft (2001), Hoesli, et al. (2004), and van Gool, et al. (2013), that real estate in a mixed-asset portfolio has a low of even negative correlation with other assets, which make real estate a good diversification asset in the portfolio. During the economic crisis the correlation between real estate and other assets increased in all cases. The increased correlation between real estate and the other assets implies that Lizieri (2013) is right with the statement that the diversification benefits of real estate do not hold in years of economic crisis. With this information, the hypotheses that '*Diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds are lower during the recent economic crises than during the preceding period*' is confirmed.

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1. INTRODUCTION

This chapter will discuss the background, scope and relevancy of the research. The contribution of real estate in a mixed-asset portfolio is a well-researched topic in the recent history. The focus of earlier research is mainly based on the modern portfolio theory and the diversification characteristics of real estate in a mixed-asset portfolio. Most important part of the diversification benefits is the relatively low relation of real estate with other asset classes. The last years there has been a downfall of the real estate market in different segments and countries. No research is conducted to see the effects of this downfall on the diversification benefits of real estate. Because Dutch pension funds are among the largest mixed-asset investors, this research is based on the diversification benefits of real estate in mixed asset-portfolios of Dutch pension funds during the economic crisis. This introduction introduces the Dutch pension funds, the development of mixed-asset portfolios and the contribution of real estate in mixed-asset portfolios.

The Netherlands has a total population of 332 pension funds. The purpose of a pension fund is not to maximize returns on the investments but to manage coverage ratio. The coverage ratio indicates whether a pension fund can fulfil their commitments in the future. This coverage ratio need to be achieved at the lowest possible risk. Pension funds in the Netherlands invest in different asset classes, a so called mixed-asset portfolio. In the annual reports of the five biggest pension funds in the Netherlands is shown that these funds invest in different asset classes. The pension funds invest in shares, infrastructure, private equity, commodities, hedge funds, bonds and real estate.

The beginning of the mixed-asset portfolios is the development of the modern portfolio theory by Markowitz (1959). The important message of the modern portfolio theory was that different assets in a mixed-asset portfolio could not only be selected on the features of the different assets but rather on the movements of the different assets opposed to each other. Taking these movements into account the portfolio had the same expected return and less risks than a portfolio constructed by ignoring these movements (Markowitz, 1959). The choice for a mixed-asset portfolio of pension funds is mainly done with the Asset Liability Management model. With this model a continuity analyses of the pension fund can be made. Besides that, the tool can be used to generate an asset mix which should be able to hedge the portfolio risk and generate portfolio returns (Beckers, 2008). Bazdarich (2006) demonstrates in an article that pension funds must establish two separate portfolios, a portfolio that covers all risks and a portfolio that generates a return. This is already being used by pension funds under the name Matching portfolio and Return portfolio (Bazdarich, 2006).

Many studies about the contribution of real estate to a mixed-asset portfolio have been published in the eighties and nineties. These studies conclude that real estate in a mixed-asset portfolio offered diversification benefits because of the low correlation with other asset classes and should therefore be an asset class that represent between 20% and 30% of a diversified portfolio (Craft, 2001). During the recent global economic crisis the investors' perception of commercial real estate as a diversifying asset class changed. Commercial real estate in a mixed-asset portfolio traditionally has been justified with a combination of convenient risk-returns, the quality to hedge inflation and the low correlation with other asset classes. Since the beginning of the economic crisis in 2007, the correlation between real

estate and other asset classes seems to increase. Even more than other financial products, real estate performed extremely poorly across different types of property, different location and in many countries since the beginning of the economic crisis (Lizieri, 2013). If the diversification benefits of real estate do not hold in years of economic crisis, due to the dependence with other asset classes, then the benefits of adding real estate to a mixed-asset portfolio may be overrated (Lizieri, 2013). Nevertheless, institutional investors are increasingly looking to real estate as an investment option because the asset class has typically provided attractive risk-adjusted returns, a cash flow stream that can be matched to liabilities, a hedge to inflation, attractive yields, and low correlations to other asset classes in the past (Deutsche Asset and Wealth Management, 2013).

The research that will be conducted is about to what extent diversification benefits in direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds are present during the economic crisis. The introduction shows that diversification benefits not hold during an economic crisis (Lizieri, 2013) but there is no evidence shown in research on the extent of this. This research tries to cover this gap in knowledge.

In the following chapter, the literature review, an extended review is made about the diversification within mixed-asset portfolios, pension fund portfolio selection, real estate in a mixed-asset portfolio, real estate characteristics and diversification benefits of real estate.

2. LITERATURE REVIEW

This chapter gives a review of the most relevant literature. This literature review will focus on the background of the research question. The first part focuses on diversification in a mixed-asset portfolio. The second part of the literature review focusses on Pension fund portfolio selection. The third part of the literature review focuses on the real estate investments in a mixed-asset portfolio of pension funds. The fourth part of the literature review focusses on the characteristics, benefits and disadvantages of direct and indirect real estate. The last part focuses on the diversification benefits of direct and indirect real estate investments.

2.1. DIVERSIFICATION IN A MIXED-ASSET PORTFOLIO

Research of Brinson, et al. (1986), and Brinson, et al. (1991) shows that more than ninety percent of the return on investments can be committed to the strategic asset allocation of the portfolio. It is therefore very important to design the investment portfolio in a grounded way. The theory that provides an answer to this question is the modern portfolio theory.

The beginning of the mixed-asset portfolios is the development of the modern portfolio theory by Markowitz (1959). The important message of the modern portfolio theory was that different assets in a mixed-asset portfolio could not only be selected on the features of the different assets but rather on the movements of the different assets opposed to each other. Taking these movement into account the portfolio had the same expected return and less risk than a portfolio constructed by ignoring these movements (Markowitz, 1959). According to Schmidt (2003), the modern portfolio theory quantifies the benefits of diversification and demonstrates opportunities for improving the performance characteristics of portfolios by combining assets (Schmidt, 2003). The annual reports of the five biggest pension funds in the Netherlands show that these funds invest in different asset classes, thus in mixed-asset portfolios. The pension funds invest in shares, infrastructure, private equity, commodities, hedge funds, bonds and real estate (Stichting Pensioenfonds ABP, 2014; Stichting Pensioenfonds Zorg en Welzijn, 2014; Stichting Pensioenfonds Metaal en Techniek, 2014; Stichting Bedrijfstakpensioenfonds voor de Bouwnijverheid, 2014; Stichting Pensioenfonds van de Metalektro, 2014).

2.2. PENSION FUND PORTFOLIO SELECTION

A tool that is widely used by pension funds is the Asset Liability Management model. With this model a continuity analyses of the pension fund can be made, based on hundreds of economic scenarios. Besides that, the tool can be used to generate an asset mix which should be able to hedge the portfolio risk and generate portfolio returns (Beckers, 2008). Bazdarich (2006) demonstrates in an article that pension funds must establish two separate portfolios, a portfolio that covers all risks and a portfolio that benefits are delivered. This is already being used by pension funds under the name Matching portfolio and Return portfolio. A matching portfolio covers the interest and inflation risks as much as possible and the Return portfolio achieves the return on investments (Bazdarich, 2006).

The Matching portfolio will be managed with the aim to buy-in the future cash flows of pensions as efficiently as possible. The investment that are made in the Matching portfolio ensures that the future cash flows that are needed for the pensions are present. Besides that, a (part) of the future expected indexation can be purchased in the Matching portfolio as well.

This portfolio covers the future cash flows, which ensures that the pension fund is not sensitive for interest risk and inflation changes (First Pensions, 2009).

The reason to make a Return portfolio is to generate additional required investment return. The investment risk of the pension fund is used for this business activity and is required to cover the costs of the pension portfolio (First Pensions, 2009).

2.3. Real estate in a mixed-asset portfolio of pension funds

Van Gool, et al. (2013) stated that adding real estate to the investment portfolio of pension funds is mainly done because of diversification benefits and the reputation of inflation hedge of real estate. Van Gool, et al. (2013) added that the percentage of allocation to real estate in pension fund portfolios was roughly ten percent in 2010 and did not change during the past decades (van Gool, et al., 2013). This is shown in Chart 1.

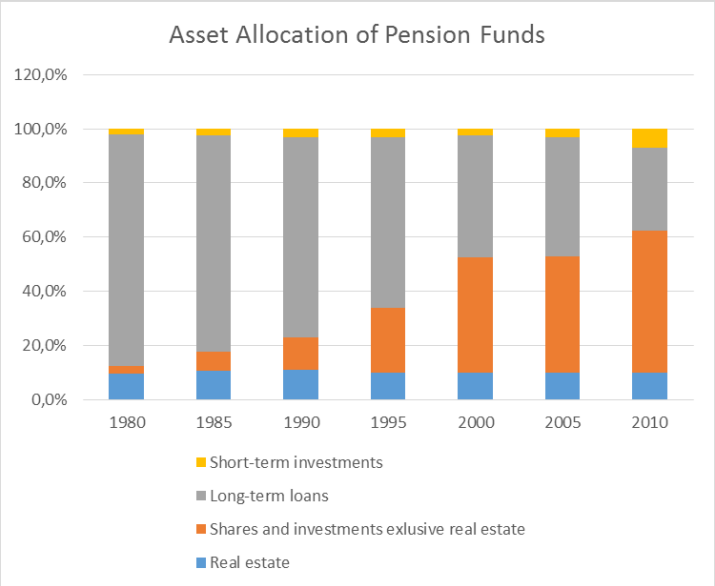

Chart 1: Asset Allocation of Pension Funds (van Gool, et al., 2013)

Despite the fact that percentage of allocation to real estate in pension fund portfolios did not change the last decades, the absolute investment in real estate changed approximately from 7 billion euro to 74 billion euro. Chart 2 shows that after a systematic build-up of the direct real estate investments the pension funds changed their focus to indirect real estate after 2005. This shift from direct to indirect real estate is driven by the need for relatively fast growth of the property portfolio and a wider range of specialized investment companies in real estate, which enabled more indirect investments (van Gool, et al., 2013).

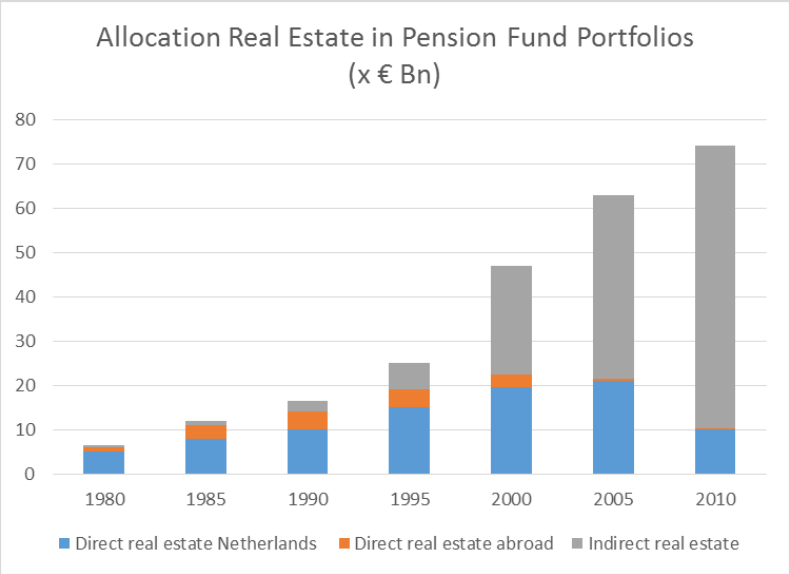

Chart 2: Allocation Real Estate in Pension Fund Portfolios (x € Bn) (van Gool, et al., 2013)

2.4. Direct versus indirect real estate

Real estate investment can be made in various categories. An important distinction is that between direct real estate investments and investments in indirect real estate. Simply stated, an investment in direct real estate is an investment in buildings also called an investment in stones. An investment in indirect real estate is an investment in shares of real estate companies (van Gool, et al., 2013).

Direct investment in real estate means that the investor directly owns the property or the ownership of a majority of financial assets titles which give the right to the income from that property and the control over the management of the real estate (van Gool, et al., 2013).

With investment in indirect real estate the real estate investor is not direct owner but the owner of a minority of financial asset titles which give the right to the income from that property without the control over the management of the real estate. This occurs with investments in shares or participation certificates in real estate funds and companies (van Gool, et al., 2013).

According to Oikarinen et al. (2011), the short-term correlation between the returns on direct and indirect real estate investments is typically found to be weak. Due to the higher liquidity, greater number of market participants, smaller transaction costs, and the existence of a public market place in the indirect real estate market, the indirect real estate market is generally more efficient than the direct market. Therefore, the prices of indirect real estate investments should react faster to shocks in the real estate market than those of direct real estate and the short-term figures show a low correlation between the assets. In contrast with the short-term performance is, according to Oikarinen, et al. (2011) and Kutlu (2010), the presence of a relation between direct and indirect real estate in the long run, which indicates that both direct and indirect real estate has a negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011). Kutlu (2010) stated that as a consequence that investors should treat the two real estate categories as a single asset class in the long run since they imply the same level of risk

and return characteristics over long horizons and diversification benefits of holding both assets are no longer possible in the long run (Kutlu, 2010).

2.4.1. Characteristics of real estate

There are different characteristics of investments in real estate. These characteristics make that investing in real estate differs from other asset classes. The most common characteristics are (van Gool, et al., 2013):

- Direct real estate can be seen as a production tool. This means that the real estate investor also have to operate on the rental market and other markets that play a role in real estate development and exploitation;
- Real estate is not portable, making it vulnerable to changes in economic and physical environment;
- Each building is unique towards geographical location, the nature of the building, the maintenance and the tenants;
- The real estate market is due to geographical aspects divided in local submarkets with their own characteristics;
- Direct real estate has high unit prices in comparison with shares and bonds. This means that there is a substantial investment needed for direct real estate;
- Direct real estate has high transaction costs in comparison with shares and bonds;
- Real estate is illiquid. Buying and selling the property requires a lot of time due to heterogeneity and complexity of the market as well as the lack of transparency of the real estate market;
- Real estate can offer revenues for a long period of time due to the long lifespan;
- Real estate has a large degree of government regulation and enjoys a lot of attention of tax authorities. Therefore, the results are also dependent on government policy;
- Investing in direct real estate is management intensive form of investing. The revenues can be influenced by the investor.

2.4.2. Benefits of direct real estate

The benefits of investing in direct real estate are closely associated with the characteristics of real estate. The benefits mentioned in the literature are (van Gool, et al., 2013):

- The investor has the ability to generate many years of relatively stable rental incomes, especially with real estate of good quality on a good location. Besides that, for a stable rental income the investor needs a creditworthy tenant and good agreements for rent adjustment;
- Long series of property yields show that the asset class direct real estate has an attractive return with a relatively limited risk;
- One of the benefits of investing in direct real estate is the diversifying power of real estate in a mixed-asset portfolio. This ability is based on the limited and sometimes even negative correlation of the return of direct real estate with the return of other property titles, such as stocks and bonds. Therefore, adding direct property to a portfolio can provide a reduced risk or an increased return;
- Direct real estate offers a correlation with the inflation and therefore a good protection against inflation, it is seen as an inflation hedge. This is mainly due to the indexation of the rental income provided by the lease contracts.

- The revenues of direct real estate can be influenced by active management. This does not only could include efforts in the field of rental agreements, rent collection and energy management but operating income and the value of the property can also be increased by maintenance, renovation and redevelopment.
- On inefficient markets such as the real estate market, which are characterized by incomplete information and market imperfections, it is possible to build a knowledge and information lead for a long period.

Research of Hoesli et al. (2004), shows that the optimal weight that should be allocated to real estate in mixed-asset portfolios, based on the diversifying power and the inflation hedge, is in the 5% to 15% range, and that the inclusion of real estate assets in such portfolios leads to a 5% to 10% reduction in the portfolio's risk level. When international real estate investments also are considered, the risk reduction is increased to 10% to 20%, and so is the weight that should be devoted to real estate in diversified portfolios (Hoesli, et al., 2004).

2.4.3. Disadvantages of direct real estate

The disadvantages of investing in direct real estate are, as well as the benefits, closely associated with the characteristics of real estate. Van Gool, et al. (2013), mentioned in their book the following disadvantages of direct real estate:

- Investing in direct real estate is a knowledge- and management-intensive form of investment, which requires a much larger acquisition and management unit than for an equally large portfolio, in terms of value, of stocks or bonds.
- Due to high real estate prices it is not easy to invest a small amount of money. A responsible risk profile can only be achieved at a large real estate portfolio. Only in case of a large portfolio the investor is able to earn back the management costs and create a good diversification.
- The real estate market is illiquid compared to stocks and bonds. As previously mentioned, the transaction costs for real estate transactions are relatively high and the transaction itself involves a lot of time.
- Finally, the performance measurement and benchmarking of real estate is difficult, not so much for the measurement of direct rental income and direct returns, but the indirect returns due to the valuation. Valuations are subjective and difficult to carry out.

2.4.4. Benefits of indirect real estate

According to van Gool, et al. (2013), the benefits of investing in indirect real estate are:

- For investments in indirect real estate, local expertise and a management organization for the property is not needed. This local expertise is available at the real estate company;
- Investments in indirect real estate can be done with a relatively small amount of money, in particular with listed real estate funds. The investor can relatively easy benefit from a large portfolio diversification;
- The transaction costs to invest in indirect real estate are lower than with direct real estate;
- The liquidity of indirect real estate is higher than that of direct real estate, especially when the real estate fund is listed;

- Investors can benefit from economies of scale. Economies of scale arise because expertise and management are centralized in one company;
- The emotional value of indirect real estate is less than in direct estate, thereby it is easier for the investor to make rational decisions;
- The investor can benefit from the effects of leverage because most real estate funds are financed with debt. This is not a specific benefit of indirect real estate because buying direct real estate can (in some cases) be financed with debt as well.

2.4.5. Disadvantages of indirect real estate

According to van Gool, et al. (2013), the disadvantages of investing in indirect real estate are:

- In case of investing in indirect real estate the investor cannot make a decision in which real estate the companies invest. Except for the choice in which fund the investor invest, there is no influence on the allocation across countries, markets, types and tenants;
- It is hard for the investor to keep a feeling with the real estate market;
- A higher risk due to the financing by debt;
- The value of real estate stocks generally fluctuates stronger than the value of the underlying property.

2.5. Diversification benefits of direct and indirect real estate

Many studies about the contribution of real estate to a mixed-asset portfolio have been published in the eighties and nineties. These studies conclude that real estate in a mixed-asset portfolio offered diversification benefits because of the low correlation with other asset classes and should therefore be an asset class that represent between 20% and 30% of a diversified portfolio (Craft, 2001). As stated in paragraph 2.4.2 the main diversification benefits of investing in direct real estate is the diversifying power of real estate in a mixed-asset portfolio. This ability is based on the limited and sometimes even negative correlation of the return of direct real estate with the return of other property titles, such as stocks and bonds. Besides that, direct real estate offers a correlation with the inflation and is therefore a good protection against inflation, it is seen as an inflation hedge (van Gool, et al., 2013). According to Hoesli et al. (2004), the optimal weight that should be allocated to real estate in mixed-asset portfolios, based on the diversifying power and the inflation hedge, is in the 5% to 15% range, and that the inclusion of real estate assets in such portfolios leads to a 5% to 10% reduction in the portfolio's risk level. When international real estate investments also are considered, the risk reduction can be increased to 10% to 20%, and so is the weight that should be devoted to real estate in diversified portfolios (Hoesli, et al., 2004). Oikarinen et al. (2011) and Kutlu (2010) stated that the relation between direct and indirect real estate is present in the long run, which indicates that indirect real estate has a negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011). The benefits of indirect real estate to a mixed-asset portfolio could therefore be seen as the same as the benefits of direct real estate to a mixed-asset portfolio over the long run.

Since the beginning of the economic crisis in 2007, the correlation between real estate and other asset classes seems to increase during the period between 2007 and 2015. Even more than other financial products, real estate performed extremely poorly across different types

of property, different location and in many countries since the beginning of the economic crisis. If the diversification benefits of real estate do not hold in years of economic crisis, due to the dependence with other asset classes, then the benefits of adding real estate to a mixed-asset portfolio may be overrated (Lizieri, 2013). Nevertheless, institutional investors are increasingly looking to real estate as an investment option because the asset class has typically provided attractive risk-adjusted returns, a cash flow stream that can be matched to liabilities, a hedge to inflation, attractive yields, and low correlations to other asset classes in the past (Deutsche Asset and Wealth Management, 2013). The real estate investments of Dutch pension funds, the biggest Dutch institutional investors, have grown in the past thirty years to the third biggest asset class. In thirty years the capital invested in real estate increased tenfold (van Gool, et al., 2013).

2.6. Conclusions

Research of Brinson, et al. (1986), and (Brinson, et al., 1991) shows that more than ninety percent of the return on investments can be committed to the strategic asset allocation of the portfolio. It is therefore very important to design the investment portfolio in a grounded way. The theory that provides an answer to this question is the modern portfolio theory. The beginning of the mixed-asset portfolios is the development of the modern portfolio theory by Markowitz (1959). The important message of the modern portfolio theory is that different assets in a mixed-asset portfolio could not only be selected on the features of the different assets but rather on the movements of the different assets opposed to each other. Taking these movement into account the portfolio has the same expected return and less risk than a portfolio constructed by ignoring these movements (Markowitz, 1959).

According to Beckers (2008) a tool that is widely used by constructing a mixed-asset portfolio for pension funds is the Asset Liability Management model. With this model a continuity analyses of the pension fund can be made and the model can be used to generate an asset mix which should be able to hedge the portfolio risk and generate portfolio returns (Beckers, 2008). Bazdarich (2006) demonstrates in an article that pension funds must establish two separate portfolios, a portfolio that covers all risks and a portfolio that benefits are delivered. This is already being used by pension funds under the name Matching portfolio and Return portfolio. A matching portfolio covers the interest and inflation risks as much as possible. (Bazdarich, 2006). The investment that are made in the Matching portfolio ensures that the future cash flows that are needed for the pensions are present. Besides that, a (part) of the future expected indexation can be purchased in the Matching portfolio as well. The Matching portfolio ensures that the pension fund is not sensitive for risk and inflation changes (First Pensions, 2009). The reason of having a Return portfolio is to achieve return on investments (Bazdarich, 2006). The investment risk of the pension fund is used for this business activity and is required to cover the costs of the pension portfolio (First Pensions, 2009).

According to van Gool, et al. (2013) adding real estate to the investment portfolio of pension funds is mainly done because of diversification benefits and the reputation of inflation hedge of real estate. Van Gool, et al. (2013) added that the percentage of allocation to real estate in pension fund portfolios was roughly ten percent in 2010 and did not change during the past decades (van Gool, et al., 2013). Despite the fact that percentage of allocation to real estate in pension fund portfolios did not change the last decades, the absolute investment in

real estate changed approximately from 7 billion euro to 74 billion euro (van Gool, et al., 2013).

Real estate investment can be made in various categories. An important distinction is of real estate is those between direct real estate investments and investments in indirect real estate. Simply stated, an investment in direct real estate is an investment in buildings also called an investment in stones. An investment in indirect real estate is an investment in shares of real estate companies (van Gool, et al., 2013). After 2005 the pension funds changed their focus from direct real estate to indirect real estate. This shift from direct to indirect real estate is driven by the need for relatively fast growth of the property portfolio and a wider range of specialized investment companies in real estate, which enabled more indirect investments (van Gool, et al., 2013).

According to Oikarinen et al. (2011), the short- term correlation between the returns on direct and indirect real estate investments is typically found to be weak. Due to the higher liquidity, greater number of market participants, smaller transaction costs, and the existence of a public market place in the indirect real estate market, the indirect real estate market is generally more efficient than the direct market. Therefore, the prices of indirect real estate investments should react faster to shocks in the real estate market than those of direct real estate and the short-term figures show a low correlation between the assets. In contrast with the short-term performance is, according to Oikarinen, et al. (2011) and Kutlu (2010), the presence of a relation between direct and indirect real estate in the long run, which indicates that both direct and indirect real estate has a negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011). Research of Hoesli et al. (2004) shows that the optimal weight that should be allocated to real estate in mixed-asset portfolios, based on the diversifying power and the inflation hedge, is in the 5% to 15% range, and that the inclusion of real estate assets in such portfolios leads to a 5% to 10% reduction in the portfolio's risk level. When international real estate investments also are considered, the risk reduction is increased to 10% to 20%, and so is the weight that should be devoted to real estate in diversified portfolios (Hoesli, et al., 2004).

There are different benefits and disadvantages of investments in direct and indirect real estate. These benefits and disadvantages make that investing in real estate differ from investing in other asset classes. The most important benefits and disadvantages of direct real estate are stated in Table 1 and the most important benefits and disadvantages of indirect real estate are stated in Table 2 (van Gool, et al., 2013):

Table 1: Benefits and disadvantages of direct real estate (van Gool, et al., 2013)

Benefits	Disadvantages
- Stable rental income; - Attractive return on limited risk; - Inflation hedge; - Diversifying power in mixed-asset portfolio; - Revenues can be influenced by active management.	- Knowledge- and management intensive form of investment; - Not easy to invest small amount of money; - Illiquid market compared with stocks and bonds; - Valuation is subjective.

Table 2: Benefits and disadvantages of indirect real estate (van Gool, et al., 2013)

Benefits	Disadvantages
- No local expertise and management organisation needed; - Relatively small amount of money needed for investment; - Low transaction costs; - Higher liquidity than direct real estate; - Benefits from economies of scale; - Less emotional value than direct real estate; - Benefits from the effect of leverage.	- No influence on the allocation across countries, markets, types and tenants; - Hard to keep feeling with real estate market; - Higher risk due to financing by debt; - Value of stocks fluctuates stronger than the value of real estate.

Many studies conclude that real estate in a mixed-asset portfolio offered diversification benefits because of the low correlation with other asset classes and should therefore be an asset class that represent between 20% and 30% of a diversified portfolio (Craft, 2001). According to Hoesli et al. (2004), the optimal weight that should be allocated to real estate in mixed-asset portfolios, based on the diversifying power and the inflation hedge, is in the 5% to 15% range (Hoesli, et al., 2004). Oikarinen et al. (2011) and Kutlu (2010) stated that the relation between direct and indirect real estate is present in the long run, which indicates that indirect real estate has a negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011).

Since the beginning of the economic crisis in 2007, the correlation between real estate and other asset classes seems to increase during the period between 2007 and 2015. Even more than other financial products, real estate performed extremely poorly across different types of property, different location and in many countries since the beginning of the economic crisis. If the diversification benefits of real estate do not hold in years of economic crisis, due to the dependence with other asset classes, then the benefits of adding real estate to a mixed-asset portfolio may be overrated (Lizieri, 2013).

3. RESEARCH METHODOLOGY

In this chapter the research methodology is described. The research methodology contains the research objective, the research question and sub questions, the hypothesis, research strategy and data collection, research breakdown structure and the breakdown structure of the sub questions.

3.1. RESEARCH QUESTION AND SUB QUESTIONS

In this part the research question and the sub questions that will give an answer to the research question are stated.

3.1.1. RESEARCH QUESTION:

According to van Gool, et al. (2013), a benefit of investing in direct real estate is the diversifying power of real estate in a mixed-asset portfolio. This ability is based on the limited and sometimes even negative correlation of the return of direct real estate with the return of other property titles, such as stocks and bonds. Besides that van Gool, et al. (2013)stated that direct real estate offers a correlation with the inflation and therefore a good protection against inflation. This is mainly due to the indexation of the rental income provided by the lease contracts. According to Kutlu (2010) analysis confirms the presence of a relation between direct and indirect real estate in the long run, which indicates that indirect real estate has a negative correlation and offers a correlation with inflation as well. As a result of this conclusion direct and indirect real estate could be seen as a single asset class because they imply the same level of risk and returns. Since the beginning of the economic crisis in 2007, the correlation between real estate and other asset classes seems to increase. Even more than other financial products, real estate performed extremely poorly since the beginning of the economic crisis (Lizieri, 2013). The following research questions tries to cover the knowledge gap about the extent of diversification benefits during an economic crisis:

To what extent are diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds present during the economic crisis (since 2007)?

3.1.2. SUB QUESTIONS:

The sub questions that need to be answered in order to answer the research question are:

1. What are the characteristics, benefits and disadvantages of direct and indirect real estate?
    A. What are the diversification benefits of direct real estate in a mixed-asset portfolio?
    B. What are the diversification benefits of indirect real estate in a mixed-asset portfolio?
2. What was the correlation between direct and indirect real estate and other assets before and during the economic crisis?
    A. What was the correlation between direct and indirect real estate with other asset classes before the economic crisis?
        - What was the trend of correlation between direct real estate and other assets before the economic crisis?

- What was the trend of correlation between indirect real estate and other assets before the economic crisis?

B. What was the correlation between direct and indirect real estate with other asset classes during the economic crisis?
   - What is the trend of correlation between direct real estate and other assets during an economic crisis?
   - What is the trend of correlation between indirect real estate and other assets during an economic crisis?

3.2. Research objective

The objective of this master thesis is to investigate whether real estate in a mixed-asset portfolio still could be seen as a diversification asset, in terms of risk and return. The research focuses on the investments in direct and indirect real estate of pension funds. With the information provided with this research investors with a mixed-asset portfolio could reconsider if real estate in their portfolio is still necessary.

3.3. Hypotheses

3.3.1. Research hypotheses

RQ: To what extend are diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds present during the economic crisis (since 2007)?

RH: Diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds are lower during the recent economic crises than during the preceding period.

3.3.2. Sub hypotheses

SQ 1: What are the characteristics, benefits and disadvantages of direct and indirect real estate? SH 1: No hypotheses
SQ 1A: What are the diversification benefits of direct real estate in a mixed-asset portfolio? SH 3: No hypotheses
SQ 1B: What are the diversification benefits of indirect real estate in a mixed-asset portfolio? SH 4: No hypotheses

SQ 2: What was the correlation between direct and indirect real estate and other assets before and during the economic crisis? SH 2: See hypotheses SH 2A and SH 2A
SQ 2A: What was the correlation between direct and indirect real estate with other asset classes before the economic crisis? SH 2A: There is a low correlation between direct and indirect real estate and other assets before the economic crisis.
• SQ 2A1: What was the trend of correlation between direct real estate and other assets before the economic crisis?
• SQ 2A2: What was the trend of correlation between indirect real estate and other assets before the economic crisis?

SQ 2B: What was the correlation between direct and indirect real estate with other asset classes during the economic crisis? SH 2B: The correlation between direct and indirect real estate is higher during an economic crisis than in the preceding period.
• SQ 2B1: What is the trend of correlation between direct real estate and other assets during an economic crisis?
• SQ 2B2: What is the trend of correlation between indirect real estate and other assets during an economic crisis?

3.4. CONCEPTUAL MODEL OF THE RESEARCH

The conceptual model of the research is described in Figure 1. The main variables in the research are the diversification benefits of real estate and the effects of the economic crisis of different assets in a mixed-asset portfolio.

The first variable arises from the fact that many studies conclude that real estate in a mixed-asset portfolio offered diversification benefits because of the low correlation with other asset classes and should therefore be an asset class that represent between 20% and 30% of a diversified portfolio (Craft, 2001). Besides that van Gool, et al. (2013)stated that direct real estate offers a correlation with the inflation and therefore a good protection against inflation.

The second variable arises from the fact that during the recent global economic crisis the investors' perception of real estate as a diversifying asset class changed. Since the beginning of the economic crisis in 2007, the correlation between real estate and other asset classes seems to increase. Even more than other financial products, real estate performed extremely poorly across different types of property, different location and in many countries since the beginning of the economic crisis (Lizieri, 2013). If the diversification benefits of real estate do not hold in years of economic crisis, due to the dependence with other asset classes, then the benefits of adding real estate to a mixed-asset portfolio may be overrated (Lizieri, 2013).

The two variables can be combined to give an answer on the main research question. With the two variables the extent to which diversification benefits hold during an economic crisis can be determined. The advice that can be given with answering this question is the presence of diversifying advantages of real estate in a mixed-asset portfolio during an economic crisis.

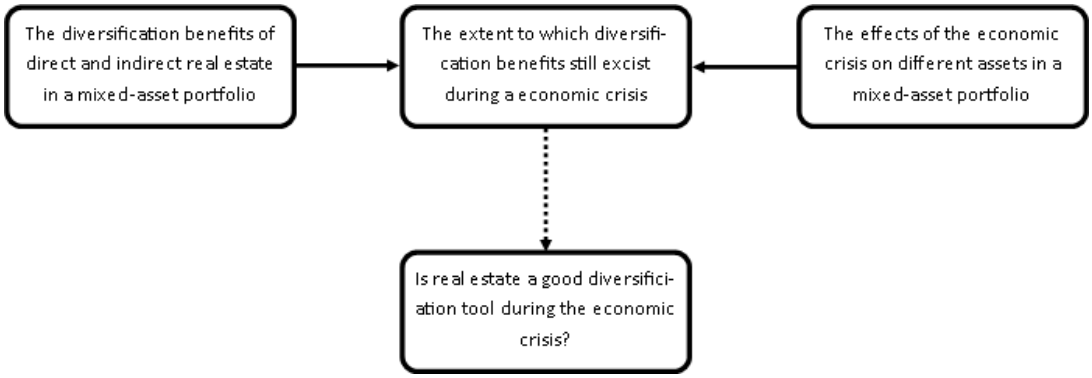

Figure 1: Conceptual model of the research

3.5. Research strategy and data collection

The research is divided in different subparts. The first part is literature research on the topic of direct and indirect real estate to research the diversification benefits of direct and indirect real estate in a mixed-asset portfolio (sub question one till sub question four). The second part consists of a qualitative research with five of the 25 biggest pension funds, which can be found in Appendix 1, in the Netherlands (mixed-asset portfolios). This part will discuss the sub questions three to six in an interview with fund managers/real estate managers of different pension funds. The third part consists of a quantitative research based on the achieved figures of the mixed-asset portfolios of the ten pension funds. This part will discuss the sub questions five to eight. In this way, all the sub questions are covered by different research methods. Based on this research, the writer answers to what extend diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds are present during the economic crisis (since 2007)?

The literature research consists of the background of research on direct and indirect real estate. The difference is made between direct real estate and indirect real estate, the benefits, advantages and disadvantages of both, the diversification in a mixed-asset portfolio and the diversification benefits of both direct and indirect real estate in a mixed-asset portfolio.

The quantitative data that will be collected of ten of the 25 biggest pension funds in the Netherlands will be analysed on the diversification benefits and correlation of direct and indirect real estate to other assets before the economic crisis and the correlation of direct and indirect real estate to each other before and during the economic crisis.

Five of the ten pension funds will be approached for interviews with the fund managers for qualitative research. This research provides information about the view of professionals in the field of mixed-asset portfolios. The information of the interviews will be used to answer in what extend the diversification benefits of direct and indirect real estate real estate still exists during an economic crisis.

3.5.1. Approach

The approach for the research is a mixed approach. To test the hypotheses for the correlation between real estate and other assets in a mixed-asset portfolio before and during the economic crisis a quantitative approach is used. The figures of pension funds will be used to determine the possible differences of correlation before and during the economic crisis.

The qualitative approach will be used to gain more information about the subject. This research provides information about the view of professionals in the field of mixed-asset portfolios. The information of the interviews, together with the quantitative data will be used to answer in what extend the diversification benefits of direct and indirect real estate real estate still exists during an economic crisis. According to Boeije (2014) the idea behind the qualitative approach is to understand considerations, arguments, experiences and motives (Boeije, 2014). The questions in the qualitative research will focus on the experiences and motives of the different companies on the topic of research.

3.5.2. Research design

The research design type that is used in the research design is the case study design. Different pension funds will be seen as different cases in this research. The case study consists of the interpretation of data sets and conducting of interviews. The interviews will be done with the same type of respondents (pension funds) and the same work positions (asset/portfolio managers) in these companies.

3.5.3. Data collection strategy

The data collection will be done by semi-structured interviews and data set collection. By using semi structured interviews the experiences and motives of asset/portfolio managers of the correlation between real estate and other assets during the economic crisis will be researched. The information that will be collected can be used to assess how the correlation developed before and during the crisis in the different pension funds.

The data sets that will be collected contains information about the development of different assets before and during the economic crisis. These developments will be balanced against each other, which gives a clear picture of the correlation between the different assets and real estate.

3.5.4. Population and sample

The total population of pension funds in the Netherlands is 332. The way of sampling is the convenience sampling. Convenience sampling means that a sample based on the cases that are easily accessible is used (Boeije, 2014). The 25 biggest pension funds are easily accessible and all of them contains enough assets to research. From these companies the ten that react first will be assessed. So, the final sample will be ten companies. The sample size of ten different companies give a sufficient view for the total population of pension funds in the Netherlands.

3.5.5. Data collection measurement

Interviews

The interviews that will be conducted are important for the background information of the subject. The interviews will describe general information of the pension funds/executive company, information about the characteristics for sub question one and information about the correlation during and before the crisis in answer on sub question two. The interview guide that will be used is added in Table 3.

Table 3: Interview Guide

SUBJECT	SUB QUESTION	INTERVIEW QUESTION
GENERAL	General information	• You work for **COMPANY**, troughout research I have come to know that this is the executive organisation for the **PENSION FUND.** To which extend is all invested capital of the pension fund placed at **COMPANY** and does **COMPANY** manage invested capital of other pension funds as well?
CHARACTERISTICS	What are the characteristics, benefits and disadvantages of direct and indirect real estate?	• Pension funds invest in different asset. One of the assets in a so called mixed-asset portfolio of pension funds is real estate. In which way was the allocation to real estate in the mixed-asset portfolio determined? • This research is mainly focussed on the period 2001-2014. How did the volume of real estate as an asset class develop during that period and which differences can be see between direct and indirect real estate? • What are, according to the interviewee, the characteristics of real estate in a mixed-asset portfolio? • Are the same characteristics present for both direct and indirect real estate?
CORRELATION	What was the correlation between direct and indirect real estate and other assets before and during the economic crisis?	• During the literature review of this thesis different sources has been accessed which describe an increased correlation between real estate and other assets during the economic crisis. Which correlation differences do you see between the economic crisis and the period before? • How do you think these correlation differences occurred? • Is it in your opinion important that the relation between real estate and other assets is low during a crisis? • Do you think that in future economic crisis the correlation between real estate and other assets will increase as well?

Datasets

The datasets will be used to calculate the correlation coefficient between real estate and other assets. A correlation exists between two variables when one of them is related or can be influenced by the other in some way. The correlation coefficient is a numerical measure to describe the degree of strength and direction by which one variable is related to another. A linear relationship means that when graphed, the points approximate a straight line pattern. A correlation coefficient can range in value from -1 to +1. The closer to +1 or -1 the better the relationship. If the correlation coefficient is close to 0, there is little or no linear correlation between the two variables. The relationship between the two variables is described as stated in Table 4 (Willemse, 2009).

Table 4: Interpretation of the correlation coefficient (Willemse, 2009)

Correlation Coefficient	General Interpretation
Between 0.9 and 1	Very strong positive relationship
Between 0.8 and 0.9	Strong positive relationship
Between 0.6 and 0.8	Moderate positive relationship
Between 0.2 and 0.6	Weak positive relationship
Between 0.0 and 0.2	Very weak positive or no relationship
Between 0.0 and –0 .2	Very weak negative or no relationship
Between –0.2 and –0.6	Weak negative relationship
Between –0.6 and –0.8	Moderate negative relationship
Between –0.8 and –0.9	Strong negative relationship
Between –0.9 and –1	Very strong negative relationship

3.5.6. Analysis techniques

Interviews

The interviews will be used for background information about the subject. The transcriptions of the interviews will be added in the appendices. The interviews will describe general information of the pension funds/executive company, information about the characteristics for sub question one and information about the correlation during and before the crisis in answer on sub question two. The most important conclusions of the interviews will be described in Chapter 4. These conclusions will be compared with the conclusions of the literature and the conclusions of the quantitative data. Comparing these separate conclusions gives the input for conclusions and recommendation of the research.

Datasets

The datasets will be used to calculate the correlation coefficient between real estate and other assets. The other assets that will be used are shares, fixed income securities, commodities and private equity. The correlation coefficient shows the correlation between different types of investment. The outcome will be a number between -1 and 1, thereby -1 is a negative correlation, 0 is a low correlation and 1 is high correlation. The calculation that is shown below is done with excel. The correlation coefficient can be calculated by using the following formula:

$$Corr\ (R_xR_y) = \frac{Cov\ (R_xR_y)}{SD\ (R_x) * SD\ (R_y)}$$

$Corr\ (R_xR_y)$	=	Correlation Coefficient between Return X and Return Y
$Cov\ (R_xR_y)$	=	Coveriance between Return X and Return Y
$SD\ (R_x)$	=	Standard Deviaton of Return X
$SD\ (R_y)$	=	Standard Deviaton of Return Y

To calculate the correlation between different assets, the covariance and the standard deviation of the investments is needed. The covariance is a measurement of how much two random variables change together. The covariance can be calculated by using the following formula:

$$Cov\ (R_1R_2) = \frac{(X_1-\mu_x)*(Y_1-\mu_y)+(X_2-\mu_x)*(Y_2-\mu_y)+...+(X_n-\mu_x)*(Y_n-\mu_y)}{n}$$

$Cov\ (R_1R_2)$	=	Coveriance between Return 1 and Return 2
$X_{1,2,n}$	=	Return X in year 1, year 2,.. untill year n
$Y_{1,2,n}$	=	Return Y in year 1, year 2,.. untill year n
μ_x	=	Average Return X over period
μ_y	=	Average Return Y over period
n	=	Number of years

The standard deviation is a measurement that can be used to quantify the amount of variation of a set of data values. The standard deviation can be calculated by using the following formula:

$$SD\ (R_x) = \sqrt{V\ (R_x)}$$

$SD\ (R_x)$	=	Standard Deviation of Return X
$V\ (R_x)$	=	Variance of Return X

All the formulas to calculate the individual parts of above mentioned calculations can be found in Appendix 2.

3.6. LIMITATIONS OF THE RESEARCH

In this chapter the limitations of the research will be stated. The report is conducted with as much care as possible and with the use of sufficient resources, but due to the time span of delivery of the research report different limitations in this research are necessary to complete the research. The following limitations will be used during the process:

The research will focus on the Dutch pension funds with a mixed-asset portfolio. Besides these pension funds there are different investment companies with a mixed-asset portfolio,

but these companies are not considered in this research. Ten of the 25 biggest pension funds provides enough information to cover the group of pension funds due to the diversity of assets in these funds. In case of no support of these funds, the next biggest pension fund will be asked for the interview and figures about the development in these funds.

The research will focus on the real estate correlation developments with other assets in the funds. The conclusions that will be provided are facing the diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio. This research do not considers if direct and indirect real estate should be a part of a mixed-asset portfolio during a crisis but only the correlation of real estate with other assets. The correlation development between those other assets and the need of these assets in a mixed-asset portfolio will not be considered as part of this research.

Due to the lack of time only the diversification benefits before and during the crisis will be used in this research. Future development of these diversification benefits, that possibly will arise, are not considered in this research and the conclusions are not based on that. Recommendations for further research can contain the use of future expectations in the same setting.

The influence of the real estate bubble is not taken into account during this research. To research this influence, there is a need for international data about foreign real estate markets and data about other economic crisis in the past. This would be too broad and requires too much time to research.

Most of the literature and research that is written on this topic is written before the crisis. A possibility is that the literature does not give sufficient information about real estate in a mixed-asset portfolio during the crisis, the writer tries to fill this gap with research information from the pension funds.

The research report need to be delivered on the 11th of September. According to this hard deadline the research will be as much as possible sufficient. The scope need to be on answering the main question, and other parts of mixed-asset portfolios are not conducted in the report.

4. RESULTS

4.1. ANALYSIS OF THE INTERVIEWS

For this research three interviews were conducted. An ideal population for the interviews would be more, but communication with the different pension funds did not have the desired effect. Just three companies were willing to give an interview. The transcription of these interviews are included in Appendix 3, Appendix 4 and Appendix 5. The interviews are taken with real estate managers of Timeos (the executive organisation for Stichting Pensioenfonds voor de Grafische Bedrijven), PGGM (the executive organisation for Stichting Pensioenfonds voor Zorg en Welzijn) and Stichting Philips Pensioenfonds.

4.1.1. UNBUNDLING OF TASKS AND RESPONSIBILITIES WITHIN THE ORGANISATION

During the last periods there was a major organisational change for pension funds in the Netherlands. According to E.J. Nilting, Timeos Pensioendiensten did arise from the unbundling of tasks and responsibilities within the organisation. The unbundling of task and responsibilities focusses on unbundling of governance and policy, execution and supervision. All the interviews show that the investments of the pension funds are done by executive organisations and had the same organisational changes.

4.1.2. THE PORTFOLIO STRUCTURE

According to E.J. Nilting, the asset mix of a pension fund is not build to maximize returns but to manage the coverage of the pension fund. The coverage ratio indicates whether the pension fund can meet their commitments in the future. This must be achieved at the lowest possible risk. The portfolio is split between a matching portfolio and a return portfolio. Within the return portfolio, a choice is made between shares and alternative investments as real estate, private equity and commodities.

Both, E.J. Nilting and M. van der Spek, stated that the allocation of real estate is mainly determined by long term riscdrivers. E.J. Nilting stated that in the past the allocation to real estate and other assets was mainly determined by an ideal mix, based on realized risk / return and that there is a shift nowadays towards a portfolio policy determined by future risk drivers as demography, unemployment and economy. According to S. Gorter the real estate portfolio policy is, besides the risk drivers, based on global allocation and functional allocation. The real estate portfolio is allocated in different economic regions (United States, Europe and Asia) and in terms of risk drivers as economy driven real estate (commercial real estate) and consumption driven real estate (retail property and houses).

According to all interview respondents, the allocation to real estate changed during the last years. The portfolios show a decrease of the percentage that is allocated to real estate. According to M. van der Spek, the change is mainly caused by the increase of alternative investment options, for example private equity and infrastructure. Besides that, according to all interview respondents, the allocation to direct real estate dropped during the past years. This switch is mainly caused by the characteristics that global and functional allocation can more easily be accomplished with indirect real estate and the intensive management of direct real estate.

4.1.3. Real estate Characteristics

According to the interview respondents, the main driver to add real estate in a mixed-asset portfolio is a stable risk/return profile of real estate. The stable rental income ensures that real estate has a good direct return and ensures a low volatility in comparison with for example liquid shares. Another characteristics of real estate is that real estate works as an inflation hedge. A limitation of that is that real estate can only be seen as an inflation hedge when there is a long term lease contract because at the end of the lease contract the rent prices will be equalised with the market prices at that moment.

All the interview respondents stated that direct and indirect real estate seem to have the same characteristics over a few years. The main reasons for this is that the return on the investments is determined by the actual real estate investment. A major benefit of investing in indirect listed real estate, in contrast with direct real estate and non-listed indirect real estate, is the high liquidity. Besides that, the return on indirect real estate can easily be higher because the real estate companies use leverage for their real estate portfolios.

4.1.4. The correlation with other assets

Real estate has, according to E.J. Nilting, a low correlation with other assets in case of normal market conditions. When exceptional market conditions as an economic crisis occurs the correlations between real estate and other assets increases, according to E.J. Nilting and S. Gorter, because of the coherence of both real estate and other assets with the micro trends and risk drivers that cause and are caused by an economic crisis. M. van der Spek adds that the correlation between real estate and other assets increased during the recent economic crisis because real estate was partially the reason of the crisis.

According to S. Gorter and M. van der Spek, the real estate market could have a low correlation during a future economic crisis as well. The correlation is not only triggered by the economic crisis but partially by the aging of the real estate portfolio. Besides that, last crisis was partially triggered by the real estate market. This could be different in the future, what possibly will result in another picture of the correlation between real estate and other assets during a future crisis.

4.2. Analysis of the quantitative data

All the quantitative data of the pension funds, which can be found in Appendix 6, is combined to one return per asset on the total portfolio that is used in the research. All the portfolios of the 10 biggest pension funds together represent a total of 665 billion euro in 2014, which is enough to represent the total invested portfolio of pension funds. The combined returns of different assets can be found in Table 4 and Appendix 7. With these figures the correlation between different assets can be calculated. The analysis of the correlation between real estate and the other assets will be described in the following paragraphs.

Table 5: Total return of 10 biggest pension funds per asset

Total Return per Asset on all Portfolios Combined					
	Liquid shares	Real Estate	Fixed interest securities	Commodities	Private Equity
2001	-13,96%	10,00%	6,12%	-32,80%	-24,80%
2002	-25,00%	7,74%	9,37%	35,50%	26,80%
2003	21,25%	7,59%	4,50%	23,30%	33,60%
2004	11,64%	10,46%	8,06%	20,90%	16,70%
2005	23,11%	16,61%	5,67%	24,71%	18,32%
2006	14,32%	27,92%	0,52%	-19,99%	18,50%
2007	5,67%	1,42%	1,46%	33,44%	29,02%
2008	-40,10%	-20,23%	-1,45%	-48,54%	-25,19%
2009	35,32%	6,03%	13,30%	21,98%	9,68%
2010	20,78%	11,95%	8,34%	7,47%	29,54%
2011	-5,96%	2,28%	10,05%	4,86%	6,32%
2012	16,10%	12,96%	12,27%	2,58%	7,45%
2013	17,14%	3,47%	-2,70%	-1,41%	17,44%
2014	13,24%	10,99%	18,73%	-27,98%	19,76%

4.2.1. CORRELATION BETWEEN REAL ESTATE AND LIQUID SHARES

The correlation between real estate and liquid shares is calculated with the different formulas mentioned in paragraph 0. The correlation is calculated over different periods. The first period that is calculated is the 2001-2014, the second is before the crisis (2001-2007) and the last period is during the economic crisis (2008-2014). The example of the calculation of the correlation between real estate and liquid shares during the period 2001-2014 is stated in Appendix 8. The results of the calculations between real estate and the other assets (fixed interest securities, commodities and private equity) and real estate and liquid shared during the other periods can be found in Appendix 9.

According to the calculation in Appendix 8, the correlation between liquid shares and real estate is 0.46 during the period 2001-2014. The average return on investments per year, combining all the present figures, can be found in Table 6. Besides that, Table 6 shows the correlation between the two asset classes during the periods 2001-2014, 2001-2007 and 2008-2014. During the period 2001-2014, the average return on real estate was with 7.8 per cent higher than the average return on liquid shares (6.68 per cent). During the period 2001-2007 real estate had an average return of 11.68 per cent and the average return of liquid shares was 5.29 per cent. **The correlation coefficient between the yearly returns of the two assets was 0.33 during the period 2001-2007**. The correlation between real estate and liquid shares can be seen as low. In contrast with the correlation during the period 2001-2007, is the correlation between the two assets is much higher during 2008-2014. With an average return of 3.92 per cent for real estate and 8.07 per cent for liquid shares, **the correlation during the period 2008-2014 was 0.86**. The correlation during the crisis can be seen as high. An overview of the average return, covariance, variance, standard deviation and correlation

coefficient between real estate and liquid shares during the different periods can be found in Appendix 9.

Table 6: The correlation between real estate and liquid shares during the periods 2001-2014, 2001-2007 and 2008-2014

Correlation between Liquid Shares and Real Estate				
	Liquid shares	Real Estate	Total Correlation	Correlation
2001	-13,96%	10,00%	0,60	0,33
2002	-25,00%	7,74%		
2003	21,25%	7,59%		
2004	11,64%	10,46%		
2005	23,11%	16,61%		
2006	14,32%	27,92%		
2007	5,67%	1,42%		
2008	-40,10%	-20,23%		0,86
2009	35,32%	6,03%		
2010	20,78%	11,95%		
2011	-5,96%	2,28%		
2012	16,10%	12,96%		
2013	17,14%	3,47%		
2014	13,24%	10,99%		

4.2.2. Correlation between real estate and fixed interest securities

The result of the calculation of the correlation between real estate and fixed interest securities, which can be found in Table 7, show that the economic crisis has the same effect for the correlation between real estate and fixed interest securities as it is for real estate and liquid shares. The correlation during the period 2001-2014 was 0.26. This low correlation is mainly caused by the **correlation during the period 2001-2007. During that period there was a negative correlation between the two assets of -0.33. The correlation during the period 2008-2014 was 0.66**, this means that the correlation before and during the economic crisis changed from a negative correlation to a relatively high positive correlation. In Appendix 9 can be found that during the whole period the average return of the real estate portfolio was 7.8 per cent opposite a return of 6.73 per cent on the fixed interest securities portfolio. During the first period (2001-2007) the real estate portfolio performed well with an 11.86 per cent of average return opposite a 5.10 per cent of average return on the fixed interest securities portfolio. During the economic crisis (2008-2014), the portfolio of fixed interest securities had a higher average return. The average return of fixed interest securities during that period was 8.36 per cent, the average return of the real estate portfolio was 3.92 during the same period. An overview of the average return, covariance, variance, standard deviation and correlation coefficient between real estate and fixed interest securities during the different periods can be found in Appendix 9.

Table 7: The correlation between real estate and fixed interest securities during the periods 2001-2014, 2001-2007 and 2008-2014

Correlation between Real Estate and Fixed Interest Securities				
	Real Estate	Fixed interest securities	Total Correlation	Correlation
2001	10,00%	6,12%	0,26	-0,33
2002	7,74%	9,37%		
2003	7,59%	4,50%		
2004	10,46%	8,06%		
2005	16,61%	5,67%		
2006	27,92%	0,52%		
2007	1,42%	1,46%		
2008	-20,23%	-1,45%		0,66
2009	6,03%	13,30%		
2010	11,95%	8,34%		
2011	2,28%	10,05%		
2012	12,96%	12,27%		
2013	3,47%	-2,70%		
2014	10,99%	18,73%		

4.2.3. Correlation between real estate and commodities

According to the results of the correlation calculation, which are shown in Table 8, the overall correlation between commodities and real estate is low (0.23). The low correlation is mainly a result of a negative correlation between real estate and commodities before the economic crisis. **The correlation before the economic crisis is -0.55.** During the economic crisis there is a high increase of the correlation between the assets. **The correlation between real estate and commodities is 0.66 during the economic crisis.** The results of the calculation of the average annual return on the portfolio during the period 2001-2014 (appendix 9) shows that real estate had an average return of 7.80 per cent and commodities had an average return of 3.14 per cent. During the first period (2001-2007) the average annual returns of commodities (12.15 per cent) and real estate (11.68 per cent) do not differ that much. During the economic crisis the average annual return of real estate is with 3.92 per cent way higher than the negative average annual return of commodities (-5.86 per cent). An overview of the average return, covariance, variance, standard deviation and correlation coefficient between real estate and commodities during the different periods can be found in Appendix 9.

Table 8: The correlation between real estate and commodities during the periods 2001-2014, 2001-2007 and 2008-2014

Correlation between Real Estate and Commodities				
	Real Estate	Commodities	Total Correlation	Correlation
2001	10,00%	-32,80%	0,23	-0,55
2002	7,74%	35,50%		
2003	7,59%	23,30%		
2004	10,46%	20,90%		
2005	16,61%	24,71%		
2006	27,92%	-19,99%		
2007	1,42%	33,44%		
2008	-20,23%	-48,54%		0,66
2009	6,03%	21,98%		
2010	11,95%	7,47%		
2011	2,28%	4,86%		
2012	12,96%	2,58%		
2013	3,47%	-1,41%		
2014	10,99%	-27,98%		

4.2.4. Correlation between real estate and private equity

According to the results of the calculations in Table 9, the correlation between real estate and private equity is 0.46 during the period 2001-2014. **During the period of 2001-2007 there was a negative correlation of -0.13** between real estate and private equity, **during the economic crisis (2008-2014) the correlation increases to a positive correlation of 0.89**. The average annual return, as shown in appendix 9, on private equity is higher than the average annual return on real estate during all the periods. Private equity had an average return of 13.08 per cent opposite a return of 7.80 per cent for the real estate portfolio during the period 2001-2014. During the period 2001-2007 private equity performed 5.20 per cent higher than real estate, 16.88 per cent for private equity and 11.68 per cent for real estate. During the economic crisis the average annual return of private equity drops but is with 9.29 per cent still higher than 3.92 per cent return on real estate. An overview of the average return, covariance, variance, standard deviation and correlation coefficient between real estate and private equity during the different periods can be found in Appendix 9.

Table 9: The correlation between real estate and private equity during the periods 2001-2014, 2001-2007 and 2008-2014

Correlation between Real Estate and Private Equity				
	Real Estate	Private Equity	Total Correlation	Correlation
2001	10,00%	-24,80%	0,46	-0,13
2002	7,74%	26,80%		
2003	7,59%	33,60%		
2004	10,46%	16,70%		
2005	16,61%	18,32%		
2006	27,92%	18,50%		
2007	1,42%	29,02%		
2008	-20,23%	-25,19%		0,89
2009	6,03%	9,68%		
2010	11,95%	29,54%		
2011	2,28%	6,32%		
2012	12,96%	7,45%		
2013	3,47%	17,44%		
2014	10,99%	19,76%		

4.3. Analysis sub questions

With the results of the interviews and the results of the quantitative data, the sub questions and associated hypotheses that are stated in the research methodology will be answered, confirmed or rejected. All the findings, analyses and information that are conducted per sub question and hypotheses will be stated briefly in this part.

4.3.1. SQ1: What are the characteristics, benefits and disadvantages of direct and indirect real estate?

There are different benefits and disadvantages of investments in direct and indirect real estate. These benefits and disadvantages make that investing in real estate differ from investing in other asset classes. The most important benefits and disadvantages of direct real estate are stated in Table 10 and the most important benefits and disadvantages of indirect real estate are stated in Table 11 (van Gool, et al., 2013).

Table 10: Benefits and disadvantages of direct real estate (van Gool, et al., 2013)

Benefits	Disadvantages
- Stable rental income; - Attractive return on limited risk; - Inflation hedge; - Diversifying power in mixed-asset portfolio; - Revenues can be influenced by active management.	- Knowledge- and management intensive form of investment; - Not easy to invest small amount of money; - Illiquid market compared with stocks and bonds; - Valuation is subjective.

Table 11: Benefits and disadvantages of indirect real estate (van Gool, et al., 2013)

Benefits	Disadvantages
- No local expertise and management organisation needed; - Relatively small amount of money needed for investment; - Low transaction costs; - Higher liquidity than direct real estate; - Benefits from economies of scale; - Less emotional value than direct real estate; - Benefits from the effect of leverage.	- No influence on the allocation across countries, markets, types and tenants; - Hard to keep feeling with real estate market; - Higher risk due to financing by debt; - Value of stocks fluctuates stronger than the value of real estate.

The advantages and benefits do not all have an impact on the choice for direct or indirect real estate in a mixed-asset portfolio. According to van Gool, et al. (2013) is adding real estate to the investment portfolio of pension funds mainly done because of diversification benefits and the reputation of inflation hedge of real estate. According to Oikarinen, et al. (2011) and Kutlu (2010), direct and indirect real estate can be seen as one asset class, because there is a presence of a relation between direct and indirect real estate in the long run, which indicates that both direct and indirect real estate has a negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011). The professionals of the interviews agree with the fact that direct and indirect real estate have the same characteristics over a few years. The main reasons for this is that the return on the investments is determined by the actual real estate investment. The function of real estate as an inflation hedge is questioned during the interviews. Real estate can only be seen as an inflation hedge when there is a long term lease contract, because at the end of the lease contract the rent prices will be equalised with the market prices at that moment.

Despite the fact that direct and indirect real estate have the same characteristics in an investment portfolio there are still some differences that are important for the choice of adding direct or indirect real estate in a mixed-asset portfolio. A major benefit of investing in indirect listed real estate, in contrast with direct real estate and non-listed indirect real estate, that is stated by van Gool, et al. (2013) and confirmed by all the interview respondents, is the high liquidity. Besides that, the return on indirect real estate can easily be higher because the real estate companies use leverage for their real estate portfolios. The information from the interviews shows that the need for knowledge and management is a major disadvantage for direct real estate. These facts corresponds to the main benefits of indirect real estate and disadvantages of direct real estate that are stated by van Gool, et al. (2013).

4.3.2. SQ2A: What was the correlation between direct and indirect real estate and other assets before the economic crisis?

Many studies about the contribution of real estate to a mixed-asset portfolio have been published in the eighties and nineties. These studies conclude that real estate in a mixed-

asset portfolio offered diversification benefits because of the low correlation with other asset classes and should therefore be an asset class of a diversified portfolio (Craft, 2001). The main diversification benefits of investing in direct real estate is the diversifying power of real estate in a mixed-asset portfolio. This ability is based on the limited and sometimes even negative correlation of the return of direct real estate with the return of other property titles, such as stocks and bonds (van Gool, et al., 2013).

Real estate investment can be made in various categories. An important distinction is that between direct real estate investments and investments in indirect real estate. Simply stated, an investment in direct real estate is an investment in buildings also called an investment in stones. An investment in indirect real estate is an investment in shares of real estate companies (van Gool, et al., 2013). The investments in direct and indirect real estate could be seen as two different asset classes but, according to Oikarinen, et al. (2011) and Kutlu (2010), there is a presence of a relation between direct and indirect real estate in the long run, which indicates that both direct and indirect real estate has a negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011). Kutlu (2010) stated that, as a consequence of the relation, investors should treat the two real estate categories as a single asset class in the long run since they imply the same level of risk and return characteristics over long horizons and diversification benefits of holding both assets are no longer possible in the long run (Kutlu, 2010). Besides that, all the interview respondents stated that direct and indirect real estate have the same characteristics over a few years and could therefore be seen as a single asset class as well. The main reasons for this is that the return on the investments is determined by the actual real estate investment.

Because direct and indirect real estate can be seen as one asset class, pension funds combine the return figures and invested capital in their annual report. The figures of the 10 biggest pension funds are combined and the correlation between real estate and other assets (liquid shares, fixed interest securities, commodities and private equity) are calculated over the annual return of all pension funds together. The findings of these calculation can be found in Appendix 9. The correlation during the period 2001-2007 can be interpreted as low or even negative. The correlation between real estate and liquid shares was 0.33, which is seen as a low correlation. The correlation between real estate and fixed interest securities, commodities and private equity was even negative. Real estate and fixed interest securities had a correlation of -0.33, real estate and commodities a correlation of -0.55 and real estate and private equity a correlation of -0.13. This means that real estate had a low correlation with other assets before the economic crisis and could therefore be seen as a good diversification instrument. The sub hypothesis that there is a low correlation between direct and indirect real estate and other assets before the economic crisis is **confirmed**.

4.3.3. SQ 2B: What was the correlation between direct and indirect real estate and other assets during the economic crisis?

Since the beginning of the economic crisis in 2007, the correlation between real estate and other asset classes seems to increase during the period between 2007 and 2015. Even more than other financial products, real estate performed extremely poorly across different types of property, different location and in many countries since the beginning of the economic

crisis. If the diversification benefits of real estate do not hold in years of economic crisis, due to the dependence with other asset classes, then the benefits of adding real estate to a mixed-asset portfolio may be overrated (Lizieri, 2013). During the interviews the same view on real estate in a mixed-asset portfolio, during the economic crisis, came forward. Real estate has, according to E.J. Nilting, a low correlation with other assets in case of normal market conditions. When exceptional market conditions as an economic crisis occurs, the correlations between real estate and other assets increases, according to E.J. Nilting and S. Gorter, because of the coherence of both real estate and other assets with the micro trends and risk drivers that cause and are caused by an economic crisis. M. van der Spek adds that the increased correlation between real estate and other assets during the recent economic crisis mainly was because real estate was partially the reason of the crisis.

Because direct and indirect real estate can be seen as one asset class, pension funds combine the return figures and invested capital in their annual report. The figures of the 10 biggest pension funds are combined and the correlation between real estate and other assets (liquid shares, fixed interest securities, commodities and private equity) are calculated over the annual return of all pension funds together. The findings of these calculation can be found in Appendix 8. The correlation during the period 2008-2014 can be interpreted as high. The correlation between real estate and liquid shares was 0.86, which is seen as a high correlation. During that period real estate and fixed interest securities had a correlation of 0.66, real estate and commodities a correlation of 0.66 and real estate and private equity a correlation of 0.89. This means that real estate had a high correlation with other assets during the economic crisis. The sub hypothesis that the correlation between direct and indirect real estate is higher during an economic crisis than in the preceding period is **confirmed**.

5. CONCLUSIONS

The previous chapters of this research contributes information and research about the relation between real estate and other assets in a mixed-asset portfolio during and before the economic crisis. While conducting the literature review, the literature shows that since the beginning of the economic crisis in 2007 the correlation between real estate and other asset classes seems to increase. Many studies about the contribution of real estate in a mixed-asset portfolio conclude that real estate offers diversification benefits because of the limited or sometimes even negative correlation with other asset classes and should therefore be represent a part of a diversified mixed-asset portfolio. If the low or even negative correlation of real estate with other assets increases during an economic crisis, the benefits adding real estate to a mixed-asset portfolio may be overrated. This research focusses on the diversification benefits of real estate during an economic crisis and supports that by calculations of the correlation between real estate and others assets in a typical mixed-asset portfolio. Therefore, this research is based on the following research question:

To what extent are diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds present during the economic crisis (since 2007)?

The beginning of mixed-asset portfolios is the development of the modern portfolio theory. The modern portfolio theory is based on the principle that different assets in a portfolio could not only be selected on the features of the assets but on the movements of the different assets opposed to each other (Markowitz, 1959). A tool that is widely used by pension funds to realise a mixed-asset portfolio is the Asset Liability Management model, which can be used to make a continuity analyses and to generate an asset mix which should be able to hedge the portfolio risk and generate portfolio returns (Beckers, 2008). According to Bazdarich (2006) a matching portfolio, which ensures that the future cash flow for the pensions are present, and a return portfolio, which generate additional required investment return, must be a part of the portfolio.

Real estate as an asset class of a mixed-asset portfolio is included because of the reputation that real estate has a low correlation with other assets, which make real estate an asset with a good diversification in the portfolio (Craft, 2001; Hoesli, et al., 2004; van Gool, et al., 2013). Real estate investment can be made in various categories. An important distinction is that between direct real estate investments and investments in indirect real estate. The investments in direct and indirect real estate could be seen as two different asset classes but, according to Oikarinen, et al. (2011) and Kutlu (2010), there is a presence of a relation between direct and indirect real estate in the long run, which indicates that both direct and indirect real estate has a low or even negative correlation with other assets in mixed-asset portfolio and offers a correlation with inflation as well (Kutlu, 2010; Oikarinen, et al., 2011). Kutlu (2010) stated that, as a consequence of the relation, investors should treat the two real estate categories as a single asset class in the long run since they imply the same level of risk and return characteristics over long horizons (Kutlu, 2010).

During the research real estate has been treated as one asset class as well. Partially because of the relation that is shown in the literature and because of the relation that has been spoken of during the interviews, but the main reason that direct and indirect real estate are

treated as one, is that most of the pension funds do the same, this means that there is no distinction made between direct and indirect real estate in the portfolio figures of these funds. Despite the fact that direct and indirect real estate have the same characteristics in an investment portfolio there are still some differences that are important for the choice of adding direct or indirect real estate in a mixed-asset portfolio. Therefore direct real estate has a stable rental income but is a knowledge- and management intensive form of investment. Indirect real estate has a higher liquidity than direct real estate and benefits from the effects of leverage. The main advantages make that pension funds are more focussed on indirect real estate nowadays.

The conducted research shows that the correlation between real estate and other assets before the crisis has a low correlation with each other. Real estate had a correlation of 0.33 with liquid shares, -0.33 with fixed interest securities, -0.55 with commodities and -0.13 with private equity, which support the statements of Craft (2001), Hoesli, et al. (2004), and van Gool, et al. (2013), that real estate in a mixed-asset portfolio has a low of even negative correlation with other assets, which make real estate a good diversification asset in the portfolio. During the economic crisis the correlation between real estate and other assets increased in all cases. In that period the correlation of real estate with liquid shares was 0.86, with interest securities 0.66, with commodities 0.66 and with private equity 0.89. The increased correlation between real estate and the other assets implies that Lizieri (2013) is right that the diversification benefits of real estate do not hold in years of economic crisis and that the benefits of adding real estate to a mixed-asset portfolio may be overrated. The interviewees underline this statement with the information that there is a coherence between real estate and other assets with the micro trends and risk drivers that cause and are caused by an economic crisis. With this information, the hypotheses that '*Diversification benefits of direct and indirect real estate investments in a mixed-asset portfolio of Dutch pension funds are lower during the recent economic crises than during the preceding period*' is **confirmed.**

This means, in answer on the research question, that the correlation between real estate and other asset increases during the economic crisis. Because the low or even negative correlation between real estate and other assets is seen as the most important diversification benefit of real estate can be stated that the diversification benefits of real estate do not hold during an economic crisis.

6. DISCUSSION

The conducted research is discussed in this chapter. The discussion focusses on the reliability and the validity of the research and the relevance and added value of the report. Besides that recommendations for further research are stated.

The beginning of mixed-asset portfolios is the development of the modern portfolio theory. The modern portfolio theory is based on the principle that different assets in a portfolio could not only be selected on the features of the assets but on the movements of the different assets opposed to each other (Markowitz, 1959). According to Craft (2001), Hoesli, et al. (2004), and van Gool (2013) real estate is as an asset class is included in a mixed-asset portfolio because of the reputation that real estate has a low correlation with other assets, which make real estate an asset with a good diversification in the portfolio. This means that, taking the modern portfolio theory into account, real estate has the ability to move opposite to other asset classes in a portfolio. The ability to move opposite to other asset classes is seen as a low correlation with other asset classes. A low correlation of real estate with other assets is important during all kind of market conditions. During low market conditions as an economic crisis, the real estate market need to develop opposite to other assets as well. During the last economic crisis it seems that, according to Lizieri (2013), the correlation between real estate and other asset classes increased. The statement of Lizieri (2013) is based on the fact that real estate, even more than other financial products, performed extremely poorly across different types of property, different location and in many countries since the beginning of the economic crisis. If the diversification benefits of real estate do not hold in years of economic crisis, due to the dependence with other asset classes, then the benefits of adding real estate to a mixed-asset portfolio may be overrated (Lizieri, 2013). The fact that the statement is only based on the performance of real estate and not on the actual correlation between real estate and others assets is the foundation of this research. The most important part of real estate in a mixed asset portfolio is the low or even negative correlation with other assets, but this is not researched during an economic crisis. It is important for mixed asset funds to gather more knowledge about the correlation differences before and during an economic crisis, which is researched in this thesis. With this information, investment managers can make a better decision concerning the addition of real estate in a mixed-asset portfolio.

During the research, quantitative and qualitative information is collected to give a sufficient view on the topic. The quantitative datasets are the basis for the research. The correlation between real estate and other assets before and during the economic crisis is calculated with these figures. The qualitative data is important for the background information of the subject and the view of professionals on the problem.

The quantitative datasets exist of the return and invested capital of the ten biggest pension funds in the Netherlands. Whit the data, the correlation between real estate and other assets is calculated. The available data that has been used for the analyses should be sufficient to cover the whole field. Collecting the needed information during the research proved to be harder than expected. The twenty-five biggest pension funds in the Netherlands has been approached and most of the pension funds did not respond during the process. The pension funds that respond, mentioned that the returns and invested capital of different assets could be found in the annual reports on their website and that more information was not available

for research. Because of this, there is a lack of data, especially during the period 2001-2007. With this information, the reliability of the final results could be questioned. But considering the fact that the same asset of different pension funds react more and less the same, which can be found in Appendix 6, the data collection should be sufficient enough to assume that the correlation of real estate before and during the economic crisis show significant differences.

The response for qualitative research (interviews) was very low during the process, only three real estate specialists of pension funds react positive on the interview request. The information that the qualitative research provided cannot be mutually checked on reliability due the fact that only three interviews has been conducted. Although all the interviewees say more and less the same about the different subjects in the interview, three interviews seems not sufficient to conclude that the information they shared is representative for the whole sector. On the other hand, the qualitative research shows a lot of similarities with the quantitative data and the literature review, which implies that the qualitative data is reliable.

However the research shows that the correlation of real estate with other assets increases during an economic crisis, the conducted research do not answer the question if real estate should be a part of a pension fund portfolio during an economic crisis. The figures that have been used during the research shows that real estate has not the volatility of some other assets and provides a relative good return on investment, which implies that real estate has some benefits in a mixed-asset portfolio. As stated in the limitations, this was not a part of the research.

The results of this research do not forecast, as stated in the limitations, the future developments in case of a new economic crisis. According to the interviewees, the possibility of an increased correlation is present during a new economic crisis. To evaluate if this possibility occurs in every economic crisis, the research should be expanded with data of economic crisis before recent economic crisis and data from different economic regions. Due to the lack of time, this could not be researched during this process.

7. RECOMMENDATIONS

Several recommendations can be made as a result of this research. The results are divided in recommendations regarding this thesis and recommendations for further research on topics that are related to this thesis.

7.1. RECOMMENDATIONS REGARDING THIS THESIS

Regarding the results of this research it is not important to make a distinction between direct or indirect real estate in a mixed-asset portfolio. The literature review and the results of the interviews shows describes a presence of a relation between direct and indirect real estate in the long run, which indicates that both direct and indirect real estate has a low or even negative correlation with other assets in mixed-asset portfolio. As a result of this relation, mixed-asset portfolio managers need to treat both asset classes as one.

The allocation to real estate within the real estate portfolio is mainly based on the return/risk profile of the investments. According to the interview information and the results of the correlation between real estate and other assets, the portfolio selection can better be made on risk drivers. When the real estate portfolio is based on risk factors as demography, unemployment rates and other economic drivers, all the parts of the real estate portfolio react different on the economic cycle.

Real estate managers of mixed-asset portfolios need to check the correlation between different types of real estate within their portfolio with other assets to check if some real estate markets do not have a higher correlation during an economic crisis. If there are real estate investments which have a low correlation during the crisis, real estate mangers can focus on real estate with these risk factors to gain more diversification benefits of real estate.

7.2. RECOMMENDATIONS FOR FURTHER RESEARCH

To give a more sufficient view of the relation between real estate and other assets, further research with more data can be conducted on the same topic. All the data during the period 2001 and 2014 of all Dutch pension funds need to be analysed to give a better view on the development of the correlation between real estate and other assets.

The research focusses on the asset real estate in a mixed-asset portfolio. During the research there is no distinction made between different real estate markets, for example office real estate, residential real estate, retail real estate and industrial real estate. Because the different real estate categories react different on the economic drivers there could be a difference in correlation between these markets and other asset classes. A recommendations is to research the differences in correlation of different real estate markets with other asset classes, to see if there are real estate investment that are not affected by the economic crisis.

The conducted research do not answer the question if real estate should be a part of a pension fund portfolio during an economic crisis. Further research could clarify to which extend real estate should be a part of a mixed-asset portfolio in the future, taking the higher correlation of real estate with other assets during an economic crisis into account.

The results of this research do not forecast, as stated in the limitations, the future developments in case of a new economic crisis. To see if the higher correlation is present during all economic crisis and in order to make a better prediction of a future economic crisis the relation between real estate and other assets should be calculated in different economic crisis and different economic regions. This research could be used to see if the higher correlation only occurs in case of a real estate bubble, as seen in the past years.

The research could be extended with other mixed-asset investors. The focus of this research is only on Dutch pension funds. The asset mix of pension funds is not build to maximize returns but to manage the coverage of the pension fund. Research on private mixed-asset investment funds can make clear if the correlation between real estate and other assets are higher when the portfolio selection is based on maximal returns.

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APPENDIX 1: 25 BIGGEST PENSION FUNDS

Table 12: 25 biggest pension funds in the netherlands

Name of pension fund	Invested capital
Stichting Pensioenfonds ABP	€ 312.592.000.000
Stichting Pensioenfonds Zorg en Welzijn	€ 148.846.000.000
Stichting Pensioenfonds Metaal en Techniek	€ 46.945.000.000
Stichting Bedrijfstakpensioenfonds voor de Bouwnijverheid	€ 42.950.594.000
Stichting Pensioenfonds van de Metalektro (PME)	€ 32.368.000.000
Stichting Shell Pensioenfonds	€ 21.190.000.000
Stichting Pensioenfonds ING	€ 18.309.858.000
Stichting Rabobank Pensioenfonds	€ 18.116.000.000
Stichting Philips Pensioenfonds	€ 16.171.000.000
Stichting Pensioenfonds voor de Grafische Bedrijven	€ 13.960.000.000
Stichting Pensioenfonds van de ABN AMRO Bank N.V.	€ 13.617.294.000
Stichting Spoorwegpensioenfonds	€ 12.645.000.000
Stichting pensioenfonds voor het Beroepsvervoer over de Weg	€ 12.629.000.000
Stichting Bedrijfspensioenfonds voor de Landbouw	€ 10.728.916.000
Stichting Bedrijfstakpensioenfonds voor de Detailhandel	€ 10.558.134.000
Stichting Pensioenfonds voor de Woningcorporaties	€ 7.763.207.000
Stichting Pensioenfonds Hoogovens	€ 7.634.000.000
Stichting Pensioenfonds voor Huisartsen	€ 7.594.147.000
Stichting Pensioenfonds Vliegend Personeel KLM	€ 7.004.600.000
Stichting Pensioenfonds PostNL	€ 6.594.891.000
Stichting Algemeen Pensioenfonds KLM	€ 6.238.500.000
Stichting Pensioenfonds Medisch Specialisten	€ 6.076.896.000
Stichting Pensioenfonds Werk- en (re)integratie	€ 5.897.313.000
Stichting Pensioenfonds KPN	€ 5.728.204.000
Stichting Pensioenfonds Horeca & Catering	€ 5.191.256.000

APPENDIX 2: TABLE OF FORMULAS

Correlation Coefficient

$$\text{Corr}(R_x R_y) = \frac{\text{Cov}(R_x R_y)}{\text{SD}(R_x) * \text{SD}(R_y)}$$

$\text{Corr}(R_x R_y)$	=	Correlation Coefficient between Return X and Return Y
$\text{Cov}(R_x R_y)$	=	Coveriance between Return X and Return Y
$\text{SD}(R_x)$	=	Standard Deviaton of Return X
$\text{SD}(R_y)$	=	Standard Deviaton of Return Y

Covariance

$$\text{Cov}(R_1 R_2) = \frac{(X_1-\mu_x)*(Y_1-\mu_y)+(X_2-\mu_x)*(Y_2-\mu_y)+\ldots+(X_n-\mu_x)*(Y_n-\mu_y)}{n}$$

$\text{Cov}(R_1 R_2)$	=	Coveriance between Return 1 and Return 2
$X_{1,2,n}$	=	Return X in year 1, year 2,.. untill year n
$Y_{1,2,n}$	=	Return Y in year 1, year 2,.. untill year n
μ_x	=	Average Return X over period
μ_y	=	Average Return Y over period
n	=	Number of years

Variance

$$\text{V}(R_x) = \frac{(X_1-\mu_x)^2+(X_2-\mu_x)^2+\ldots+(X_n-\mu_x)^2}{n}$$

$\text{V}(R_x)$	=	Variance of Return X
$X_{1,2,n}$	=	Return X in year 1, year 2,.. untill year n
μ_x	=	Average Return X over period
n	=	Number of years

Average Return over period

$$\mu_x = \frac{X_1+X_2+\ldots+X_n}{n}$$

μ_x = Average Return X over period

$X_{1,2,n}$ = Return X in year 1, year 2,.. untill year n

n = Number of years

Standard Deviation

$$SD(R_x) = \sqrt{V(R_x)}$$

$SD(R_x)$ = Standard Deviation of Return X

$V(R_x)$ = Variance of Return X

APPENDIX 3: INTERVIEW TIMEOS PENSIOENDIENSTEN

Bedrijf: Timeos Pensioendiensten (uitvoerende organisatie Pensioenfonds voor de Grafische Bedrijven)

Naam: E.J. Nilting

Functie: Manager Real Estate Investments

Vragen en antwoorden:

1. U werkt voor Timeos Pensioendiensten, uit de informatie begrijp ik dat dit de uitvoeringsorganisatie is voor pensioenfonds PGB. Is al het vermogen van PGB ondergebracht bij Timeos en zijn er nog andere pensioenfondsen waarvan het vermogen bij deze organisatie is ondergebracht?

   Timeos is de enige uitvoerende partij voor PGB. Dit is tot stand gekomen door een splitsing van verschillende taken binnen de organisatie. Hierbij werd een duidelijke splitsing bewerkstelligd tussen bestuur & beleid, toezicht en uitvoering. Daarnaast is het zo dat de Timeos, de uitvoerende organisatie, deels werkt met externe managers.

2. Pensioenfondsen beleggen in verschillende assets. Eén van de assets in een mixed asset portefeuille vastgoed. Hoe is het aandeel van vastgoed in het totale portefeuille ontstaan?

   Pensioenfondsen zijn een soort bijzondere verzekeraars. Het vermogen van een pensioenfonds wordt niet belegt voor een maximaal rendement maar om de dekkingsgraad te managen. De dekkingsgraad geeft hierbij aan of een pensioenfonds aan de verplichtingen die zij heeft kan voldoen in de toekomst. Deze dekkingsgraad moet gehaald worden tegen een zo laag mogelijk risico.

   Wanneer er naar de portefeuille gekeken wordt is de splitsing in eerste instantie gemaakt tussen vastrentende waarden en zakelijke waarden. De vastrentende waarden worden gebruikt om het renterisico voor de belegger af te dekken en de zakelijke waarden worden gebruikt om de uitkeringen mee te laten stijgen met de verhogingen van prijzen en lonen.

   Binnen het beleggen in zakelijke waarden wordt vervolgens de keuze gemaakt tussen aandelen en alternatieve beleggingen. Bij de alternatieve beleggingen zijn bijvoorbeeld indirect vastgoed, direct vastgoed, private equity en grondstoffen.

   Waar in het verleden de allocatie naar vastgoed en andere assets voornamelijk werd bepaald door een ideale mix, gebaseerd op gerealiseerd rendement/risico is er gedurende de laatste jaren een verschuiving zichtbaar naar portefeuillebeleid vanuit risicodrivers. Voorbeelden van risicodrivers die daarvoor kunnen worden gebruikt zijn demografie, werkgelegenheid, economie.

   VB: Een demografische risicodriver kan bijvoorbeeld zijn de vergrijzing van de samenleving. Hierdoor wordt ouderenhuisvesting een belangrijk onderdeel van het

vastgoed in de toekomst. Het pensioenfonds kan er door die ontwikkeling voor kiezen om ouderenhuisvesting op te nemen in de portefeuille.

3. Mijn onderzoek richt zich vooral op de periode 2001-2014 omdat hierbij de verschillen voor en tijdens een economische crisis goed bekeken kunnen worden. Hoe heeft het aandeel van vastgoed binnen de totale portefeuille zich ontwikkeld gedurende de periode 2001 – 2014? Wat is hierbij de verhouding tussen direct/indirect vastgoed?

   Het aandeel van vastgoed in de portefeuille is in de periode 2001-2014 gedaald van ± 10 % naar ± 5 %. Het aandeel van direct vastgoed is hierbij ook flink gedaald. Op dit moment zijn er nog 6 panden in het bezit van het pensioenfonds. Daarnaast zijn er participaties in private vastgoedfondsen en beleggingen in beursgenoteerd indirect vastgoed.

4. Indien er gedurende de periode veel verandering heeft plaatsgevonden, wat is de reden van die verandering?

   Vastgoed valt onder alternatieve beleggingen in de beleggingsmix, de ideale hoeveelheid alternatieve beleggingen conform het beleid van het pensioenfonds is 20% van de gehele portefeuille. Binnen alternatieve beleggingen zijn verschillende assets opgenomen. Bij normale performance van deze beleggingen zal de verdeling tussen de verschillende assets nagenoeg gelijk zijn omdat er geen grote performance verschillen zijn tussen de onderlinge assets.

5. Wat zijn volgens u de karakteristieken van vastgoed in een mixed-asset portfolio?

   Vastgoed kenmerkt zich voornamelijk door de stabiele huurinkomsten. De stabiele inkomsten zorgen ervoor dat vastgoed in vergelijking met bijvoorbeeld aandelen weinig volatiel is. De out of under performance van vastgoed zal daardoor niet heel ver van het verwachte rendement liggen. Daartegenover staat dat de mogelijkheid op een hoger rendement bij aandelen groter is.

   Een ander kenmerk is dat vastgoed tijdens het huurcontract meegroeit met de inflatie, een zogenaamde inflatie hedge. Een kanttekening hierbij is wel dat aan het einde van het huurcontract een nieuw huurcontract afgesloten moet worden en deze in moeilijke tijden lager zal liggen, dit zal de stijging met inflatie weer teniet doen.

6. Zijn deze karakteristieken van vastgoed in een mixed-asset portfolio hetzelfde bij zowel direct vastgoed als indirect vastgoed, en waarom wel of niet?

   Het investeren in vastgoed zal op de lange termijn niet veel anders zijn bij direct vastgoed, private vastgoedfondsen of beursgenoteerd indirect vastgoed. Een groot voordeel van beursgenoteerd indirect vastgoed is de hogere liquiditeit ten opzichte van direct vastgoed en private vastgoedfondsen. Deze liquiditeit is in de aandeelprijs meegenomen. Tevens kan, bij zowel private vastgoedfondsen als beursgenoteerd indirect vastgoed, er gebruik gemaakt worden van de hefboomwerking door financiering met geleend geld. Door middel van deze hefboom kunnen hogere rendementen gegenereerd worden, maar kan het rendement ook harder onderuit gaan. Op lange termijn zal in alle gevallen de waarde van het vastgoed, mits de

uitvoerende organisatie op een goed niveau managet, de doorslag geven in het uiteindelijke rendement van de belegging.

VB: Hoog Catharijne kan gekocht worden door pensioenfonds (directe belegging), privaat vastgoedfonds en beursgenoteerd vastgoedfonds. De waarde van het vastgoed, participaties of aandelen wordt uiteindelijk bepaald door de waarde en inkomsten van het vastgoed zelf. Bij aandelen zal de waarde volatieler zijn, maar door de waarde van het vastgoed zal het uiteindelijke rendement op langere termijn toch dezelfde stijging/daling hebben(indien geen rekening wordt gehouden met het hefboomeffect van geleend geld).

7. Tijdens het vooronderzoek voor mijn thesis ben ik op diverse onderzoeken gestuit waarin geschreven is dat er tijdens de afgelopen economische crisis mogelijk een grotere correlatie was tussen vastgoed en andere assets. Beaamt u dit? En hoe denkt u dat deze hogere correlatie tussen vastgoed en andere assets is ontstaan?

   Er wordt gezegd van vastgoed dat er een lage correlatie is met andere assets. Bij normale marktomstandigheden is er inderdaad een lage correlatie doordat de assets zich op hun eigen manier ontwikkelen. Maar bij uitzonderlijke situaties als afgelopen economische crisis is de correlatie door middel van microtrends groter.

   VB: door de economische crisis stijgt de werkloosheid. Door de hogere werkloosheid heeft de bevolking minder te besteden. Hierdoor zal bijvoorbeeld de verkoop van woningen dalen en de huurprijzen van woningen onder druk komen te staan, de woningmarkt daalt hierdoor mee in de crisis.

8. Denkt u dat er tijdens een eventueel toekomstige economische crisis wederom een grotere correlatie ontstaat tussen vastgoed en andere assets of denkt u dat het een éénmalige ontwikkeling was?

   In principe worden de microtrends die belangrijk zijn voor het vastgoed tijdens een economische crisis negatief beïnvloed. Daarom verwacht ik ook dat in toekomstige situaties een soortgelijke situatie op zal treden.

APPENDIX 4: INTERVIEW STICHTING PHILLIPS PENSIOENFONDS

Bedrijf: Stichting Phillips Pensioenfonds

Naam: S. Gorter

Functie: Vastgoed beleggingen

Vragen en antwoorden:

1. U werkt voor Stichting Philips Pensioenfonds. Naar aanleiding van mijn vooronderzoek en eerdere gesprekken is gebleken dat veel pensioenfondsen werken met een uitvoeringsorganisatie. Worden de beleggingen van Philips Pensioenfonds door de eigen organisatie gedaan?

   Alle beleggingen (aandelen, obligaties, vastgoed, etc.) van Philips Pensioenfonds worden gemanaged door een externe beheerder op basis van door het fonds opgestelde beleggingsrichtlijnen, behoudens nog een hele kleine restportefeuille direct vastgoed welke direct door het fonds beheerd wordt en onderwerp van verkopen is. Deze restportefeuille is nog onderdeel van een voorheen (tot 2007) grote portefeuille direct vastgoed. Deze portefeuille is in de loop der jaren afgebouwd.

2. Pensioenfondsen beleggen in verschillende assets. Eén van de assets in een mixed asset portefeuille is vastgoed. Hoe is het aandeel van vastgoed in het totale portefeuille ontstaan? Wordt er bij de samenstelling van de ideale portefeuille voornamelijk gekeken naar gerealiseerde rendementen of wordt er hierbij voornamelijk gekeken naar risicodrivers als demografie, werkgelegenheid en economie, en waarom?

   De huidige asset mixed vastgoedportefeuille is, behoudens de restportefeuille direct vastgoed, een portefeuille die opgebouwd is langs lijnen gebaseerd op een globale spreiding en een spreiding naar functie. Het gaat dan om een gediversifieerde portefeuille over verschillende economische regio's (VS, EU, Azië) en verschillende sectoren/drivers zoals economie gedreven (kantoren/bedrijfshallen) en consumptie gedreven (winkels/woningen). Het streven daarbij is het realiseren van een portefeuille met een stabiele/optimale verhouding tussen risico en rendement.

3. Mijn onderzoek richt zich vooral op de periode 2001-2014 omdat hierbij de verschillen voor en tijdens een economische crisis goed bekeken kunnen worden. Hoe heeft het aandeel van vastgoed binnen de totale portefeuille zich ontwikkeld gedurende de periode 2001 – 2014? Wat is hierbij de verhouding tussen direct/indirect vastgoed?

   Tot circa 2007/2008 had Philips Pensioenfonds uitsluitend een direct vastgoedportefeuille uitsluitend georiënteerd op Nederland. Medio 2007 is op basis van aanpassingen in het totale beleggingsbeleid besloten de portefeuille direct vastgoed geheel om te zetten naar indirect vastgoed met een wereldwijde spreiding. Kortom gedurende de onderzoeksperiode is de portefeuille opzet geheel gewijzigd

waarbij de wijzigingen in de vastgoedportefeuille niet ingegeven zijn door de effecten van economische crisis maar door een betere afstemming van het gehele beleggingsbeleid op de structuur van de pensioenverplichtingen van het fonds.

4. Wat zijn volgens u de karakteristieken van vastgoed in een mixed-asset portfolio?

   Vastgoed laat ten opzichte van andere assetcategorieën een stabieler rendementsrisicoprofiel zien waarbij niet uitgesloten kan worden dat dit gekleurd wordt door de wijze van meting van voornamelijk indirecte rendementen/waarderingen (smoothing/lagging). Door in een vastgoedportefeuille ook vastgoed op te nemen met verschillende functies die verschillend reageren op economische ontwikkelingen kan dit risico-rendementsprofiel verder een stabiel gedrag/beeld gaan vertonen.

5. Zijn deze karakteristieken van vastgoed in een mixed-asset portfolio hetzelfde bij zowel direct vastgoed als indirect vastgoed, en waarom wel of niet?

   Op de lange termijn zouden rendementen tussen direct en indirect vastgoed naar elkaar toe moeten groeien omdat in alle gevallen het rendement op vastgoed uiteindelijk door het resultaat op stenen/verhuur bepaald wordt. Het onderling afwijken van rendementen op direct versus indirect vastgoed wordt uitsluitend bepaald door de impact van beurssentimenten op het rendement van indirect vastgoed. Daarnaast kunnen verschillen ontstaan vanwege eventuele hogere of lagere externe financieringen van het vastgoed (bij indirect vastgoed is externe financiering min of meer standaard, bij direct vastgoed is dit veel minder het geval en is vaak sprake van uitsluitend een financiering van de portefeuille uit eigen middelen).

6. Tijdens het vooronderzoek voor mijn thesis ben ik op diverse onderzoeken gestuit waarin geschreven is dat er tijdens de afgelopen economische crisis mogelijk een grotere correlatie was tussen vastgoed en andere assets. Beaamt u dit? En hoe denkt u dat deze hogere correlatie tussen vastgoed en andere assets is ontstaan?

   Een hogere correlatie mbt risico-rendement van vastgoed met de obligatiesector zou me verbazen. Een hogere correlatie met aandelen/zakelijke waarden lijkt niet onmogelijk nu vastgoed en aandelen in belangrijke mate drijven op economische ontwikkelingen waarbij de verbanden tussen vastgoed en economische ontwikkelingen trager worden doorgegeven in de data dan bij aandelen. Verder lijkt niet uit te sluiten dat dit verschillend is voor de verschillende economische blokken op wereldschaal.

7. Is het juist niet belangrijk dat de correlatie tijdens een economische crisis laag blijf? Aangezien er tijdens periodes van crisis juist het meeste risico ontstaat?

   Vanuit beheersing van rendement-risico is het altijd gewenst dat de correlatie tussen de verschillende assetcategorieën in een portefeuille met aandelen, vastrentende waarden, vastgoed e.d. laag is. Dat geldt zowel in tijden van voorspoed als in tijden van economische crisis. Daarbij valt vanuit het perspectief van een lange termijn belegger op te merken dat veel risico fictief van aard is zolang je niet verplicht bent tot handelen/transacties in crisistijden (er van uitgaande dat markten altijd op en neer zullen blijven bewegen).

8. Denkt u dat er tijdens een eventueel toekomstige economische crisis wederom een grotere correlatie ontstaat tussen vastgoed en andere assets of denkt u dat het een éénmalige ontwikkeling was?

   Ik denk dat je afhankelijk van welke relaties je over een bepaalde tijdsduur, locatie enz, precies onderzoekt er altijd wel weer signalen zullen zijn dat iets meer of minder tijdelijk hoger of lager correleert. Ook het soort crisis lijkt hierbij verschillen te kunnen opleveren. Verder valt op te merken dat de vastgoedmarkt een voorraadmarkt is die in de loop van de tijd verouderd en daarmee negatief bijdraagt aan rendementen/risico waardoor op termijn ook hierdoor verschillen kunnen ontstaan in correlaties afhankelijk van de mate waarin een belegger er in slaagt zijn portefeuille te verjongen. Kortom de beleggings-/vastgoedmarkt is een dynamisch en tijdsafhankelijk gebeuren waarbij het niet eenvoudig is bepaalde karakteristieken vast te stellen. Hierbij valt aan te tekenen dat de feitelijke vastgoedmarkt veel groter is dan de vastgoedmarkt die gemeten wordt. Kortom het trekken van generieke conclusie, zeker wanneer die niet erg duidelijk zijn, met betrekking tot de vastgoedmarkt blijft gevaarlijk.

APPENDIX 5: INTERVIEW PGGM

Bedrijf: PGGM (uitvoerende organisatie voor onder andere Pensioenfonds voor zorg en welzijn)

Naam: M. van der Spek

Functie: Director Strategy Private Real Estate

Vragen en antwoorden:

1. U werkt voor PGGM, uit de informatie begrijp ik dat dit de uitvoeringsorganisatie is voor onder andere het pensioenfonds voor zorg en welzijn. Is al het vermogen van dit pensioenfonds ondergebracht bij PGGM en voor welke andere pensioenfondsen werkt PGGM?

   Het grootste gedeelte van het vermogen van het pensioenfonds voor zorg en welzijn is ondergebracht bij PGGM en slechts een paar mandaten bij andere managers. Naast het vermogen van pensioenfonds voor zorg en welzijn wordt er ook door het pensioenfonds voor architectenbureaus, het pensioenfonds voor particuliere beveiliging, het pensioenfonds voor het schilders-, afwerkings- en glaszetbedrijf en het pensioenfonds voor huisartsen een beroep gedaan op de expertise van PGGM.

2. Pensioenfondsen beleggen in verschillende assets. Eén van de assets in een mixed asset portefeuille vastgoed. Hoe is het aandeel van vastgoed in het totale portefeuille ontstaan? Wordt er hierbij voornamelijk gekeken naar gerealiseerde rendementen of wordt er hierbij voornamelijk gekeken naar risicodrivers als demografie, werkgelegenheid en economie.

   Al heel erg lang is vastgoed een onderdeel van de portefeuille omdat het helpt bij de diversificatie van de portefeuille, een stabiel rendement levert en bovendien een relatief hoog cash rendement geeft. Momenteel is de allocatie naar vastgoed 12% van het geheel. Bij de opbouw van de portefeuille wordt vooral gekeken naar de lange termijn (risico)drivers en niet de korte termijn rendementen. Wel moeten de rendementen voldoen aan een vooraf bepaalde rendementseis (die weer afhankelijk is van de risico's van de onderliggende belegging).

3. Mijn onderzoek richt zich vooral op de periode 2001-2014 omdat hierbij de verschillen voor en tijdens een economische crisis goed bekeken kunnen worden. Hoe heeft het aandeel van vastgoed binnen de totale portefeuille zich ontwikkeld gedurende de periode 2001 – 2014? Wat is hierbij de verhouding tussen direct/indirect vastgoed?

   De allocatie naar vastgoed was in 2001 15% en is die nu 12%. Onze insteek in de gehele periode is echter dat het niet uitmaakt wat of het om direct of indirect vastgoed gaat, het rendement en risico op de langere termijn is hetzelfde. Vandaar dat onze allocatie 50% beursgenoteerd en 50% niet beursgenoteerd vastgoed is. Direct vastgoed hebben we niet opgenomen in onze portefeuille, vanwege het intensieve management. Al het vastgoed is dus indirect.

4. Indien er gedurende de periode veel verandering heeft plaatsgevonden, wat is de reden van die verandering en hoe komen deze keuzes voor veranderingen tot stand?

   De verlaging van het aandeel vastgoed in de portefeuille is voornamelijk ontstaan door de groei in alternatieve illiquide beleggingen, zoals private equity en infrastructuur.

5. Wat zijn volgens u de karakteristieken van vastgoed in een mixed-asset portfolio?

   Stabiel rendement, relatief hoog cash rendement en diversificatie. Als organisatie geloven wij iets minder in inflatiehedge, omdat dit weinig aantoonbaar is gemaakt door de literatuur. Wel is het standpunt vanuit de organisatie dat het iets beter helpt dan een obligatie of een aandeel.

6. Zijn deze karakteristieken van vastgoed in een mixed-asset portfolio hetzelfde bij zowel direct vastgoed als indirect vastgoed, en waarom wel of niet?

   De karakteristieken van vastgoed zijn bij direct en indirect vastgoed inderdaad hetzelfde op de lange termijn. Het is echter wel zo dat op korte termijn beursgenoteerd vastgoed anders reageert. Het kent een hogere volatiliteit en correlatie met aandelen, maar als je naar langere periodes dan drie jaar kijkt dan is dit verschil zo goed verwaarloosbaar.

7. Tijdens het vooronderzoek voor mijn thesis ben ik op diverse onderzoeken gestuit waarin geschreven is dat er tijdens de afgelopen economische crisis mogelijk een grotere correlatie was tussen vastgoed en andere assets. Beaamt u dit? En hoe denkt u dat deze hogere correlatie tussen vastgoed en andere assets is ontstaan?

   Ja, de correlatie was hoger dan in het verleden. Vooral de impact op beursgenoteerd vastgoed was enorm, aangezien alle financiële ondernemingen op de beurs hard werden afgestraft en vastgoed wordt op de beurs gezien als financiële onderneming (dit komt mede door de hoge leverage). Hierdoor was de waardedaling heel groot. Buiten de beurs viel het in de meeste landen nog wel mee, maar de UK gaf een belangrijk signaal af. De taxateurs daar lieten zijn gedeeltelijk leiden door wat er op de beurs gebeurde en zodoende werden de waardering harder en sneller afgestraft dan in andere landen. Kans is ook groot dat dit in andere landen een wat grotere rol gaat hebben in de toekomst, zonder dat het dezelfde omvang gaat hebben als in de UK. Verder was natuurlijk een gedeelte van de crisis ontstaan door vastgoed, namelijk de woningmark in de US en dus is het logisch dat de vastgoedmarkt in de US dan wat harder dan normaal wordt geraakt.

8. Is het juist niet belangrijk dat de correlatie tijdens een economische crisis laag blijf? Aangezien er tijdens periodes van crisis juist het meeste risico ontstaat?

   Ja, dat is belangrijk, maar zal ook altijd wel zo blijven. Bedenk wel dat vastgoed traag reageert en dat kan simpelweg niet anders. Huurcontracten zijn afgesloten voor meerdere jaren (soms wel > 10 jaar) en dat verandert niet als er een crisis is. De waarde kan dan dus ook niet van de ene op de andere dag veel dalen. De vertraging zorgt er dus automatisch voor dat er sprake zal blijven van een lagere correlatie en dit helpt beleggers. Vastgoed blijft vaak in het jaar van crisis nog een goed rendement

leveren en pas het jaar daarna of zelfs daarna zie je het effect op vastgoed. Aandelenmarkten zijn dan al vaak weer herstellende.

9. Denkt u dat er tijdens een eventueel toekomstige economische crisis wederom een grotere correlatie ontstaat tussen vastgoed en andere assets of denkt u dat het een éénmalige ontwikkeling was?

   In een crisis die niet wordt getriggerd door de vastgoedmarkt is dat inderdaad het geval en ik denk dat in die gevallen in de toekomst de correlatie niet zo hoog zal zijn in vergelijking tot de afgelopen crisis.

APPENDIX 6: DATA COLLECTION 10 BIGGEST PENSION FUNDS

Table 13: Data collection Stichting Pensioenfonds ABP, return and invested capital per asset

Stichting Pensioenfonds ABP (return in %, total capital in € x1000)															
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)					€ 70.909	€ 77.706	€ 75.347	€ 56.012	€ 73.863	€ 77.559	€ 78.263	€ 94.409	€ 104.072	€ 119.285
	Return (%)	-	-	-	-	20,80%	13,50%	5,30%	-39,40%	37,08%	17,09%	-6,20%	16,30%	15,40%	13,90%
Real estate (direct/indirect)	Total Capital (€)					€ 20.396	€ 18.800	€ 19.053	€ 14.868	€ 15.605	€ 19.686	€ 23.626	€ 28.379	€ 26.693	€ 33.345
	Return (%)	-	-	-	-	18,20%	35,70%	-9,40%	-30,00%	13,20%	16,80%	1,20%	16,20%	1,30%	9,70%
Fixed interest securities	Total Capital (€)					€ 82.346	€ 90.240	€ 95.266	€ 77.449	€ 80.521	€ 93.213	€ 98.936	€ 110.987	€ 92.375	€ 106.222
	Return (%)	-	-	-	-	4,30%	0,90%	1,90%	0,40%	12,70%	4,70%	4,20%	10,50%	1,00%	13,90%
Commodities	Total Capital (€)					€ 5.147	€ 6.267	€ 5.629	€ 3.976	€ 5.826	€ 949	€ 9.598	€ 10.115	€ 11.997	€ 9.625
	Return (%)	-	-	-	-	23,20%	-18,50%	31,00%	-46,20%	23,20%	10,30%	6,10%	4,40%	-3,90%	-21,90%
Private equity	Total Capital (€)					€ 5.718	€ 10.444	€ 9.743	€ 6.915	€ 9.155	€ 13.045	€ 14.028	€ 14.611	€ 15.296	€ 16.844
	Return (%)	-	-	-	-	27,20%	29,40%	29,40%	-24,50%	8,20%	29,60%	5,90%	5,20%	17,50%	23,30%

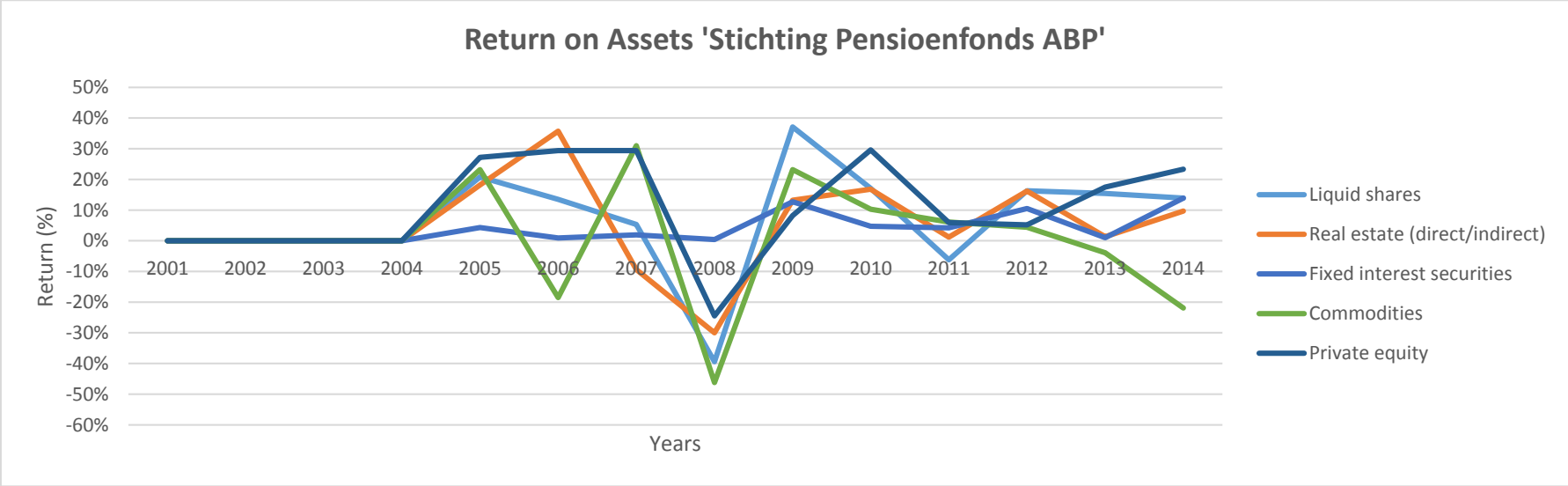

Chart 3: Return on investments Stichting Pensioenfonds ABP

Table 14: Data collection Stichting Pensioenfonds Zorg en Welzijn, return and invested capital per asset

Stichting Pensioenfonds Zorg en Welzijn (return in %, total capital in € x1.000.000)																
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Liquid shares	Total Capital (€)	€ 23.258	€ 20.476	€ 25.696	€ 28.321	€ 33.658	€ 37.195	€ 36.160	€ 22.986	€ 29.893	€ 30.878	€ 32.805	€ 34.432	€ 39.839	€ 53.049	
	Return (%)	-12,70%	-22,80%	23,80%	12,00%	21,20%	16,30%	7,40%	-40,20%	30,20%	31,00%	-4,30%	15,60%	21,30%	10,50%	
Real estate (direct/indirect)	Total Capital (€)	€ 7.563	€ 7.033	€ 6.278	€ 6.229	€ 8.215	€ 10.512	€ 12.347	€ 9.903	€ 12.504	€ 13.853	€ 13.845	€ 15.624	€ 15.244	€ 19.735	
	Return (%)	9,80%	9,10%	8,60%	12,60%	17,80%	29,40%	9,80%	-21,50%	8,70%	10,20%	1,64%	15,99%	7,58%	13,87%	
Fixed interest securities	Total Capital (€)	€ 13.620	€ 13.496	€ 15.985	€ 20.615	€ 21.375	€ 23.449	€ 27.340	€ 11.182	€ 23.407	€ 29.612	€ 34.730	€ 42.044	€ 42.906	€ 51.656	
	Return (%)	6,00%	9,50%	4,70%	6,30%	4,50%	0,90%	3,10%	0,70%	9,70%	11,40%	30,40%	17,70%	-10,00%	34,30%	
Commodities	Total Capital (€)	€ 1.952	€ 1.780	€ 2.246	€ 1.926	€ 3.559	€ 4.043	€ 5.292	€ 3.749	€ 5.844	€ 6.928	€ 2.186	€ 9.315	€ 9.493	€ 6.451	
	Return (%)	-32,80%	35,50%	23,30%	20,90%	26,90%	-22,30%	35,60%	-50,40%	21,00%	5,40%	2,50%	0,80%	1,90%	-37,70%	
Private equity	Total Capital (€)	€ 2.811	€ 2.537	€ 2.703	€ 2.839	€ 3.497	€ 3.234	€ 4.410	€ 4.137	€ 4.983	€ 6.880	€ 7.403	€ 7.855	€ 8.091	€ 9.004	
	Return (%)	-24,80%	26,80%	33,60%	16,70%	3,80%	-16,70%	28,10%	-26,90%	14,00%	31,20%	5,30%	9,80%	19,40%	12,30%	

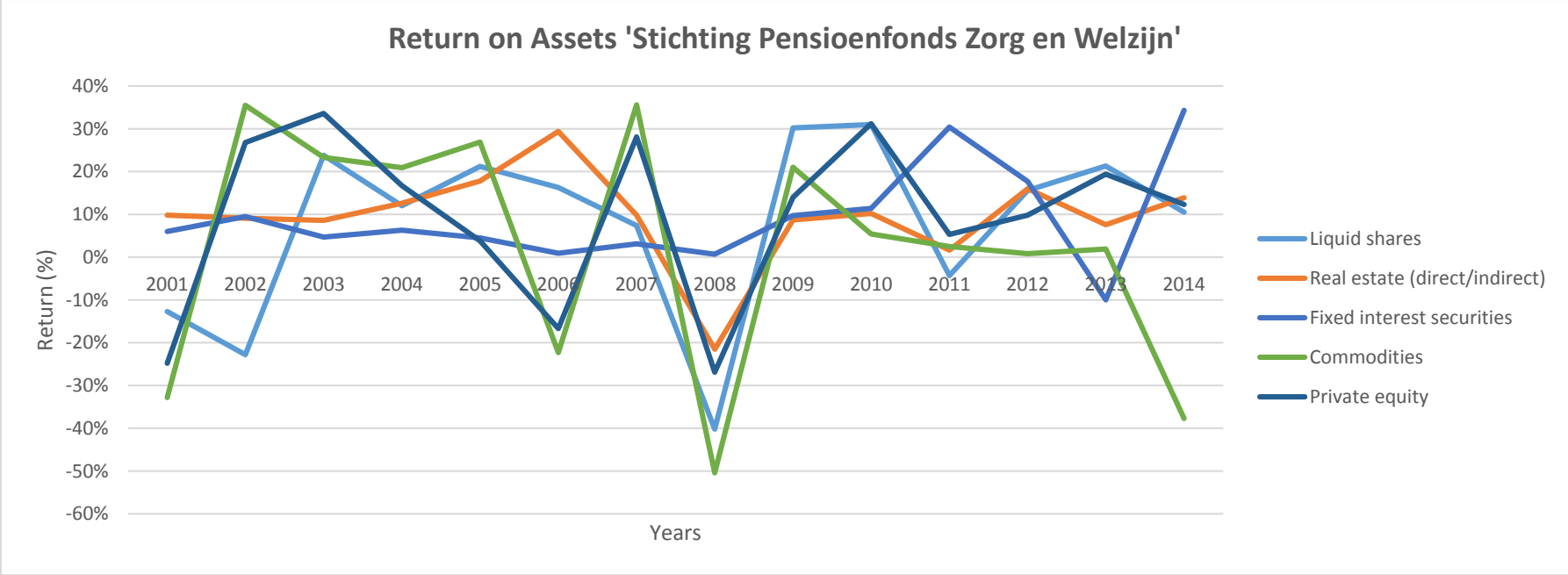

Chart 4: Return on investments Stichting Pensioenfonds Zorg en Welzijn

Table 15: Data collection Stichting Pensioenfonds Metaal en Techniek, return and invested capital per asset

Stichting Pensioenfonds Metaal en Techniek (return in %, total capital in € x1.000.000)																
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)				€ 8.142	€ 10.315	€ 12.072	€ 11.919	€ 5.234	€ 7.464	€ 8.468	€ 8.135	€ 9.909	€ 11.733	€ 16.262
	Return (%)	-	-	-	13,70%	31,50%	15,20%	8,70%	-43,10%	39,20%	20,30%	-5,90%	16,30%	15,80%	12,20%
Real estate (direct/indirect)	Total Capital (€)				€ 2.926	€ 3.275	€ 4.251	€ 4.644	€ 3.874	€ 3.753	€ 4.290	€ 4.448	€ 4.872	€ 4.382	€ 4.890
	Return (%)	-	-	-	17,40%	22,30%	22,90%	6,30%	-15,60%	-2,00%	10,10%	2,70%	9,60%	3,30%	15,60%
Fixed interest securities	Total Capital (€)				€ 9.829	€ 11.250	€ 11.930	€ 13.385	€ 15.013	€ 17.443	€ 19.897	€ 23.392	€ 27.653	€ 28.467	€ 34.001
	Return (%)	-	-	-	9,20%	8,20%	0,20%	-0,30%	-7,10%	11,30%	9,60%	15,50%	13,10%	-5,50%	26,00%
Commodities	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Private equity	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

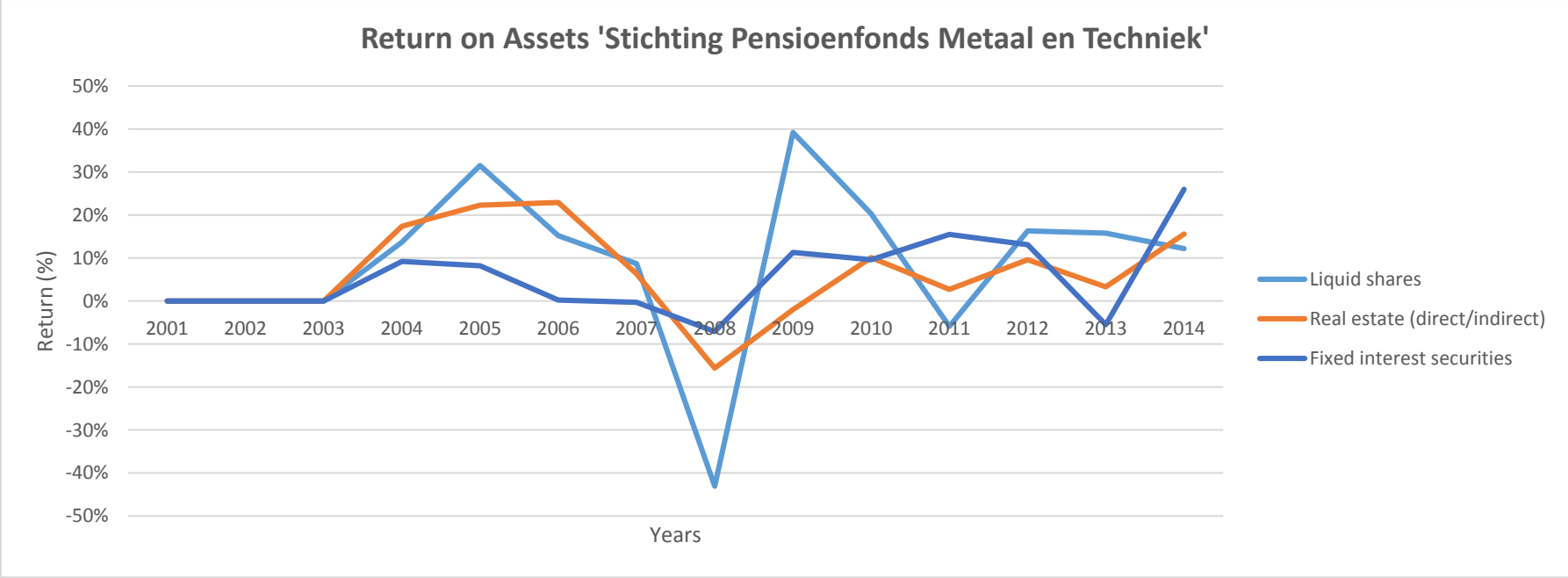

Chart 5: Return on investments Stichting Pensioenfonds Zorg en Welzijn

Table 16: Data collection Stichting Bedrijfstakpensioenfonds voor de Bouwnijverheid, return and invested capital per asset

Stichting Bedrijfstakpensioenfonds voor de Bouwnijverheid (return in %, total capital in € x1.000.000)																
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)		€ 4.085	€ 5.589	€ 6.256	€ 8.097	€ 8.812	€ 8.759	€ 5.890	€ 8.327	€ 10.070	€ 8.934	€ 12.044	€ 12.858	€ 15.597
	Return (%)	-	-30,70%	12,80%	9,50%	26,30%	12,80%	1,70%	-39,70%	31,40%	18,90%	-6,00%	16,40%	15,10%	18,10%
Real estate (direct/indirect)	Total Capital (€)		€ 4.543	€ 4.837	€ 4.915	€ 5.075	€ 5.718	€ 5.963	€ 5.808	€ 5.101	€ 5.211	€ 5.651	€ 5.636	€ 5.880	€ 6.513
	Return (%)	-	6,40%	7,90%	4,30%	7,50%	12,70%	9,20%	-4,70%	-10,50%	3,30%	4,90%	1,80%	1,60%	8,80%
Fixed interest securities	Total Capital (€)		€ 7.222	€ 7.483	€ 8.383	€ 9.800	€ 10.053	€ 11.307	€ 11.876	€ 12.183	€ 12.945	€ 12.289	€ 16.628	€ 15.633	€ 21.806
	Return (%)	-	9,90%	4,20%	7,80%	4,90%	-0,50%	1,30%	4,60%	11,20%	7,20%	4,80%	12,50%	-1,00%	9,80%
Commodities	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Private equity	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

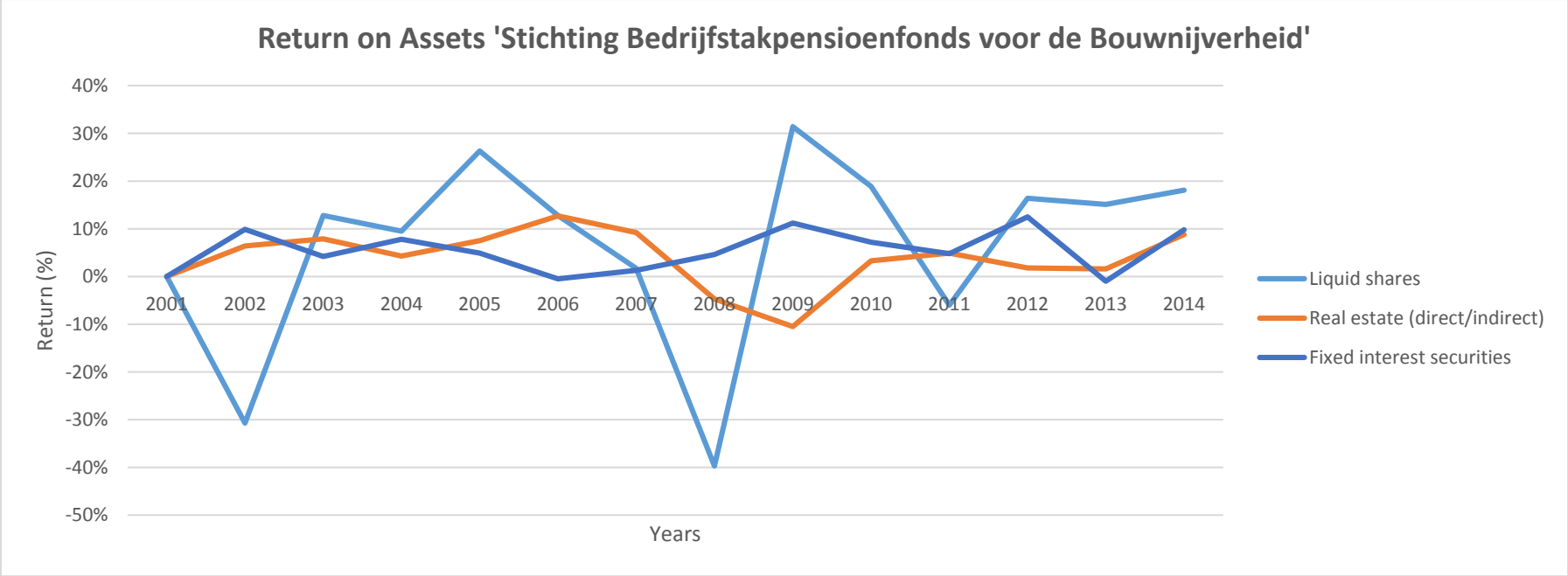

Chart 6: Return on investments Stichting Bedrijfstakpensioenfonds voor de Bouwnijverheid

Table 17: Data collection Stichting Pensioenfonds van de Metalektro, return and invested capital per asset

Stichting Pensioenfonds van de Metalektro (return in %, total capital in € x1.000.000)																
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Liquid shares	Total Capital (€)				€ 4.948	€ 7.633	€ 8.283	€ 9.329	€ 3.322	€ 5.214	€ 5.719	€ 5.880	€ 7.430	€ 9.007	€ 12.614	
	Return (%)	-	-	-	8,30%	34,10%	13,70%	5,10%	-45,90%	33,80%	21,70%	-6,00%	15,60%	18,90%	11,50%	
Real estate (direct/indirect)	Total Capital (€)				€ 1.655	€ 1.576	€ 1.481	€ 1.604	€ 1.673	€ 1.665	€ 1.748	€ 1.842	€ 2.040	€ 2.084	€ 2.130	
	Return (%)	-	-	-	13,20%	14,60%	12,10%	7,30%	1,50%	-3,90%	3,20%	3,40%	2,00%	1,80%	9,00%	
Fixed interest securities	Total Capital (€)				€ 8.802	€ 9.098	€ 9.686	€ 9.879	€ 11.829	€ 11.798	€ 13.849	€ 16.575	€ 20.859	€ 20.322	€ 23.522	
	Return (%)	-	-	-	10,30%	12,70%	-0,40%	-0,10%	-10,50%	18,70%	12,63%	5,33%	10,61%	-3,33%	13,95%	
Commodities	Total Capital (€)															
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Private equity	Total Capital (€)															
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

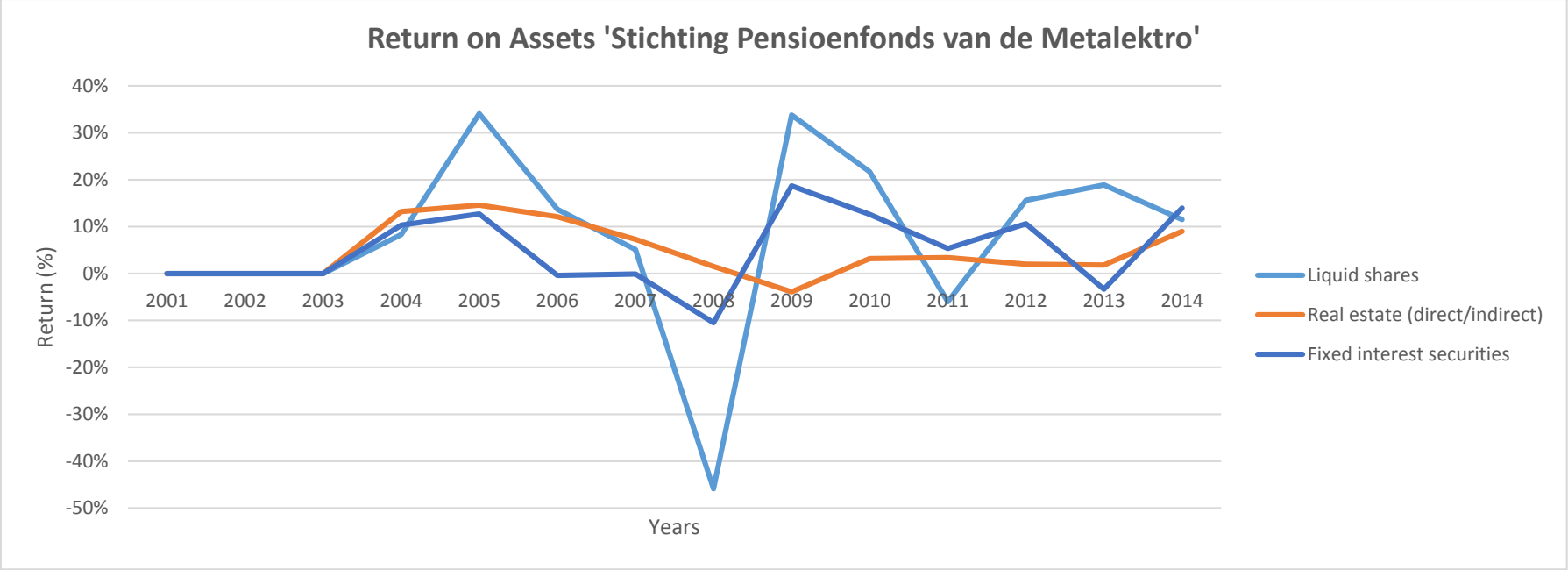

Chart 7: Return on investments Stichting Pensioenfonds van de Metalektro

Table 18: Data collection Stichting Shell Pensioenfonds, return and invested capital per asset

Stichting Shell Pensioenfonds (return in %, total capital in € x1.000.000)		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)									€ 5.810	€ 6.904	€ 6.769	€ 8.736	€ 8.364	€ 9.209
	Return (%)	-	-	-	-	-	-	-	-	42,70%	18,60%	-10,50%	17,10%	19,80%	12,00%
Real estate (direct/indirect)	Total Capital (€)									€ 387	€ 430	€ 464	€ 632	€ 815	€ 1.008
	Return (%)	-	-	-	-	-	-	-	-	15,00%	14,40%	14,30%	10,40%	13,40%	9,80%
Fixed interest securities	Total Capital (€)									€ 5.750	€ 6.650	€ 8.157	€ 8.153	€ 10.197	€ 11.841
	Return (%)	-	-	-	-	-	-	-	-	11,70%	23,10%	3,60%	14,60%	-2,10%	8,50%
Commodities	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Private equity	Total Capital (€)									€ 1.588	€ 1.576	€ 1.657	€ 1.826	€ 1.714	€ 1.908
	Return (%)	-	-	-	-	-	-	-	-	5,40%	23,80%	11,30%	15,30%	9,60%	22,10%

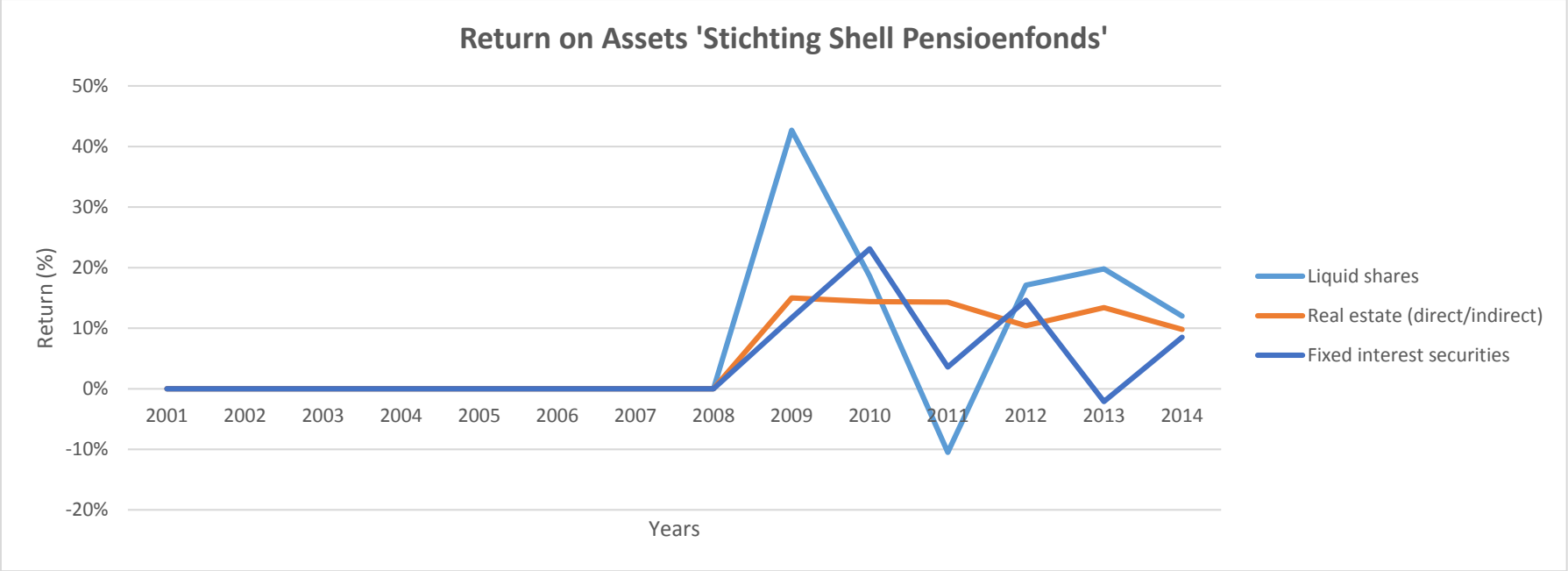

Chart 8: Return on investments Stichting Shell Pensioenfonds

Table 19: Data collection Stichting Pensioenfonds ING, return and invested capital per asset

Stichting Pensioenfonds ING (return in %, total capital in € x1.000.000)		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)							€ 3.613	€ 3.091	€ 4.168	€ 4.262	€ 3.961	€ 4.371	€ 4.511	€ 4.048
	Return (%)	-	-	-	-	-	-	1,50%	-42,10%	37,30%	20,50%	-6,70%	12,30%	12,70%	17,60%
Real estate (direct/indirect)	Total Capital (€)							€ 1.012	€ 842	€ 796	€ 1.089	€ 978	€ 1.060	€ 1.015	€ 1.180
	Return (%)	-	-	-	-	-	-	-0,50%	-26,10%	-0,70%	9,80%	8,20%	9,10%	2,00%	21,60%
Fixed interest securities	Total Capital (€)							€ 5.414	€ 5.483	€ 6.933	€ 6.960	€ 8.741	€ 10.632	€ 11.658	€ 17.816
	Return (%)	-	-	-	-	-	-	-3,60%	10,50%	6,40%	9,60%	12,90%	11,90%	0,80%	10,50%
Commodities	Total Capital (€)										€ 463	€ 283	€ 198		
	Return (%)	-	-	-	-	-	-	-	-	-	24,10%	-8,90%	-3,30%	-	-
Private equity	Total Capital (€)							€ 87	€ 82	€ 109	€ 141	€ 243	€ 317	€ 349	€ 480
	Return (%)	-	-	-	-	-	-	32,70%	-21,30%	7,90%	9,00%	27,80%	7,70%	8,00%	26,40%

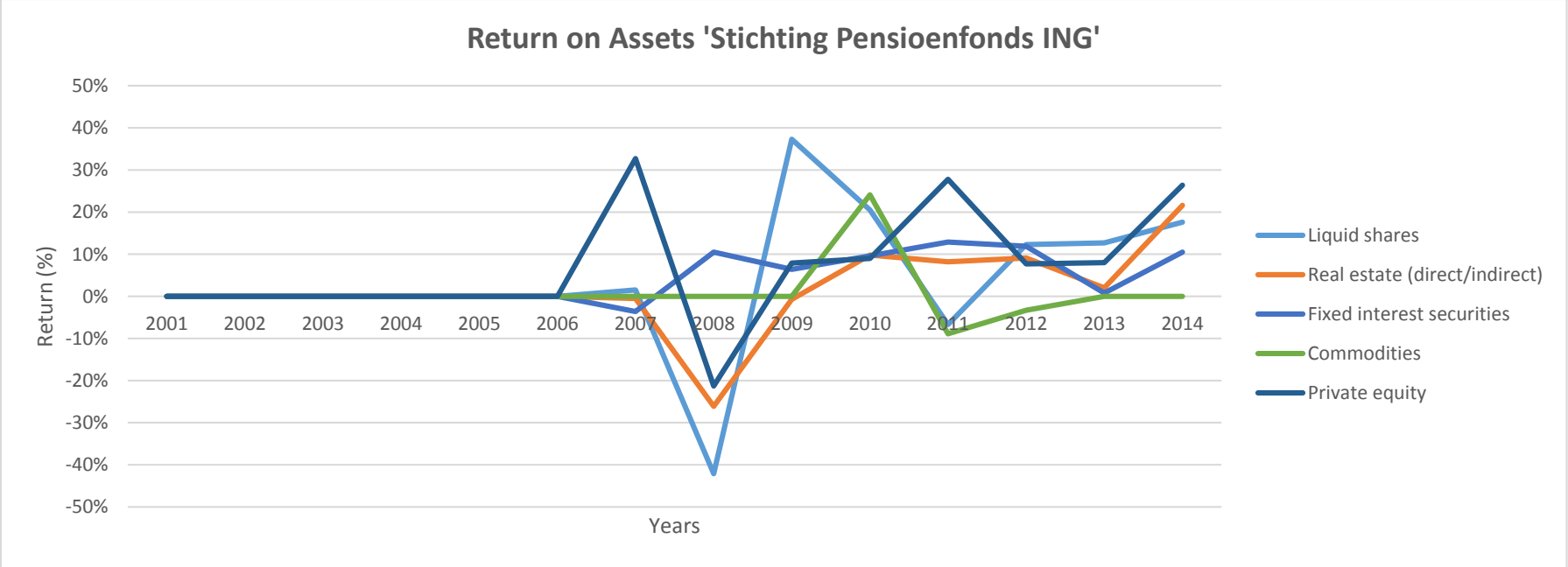

Chart 9: Return on investments Stichting Pensioenfonds ING

Table 20: Data collection Stichting Rabobank Pensioenfonds, return and invested capital per asset

Stichting Rabobank Pensioenfonds (return in %, total capital in € x1.000.000)															
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)											€ 4.424	€ 5.526	€ 7.143	€ 8.559
	Return (%)	-	-	-	-	-	-	-	-	-	-	-6,50%	16,28%	23,97%	12,10%
Real estate (direct/indirect)	Total Capital (€)											€ 1.035	€ 1.058	€ 1.227	€ 1.495
	Return (%)	-	-	-	-	-	-	-	-	-	-	4,50%	1,39%	2,99%	4,20%
Fixed interest securities	Total Capital (€)											€ 5.217	€ 7.895	€ 7.358	€ 7.826
	Return (%)	-	-	-	-	-	-	-	-	-	-	5,50%	7,49%	-0,23%	8,30%
Commodities	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	2,60%	-1,10%	-	-32,80%
Private equity	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	8,10%	6,60%	7,00%	22,60%

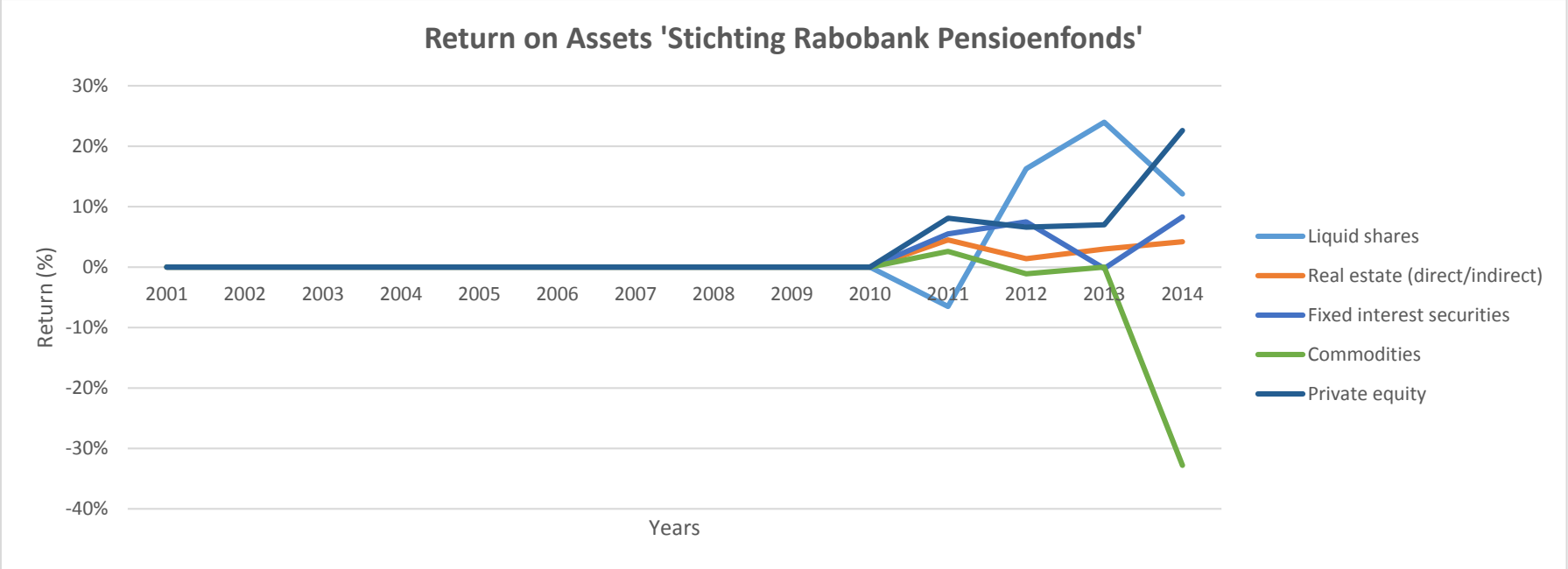

Chart 10: Return on investments Stichting Rabobank Pensioenfonds

Table 21: Data collection Stichting Philips Pensioenfonds, return and invested capital per asset

Stichting Philips Pensioenfonds (return in %, total capital in € x1.000.000)		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)	€ 8.023	€ 5.442	€ 4.635	€ 3.697	€ 4.066	€ 4.185	€ 3.603	€ 1.772	€ 2.329	€ 2.183	€ 2.109	€ 2.309	€ 2.504	€ 4.994
	Return (%)	-17,60%	-29,00%	17,30%	12,40%	30,00%	12,60%	-0,20%	-40,70%	30,80%	20,90%	-5,00%	15,50%	18,10%	16,20%
Real estate (direct/indirect)	Total Capital (€)	€ 2.114	€ 1.910	€ 1.552	€ 1.348	€ 1.231	€ 1.342	€ 1.191	€ 541	€ 504	€ 607	€ 676	€ 666	€ 805	€ 1.784
	Return (%)	10,71%	5,92%	2,51%	4,60%	9,00%	10,50%	17,50%	-1,70%	-5,90%	14,70%	10,40%	2,00%	16,40%	5,30%
Fixed interest securities	Total Capital (€)	€ 4.468	€ 4.700	€ 5.483	€ 8.259	€ 8.720	€ 8.403	€ 8.285	€ 9.871	€ 9.374	€ 9.566	€ 9.963	€ 10.798	€ 10.417	€ 10.701
	Return (%)	6,50%	8,20%	4,30%	9,00%	10,40%	-1,90%	-1,00%	-13,00%	34,52%	18,95%	6,75%	14,40%	-4,80%	26,66%
Commodities	Total Capital (€)								€ 61	€ 73	€ 81	€ 199	€ 178	€ 134	€ 178
	Return (%)	-	-	-	-	-	-	-	-39,80%	20,50%	25,70%	-9,40%	-1,10%	-13,40%	-4,30%
Private equity	Total Capital (€)								€ 64	€ 57	€ 77	€ 40			
	Return (%)	-	-	-	-	-	-	-	6,50%	-8,60%	25,30%	7,80%	-	-	-

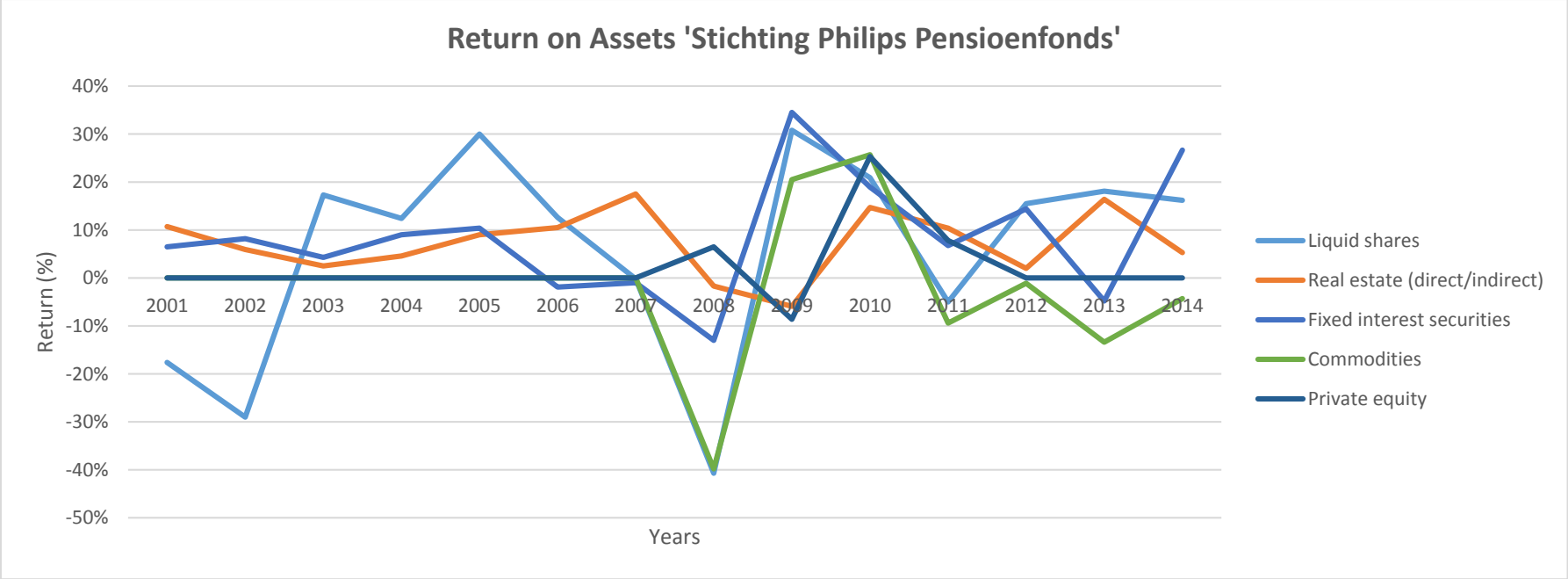

Chart 11: Return on investments Stichting Philips Pensioenfonds

Table 22: Data collection Stichting Pensioenfonds voor de Grafische Bedrijven, return and invested capital per asset

Stichting Pensioenfonds voor de Grafische Bedrijven (return in %, total capital in € x1.000.000)																
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Total Capital (€)					€ 4.137	€ 4.265	€ 4.478	€ 2.652	€ 3.288	€ 3.673	€ 3.884	€ 3.984	€ 4.593	€ 6.523
	Return (%)	-	-	-	-	23,90%	15,40%	6,90%	-39,00%	33,60%	21,80%	-6,40%	17,23%	14,39%	16,09%
Real estate (direct/indirect)	Total Capital (€)					€ 608	€ 714	€ 777	€ 757	€ 823	€ 919	€ 746	€ 1.324	€ 1.454	€ 1.649
	Return (%)	-	-	-	-	13,30%	18,40%	10,20%	-9,30%	-1,80%	8,40%	-2,30%	3,60%	-0,63%	5,61%
Fixed interest securities	Total Capital (€)					€ 4.165	€ 4.105	€ 4.436	€ 3.165	€ 3.557	€ 4.116	€ 6.341	€ 8.396	€ 8.357	€ 11.056
	Return (%)	-	-	-	-	8,60%	0,70%	2,00%	-1,00%	9,80%	1,00%	5,60%	9,34%	-3,42%	21,69%
Commodities	Total Capital (€)							€ 165	€ 183	€ 201	€ 278				
	Return (%)	-	-	-	-	-	-	47,20%	-64,30%	15,40%	16,50%	-	-	-	-
Private equity	Total Capital (€)														
	Return (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

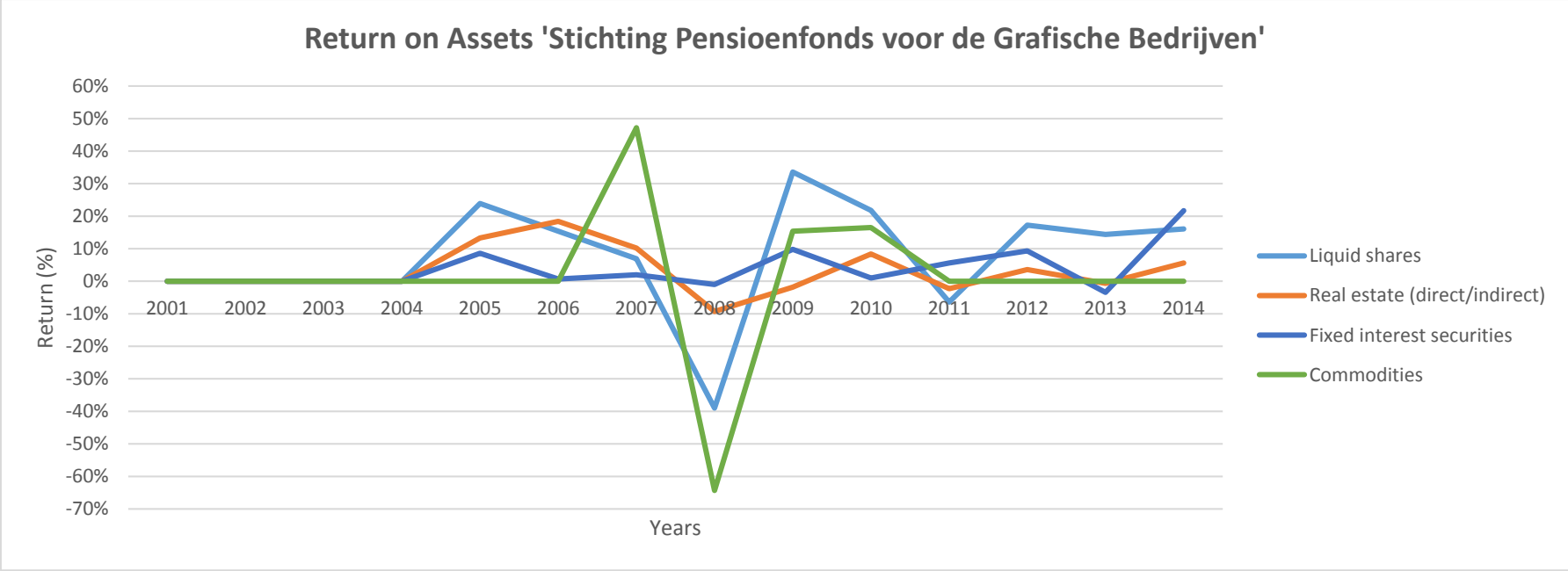

Chart 12: Return on investments Stichting voor de Grafische Bedrijven

APPENDIX 7: DATA COLLECTION 10 BIGGEST PENSION FUNDS COMBINED

Table 23: Total return per asset of all pension funds combined

Total Return per Asset on all Portfolios Combined															
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid shares	Return (%)	-13,96%	-25,00%	21,25%	11,64%	23,11%	14,32%	5,67%	-40,10%	35,32%	20,78%	-5,96%	16,10%	17,14%	13,24%
Real estate (direct/indirect)	Return (%)	10,00%	7,74%	7,59%	10,46%	16,61%	27,92%	1,42%	-20,23%	6,03%	11,95%	2,28%	12,96%	3,47%	10,99%
Fixed interest securities	Return (%)	6,12%	9,37%	4,50%	8,06%	5,67%	0,52%	1,46%	-1,45%	13,30%	8,34%	10,05%	12,27%	-2,70%	18,73%
Commodities	Return (%)	-32,80%	35,50%	23,30%	20,90%	24,71%	-19,99%	33,44%	-48,54%	21,98%	7,47%	4,86%	2,58%	-1,41%	-27,98%
Private equity	Return (%)	-24,80%	26,80%	33,60%	16,70%	18,32%	18,50%	29,02%	-25,19%	9,68%	29,54%	6,32%	7,45%	17,44%	19,76%

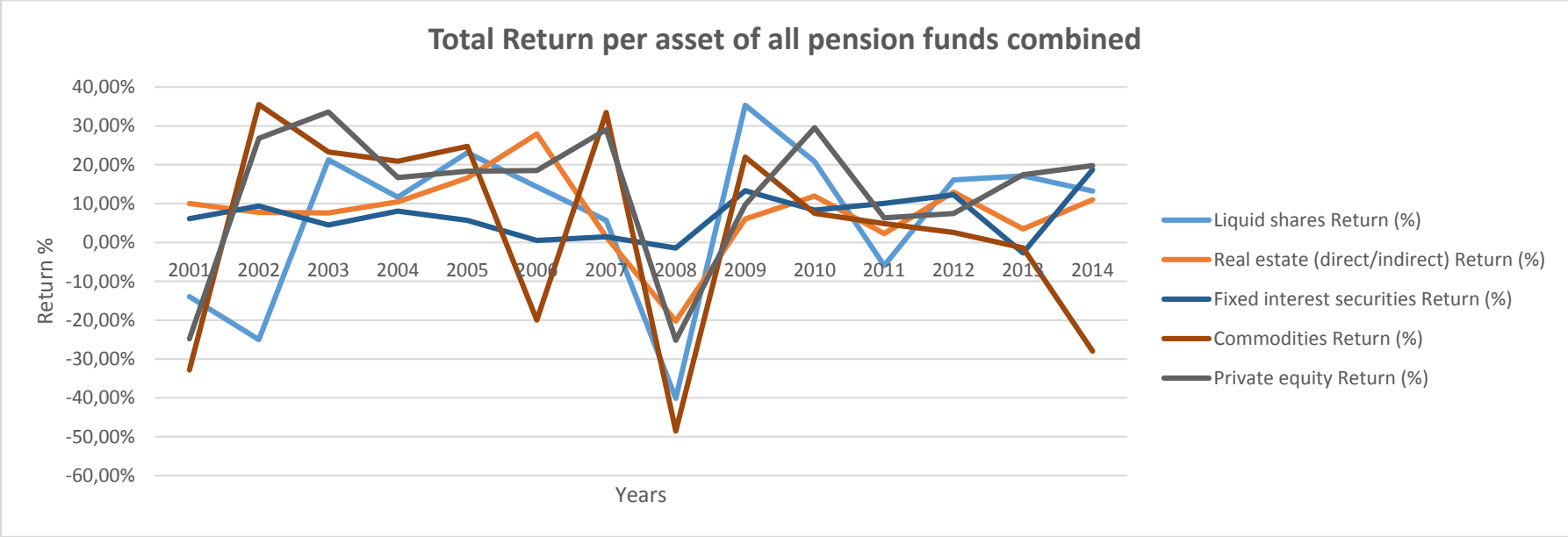

Chart 13: Total Return per asset of all pension funds combined

APPENDIX 8: EXAMPLE OF THE CALCULATION OF CORRELATION

The correlation between real estate and liquid shares during the period 2001-2014 is as follows:

STEP 1: The formula for the average return will be used to calculate the average return of liquid shares and the average return of real estate during the period 2001-2014, the formula and calculation is as follows:

Average return over period

$$\mu_x = \frac{X_1+X_2+\ldots+Xn}{n}$$

μ_x = Average Return X over period

$X_{1,2,n}$ = Return X in year 1, year 2,.. untill year n

n = Number of years

Average return Liquid Shares

$$\mu_x = \frac{\begin{array}{c}-13{,}96 + -25 + 21{,}25 + 11{,}64 + 23{,}11 + 14{,}32 + 5{,}67 + \\ -40{,}1 + 35{,}32 + 20{,}78 + -5{,}96 + 16{,}1 + 17{,}14 + 13{,}24\end{array}}{14} = 6{,}68$$

Average return Real Estate

$$\mu_y = \frac{\begin{array}{c}10{,}00 + 7{,}74 + 7{,}59 + 10{,}46 + 16{,}61 + 27{,}92 + 1{,}42 + \\ -20{,}23 + 6{,}03 + 11{,}95 + 2{,}28 + 12{,}96 + 3{,}47 + 10{,}99\end{array}}{14} = 7{,}80$$

STEP 2: The calculated average return can be used to calculate the covariance. The covariance between liquid shares and real estate during the period 2001-2014 can be calculated as follows:

Calculation of the covariance

$$\text{Cov}(R_1R_2) = \frac{(X_1-\mu_x)*(Y_1-\mu_y)+(X_2-\mu_x)*(Y_2-\mu_y)+\ldots+(X_n-\mu_x)*(Y_n-\mu_y)}{n}$$

$\text{Cov}(R_1R_2)$	=	Coveriance between Return 1 and Return 2
$X_{1,2,n}$	=	Return X in year 1, year 2,.. untill year n
$Y_{1,2,n}$	=	Return Y in year 1, year 2,.. untill year n
μ_x	=	Average Return X over period
μ_y	=	Average Return Y over period
n	=	Number of years

The Covariance between liquid shares and real estate

$$\text{Cov}(R_1R_2) = \frac{\begin{array}{c}(-13{,}96 - 6{,}88) * (10{,}00 - 7{,}80) + (-25{,}00 - 6{,}88) * (7{,}74 - 7{,}80) + \\ (-21{,}25 - 6{,}68) * (7{,}59 - 7.80) + (11{,}64 - 6{,}88) * (10{,}46 - 7{,}80) + \\ (23{,}11 - 6{,}88) * (16{,}61 - 7{,}80) + (14{,}32 - 6{,}88) * (27{,}92 - 7{,}80) + \\ (5{,}67 - 6{,}88) * (1{,}42 - 7{,}80) + (-40{,}10 - 6{,}88) * (-20{,}23 - 7{,}80) + \\ (35{,}32 - 6{,}88) * (6{,}03 - 7{,}80) + (20{,}78 - 6{,}88) * (11{,}95 - 7{,}80) + \\ (-5{,}96 - 6{,}88) * (2{,}28 - 7{,}80) + (16{,}10 - 6{,}88) * (12{,}96 - 7{,}80) + \\ (17{,}14 - 6{,}88) * (3{,}47 - 7{,}80) + (13{,}24 - 6{,}88) * (10{,}99 - 7{,}80)\end{array}}{14} = 0{,}0120$$

STEP 3: The calculated average return can be used to calculate the variance of the liquid shares and the variance of real estate during the period 2001-2014. The variance can be calculated as follows:

Calculation of the variance

$$V(R_x) = \frac{(X_1-\mu_x)^2+(X_2-\mu_x)^2+\ldots+(X_n-\mu_x)^2}{n}$$

$V(R_x)$ = Variance of Return X
$X_{1,2,n}$ = Return X in year 1, year 2,.. untill year n
μ_x = Average Return X over period
n = Number of years

Variance of Liquid Shares

$$V(R_x) = \frac{\begin{array}{c}(-13{,}96 - 6{,}68)^2 + (-25{,}00 - 6{,}68)^2 + (21{,}25 - 6{,}68)^2 + \\ (11{,}64 - 6{,}68)^2 + (23{,}11 - 6{,}68)^2 + (14{,}32 - 6{,}68)^2 + \\ (5{,}67 - 6{,}68)^2 + (-40{,}10 - 6{,}68)^2 + (35{,}32 - 6{,}68)^2 + \\ (20{,}78 - 6{,}68)^2 + (-5{,}96 - 6{,}68)^2 + (16{,}1 - 6{,}68)^2 + \\ (17{,}14 - 6{,}68)^2 + (13{,}24 - 6{,}68)^2\end{array}}{14} = 0{,}0400$$

Variance of Real Estate

$$V(R_y) = \frac{\begin{array}{c}(10{,}00 - 7{,}80) + (7{,}74 - 7{,}80) + (7{,}59 - 7{,}80) + \\ (10{,}46 - 7{,}80) + (16{,}61 - 7{,}80) + (27{,}92 - 7{,}80) + \\ (1{,}42 - 7{,}80) + (-20{,}23 - 7{,}80) + (6{,}03 - 7{,}80) + \\ (11{,}95 - 7{,}80) + (2{,}28 - 7{,}80) + (12{,}96 - 7{,}80) + \\ (3{,}47 - 7{,}80) + (10{,}99 - 7{,}80)\end{array}}{14} = 0{,}0102$$

STEP 4: The variance will be used to calculate the standard deviation. The standard deviation of the liquid shares and the standard deviation of the real estate, during the period 2001-2014, will be calculated as follows:

Calculation of the standard deviation

$SD(R_x) = \sqrt{V(R_x)}$

$SD(R_x)$ = Standard Deviation of Return X
$V(R_x)$ = Variance of Return X

Standard Deviation Liquid Shares

$SD(R_x) = \sqrt{(0,0400)} = 0,2001$

Standard Deviation Real Estate

$SD(R_y) = \sqrt{(0,0102)} = 0,1010$

STEP 5: The variance will be used to calculate the standard deviation. The standard deviation of the liquid shares and the standard deviation of the real estate, during the period 2001-2014, will be calculated as follows:

Calculation of the correlation coefficient

$$Corr\ (R_xR_y) = \frac{Cov\ (R_xR_y)}{SD\ (R_x) * SD\ (R_y)}$$

$Corr\ (R_xR_y)$	=	Correlation Coefficient between Return X and Return Y
$Cov\ (R_xR_y)$	=	Coveriance between Return X and Return Y
$SD\ (R_x)$	=	Standard Deviation of Return X
$SD\ (R_y)$	=	Standard Deviation of Return Y

Correlation coefficient of liquid shares and real estate

$$Corr\ (R_xR_y) = \frac{0{,}0120}{0{,}2001 * 0{,}1010} = 0{,}60$$

APPENDIX 9: RESULTS OF THE CALCULATIONS

Liquid shares and real estate (2001-2014)		
	Liquid shares	Real estate
Average return	6,68%	7,80%
Covariance	0,0120	
Variance	0,0400	0,0102
Standard deviation	0,2001	0,1010
Correlation coefficient	0,60	

Liquid shares and real estate (2001-2007)		
	Liquid shares	Real estate
Average return	5,29%	11,68%
Covariance	0,0044	
Variance	0,0283	0,0061
Standard deviation	0,1683	0,0784
Correlation coefficient	0,33	

Liquid shares and real estate (2008-2014)		
	Liquid shares	Real estate
Average return	8,07%	3,92%
Covariance	0,0207	
Variance	0,0514	0,0112
Standard deviation	0,2266	0,1060
Correlation coefficient	0,86	

Fixed interest securities and real estate (2001-2014)		
	Liquid shares	Real estate
Average return	7,80%	6,73%
Covariance	0,0015	
Variance	0,0102	0,0033
Standard deviation	0,1010	0,0579
Correlation coefficient	0,26	

Fixed interest securities and real estate (2001-2007)		
	Liquid shares	Real estate
Average return	11,68%	5,10%
Covariance	-0,0008	
Variance	0,0061	0,0009
Standard deviation	0,0784	0,0300
Correlation coefficient	-0,33	

Fixed interest securities and real estate (2008-2014)		
	Liquid shares	Real estate
Average return	3,92%	8,36%
Covariance	0,0051	
Variance	0,0112	0,0053
Standard deviation	0,1060	0,0726
Correlation coefficient	0,66	

Commodities and real estate (2001-2014)		
	Liquid shares	Real estate
Average return	7,80%	3,14%
Covariance	0,0060	
Variance	0,0102	0,0644
Standard deviation	0,1010	0,2538
Correlation coefficient	0,23	

Commodities and real estate (2001-2007)		
	Liquid shares	Real estate
Average return	11,68%	12,15%
Covariance	-0,0107	
Variance	0,0061	0,0630
Standard deviation	0,0784	0,2510
Correlation coefficient	-0,55	

Commodities and real estate (2008-2014)		
	Liquid shares	Real estate
Average return	3,92%	-5,86%
Covariance	0,0157	
Variance	0,0112	0,0496
Standard deviation	0,1060	0,2226
Correlation coefficient	0,66	

Private equity and real estate (2001-2014)		
	Liquid shares	**Real estate**
Average return	7,80%	13,08%
Covariance	0,0081	
Variance	0,0102	0,0304
Standard deviation	0,1010	0,1744
Correlation coefficient	0,46	

Private equity and real estate (2001-2007)		
	Liquid shares	**Real estate**
Average return	11,68%	16,88%
Covariance	-0,0018	
Variance	0,0061	0,0324
Standard deviation	0,0784	0,1800
Correlation coefficient	-0,13	

Private equity and real estate (2008-2014)		
	Liquid shares	**Real estate**
Average return	3,92%	9,29%
Covariance	0,0151	
Variance	0,0112	0,0255
Standard deviation	0,1060	0,1598
Correlation coefficient	0,89	

APPENDIX 10: ONE ENGLISH PAGE OF THE INTERVIEW WITH TIMEOS

Company: Timeos Pensioendiensten (executive organisation of 'Pensioenfonds voor de Grafische Bedrijven')

Name: E.J. Nilting

Function: Manager Real Estate Investments

Question and answers:

1. You work for Timeos Pensioendiensten, troughout research I have come to know that this is the executive organisation for the pension fund PGB. To which extend is all invested capital of the pension fund placed at Timeos and does Timeos manage invested capital of other pension funds as well?

   Timeos is the only executive organisation for the pension fund PGB. This has been established by the unbundling of tasks and responsibilities within the pension fund PGB. The unbundling of task and responsibilities focusses on unbundling of governance and policy, execution and supervision. Besides that Timeos works partially with external managers for the executive tasks.

2. Pension funds invest in different asset. One of the assets in a so called mixed-asset portfolio of pension funds is real estate. In which way was the allocation to real estate in the mixed-asset portfolio determined?

   Pension funds are a sort of special insurance companies. The purpose of a pension fund is not to maximize returns on the investments but to manage coverage ratio. The coverage ratio indicates whether a pension fund can fulfil their commitments in the future. This coverage ratio need to be achieved at the lowest possible risk.

   Initially, the investment portfolio of a pension fund is divided into a matching portfolio and a return portfolio. The matching portfolio is used to hedge the interest rate risk of the pension fund and the return portfolio is used to generate benefits for the increase of future payments, in order to compensate for the increase of wages and prices.

   The matching portfolio is divided into different assets. Firstly the portfolio is divided into liquid shares and alternative investments. After that, the alternative investment are split into different assets, such as, direct and indirect real estate, private equity and commodities.

   In the past the allocation to real estate and other assets was mainly determined by an ideal mix, based on a risk and return profile. Nowadays, there is a shift towards a portfolio design that is based on future risk drivers. Examples of risk drivers that can be used for the portfolio allocation are demographic figures, unemployment rate and the economy.

   For example, a demographic risk driver can be the aging of society. This makes that housing facilities for elderly will be an important part of the real estate in the future. This development can make the pension fund investors convince to include housing facilities for elderly in the future pension fund portfolio.