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Home Equity Bias in Danish pension funds

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Executive Summary

Modern Portfolio Theory (MPT) has revolutionized how investors think about asset allocation by offering groundbreaking ideas on how to allocate investments quantitatively. MPT suggests that investors can achieve superior returns and lower risks by holding international diversified portfolios. Despite this, empirical studies suggest that investors tend to overweight domestic equities, which adversely affects the risk-return relationship.

This thesis investigates home equity bias in Danish pension funds to see if they act in accordance with theory and exploits the positive effects of international diversification. Inefficient investments by the pension funds negatively affect people's economic wealth, and have direct consequences on the economic growth. This makes Danish pension funds particularly interesting, as we know that a sub-optimal asset allocation will represent a significant efficiency loss for the whole Danish society.

A correlation analysis showed that international diversification still provides risk reduction possibilities. The analysis confirmed that Danish pension funds could still significantly reduce their portfolio risk through international diversification without compromising return, even though correlations have increased over time. It would therefore be surprising if the Danish pension funds do not make use of these opportunities. Applying three benchmark models on Danish pension funds showed that the home equity bias in Danish pension funds has sharply decreased over the last decade, but that the sector still exhibits significant home equity bias. Consequently, the overweight of domestic equities corresponds to a welfare loss for the Danish society through Danish citizens bearing unnecessary portfolio risk.

From a rational perspective it was surprising to find that large institutional investors, represented by Danish pension funds, exhibits significant home equity bias. Our findings suggest that the negligence of international diversification within the Danish pension fund sector can be explained by a combination of factors. Pension fund managers appear to direct investments to countries with a high ranking in corporate governance and transparency, a factor where Denmark is ranked at the very top. In addition, they also appear to suffer from behavioral bias in the form of over-optimism, and a lesser extent herding. Thus, similarly to previous studies on this subject we conclude that the home equity bias cannot be explained by a single factor. Rather, the home equity bias within Danish pension funds is attributable to both institutional and behavioral factors.

Table of contents

1.0 Introduction and methodology

This section will introduce the reader to the choice of topic, and the reasoning behind this choice. The reader will also be presented with an overview of the structure of the thesis. Lastly, this section includes a presentation of the data used and which limitations we have taken.

1.1 Introduction

Danish pension funds are large institutional investors. They play a major role in the financial market and constitute an integral part of the economy. Danish pension funds administer large sums of capital and are responsible for managing the pension savings for the majority of the Danish people. The main goal of pension funds is to generate stable long-term returns to provide pensions to employees when they reach the end of their working years. Pension funds enable people to smoothen out consumption from working years to their retirement. This also contributes to financial stability and macroeconomic development. The increasing popularity of private pension funds, as well as an increasing elder population suggests that the importance of pension funds is only expected to increase in the coming years. Poor and inefficient investments by the pension funds directly affect people's lives, and may have serious consequences for the overall economy. It is therefore of high importance that the pension funds invest their assets in an efficient way, by managing both risk and return.

Modern Portfolio Theory has revolutionized how investors think about asset allocation and has become a cornerstone of financial theory. It has long been recognized that investors can achieve superior returns and lower risks by holding international diversified portfolios. One would therefore expect professional investors to act in accordance with the theory and fully exploit the benefits of international diversification. However, looking at investors' historical asset allocation there seems to be a discrepancy between theory and practice. Portfolios tend to be heavily invested in domestic equities, which is difficult to explain given the benefits of international diversification. In consequence, many investors bear greater risk than what could be achieved through dispersing investments across different international markets. This area of research has drawn a lot of attention. Still, no one has been able to solve what is referred to as the home equity bias puzzle.

Due to the pension funds' large impact on the Danish economy, we find that an investigation of the home equity bias within this sector provides both an interesting and relevant thesis. Not only do the investment strategies of Danish pension funds affect the Danish economy today, they also play a key role in deciding

the future welfare level in Denmark due to their direct influence on the future purchasing power of pensioners.

1.2 Problem Identification

This thesis investigates the home equity bias within Danish pension funds. The focus of this thesis is on the justification of international diversification, the scope of the bias and the probable explanations behind the negligence of international diversification.

Although it is widely accepted that individual investors are highly concentrated in their domestic market, the same should not be expected from institutional investors. One would expect that the internal resources and knowledge enable them to invest internationally. If there is a discrepancy between portfolio theory and actual investments made by Danish pension funds, it represents a significant cost for the Danish society.

In order to approach our research subject, we have chosen the following problem statement;

Portfolios tend to be heavily invested in domestic equities, which is difficult to explain given the benefits of international diversification. As global financial markets have become more integrated it has also become easier to diversify internationally. However, integration may also have increased correlations between markets and hence reduce the benefits of diversification. The idea for this thesis is first to investigate the change in correlation between Denmark and international markets and how this has developed over time, then second to document the extent of international diversification by Danish pension funds and evaluate this in light of modern portfolio theory. Lastly, the empirical explanations on home bias from earlier studies will be investigated in regards to the Danish pension funds.

Through an analysis of the changing correlations over time, we are able to identify the true benefits of international diversification. It might be that globalization has increased correlations between markets to a level where the benefits of international diversification are diminished. If this is the case then the home equity bias could be justified, and that there in fact is no bias.

When we have concluded whether international diversification still provides portfolio benefits, documenting the extent of international diversification in Danish pension funds enables us to determine the scope of home bias in Danish pension funds. Through applying benchmark models that are based on modern portfolio theory, this section enables us to quantify the size of the bias.

Once the scope of the home equity bias has been established we apply the most acclaimed explanations for the home equity bias from previous researchers on the Danish pension fund sector. This enables us to see if the findings for the average investor also apply to professional Danish pension funds.

1.3 Structure of the thesis

This thesis is divided into seven main chapters. Each chapter is divided into a number of sections that reflect the scope of each chapter. A brief outline of each chapter is given below.

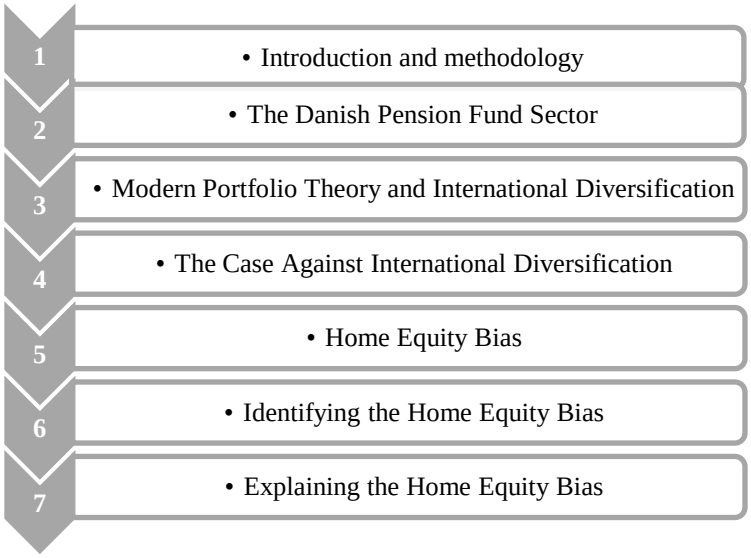

Figure 1: Shows the overall structure of our thesis.

1.0 Introduction and methodology

This chapter provides the reader with a general outline of the thesis. The reader will be introduced to the reasoning behind the choice of topic and be given an overview of the structure of the thesis. The reader will also be introduced to the data used throughout this thesis and the limitations that have been taken.

2.0 The Danish Pension Fund Sector

This chapter will provide the reader with relevant knowledge about the Danish Pension system and the Danish pension funds. The chapter will further highlight the importance of Danish pension funds as well as give a short description of the legal framework surrounding Danish pension funds.

3.0 Modern Portfolio Theory and International Diversification

This chapter will give the reader an introduction to the theory needed to fully understand the concept of home bias. The theoretical aspects given in this chapter lay a foundation for the analysis of home bias. The focus of this chapter will be on modern portfolio theory as well as the theoretical foundation of international diversification.

4.0 The Case Against International Diversification

This chapter will present the main critique against international diversification. This critique will then be investigated in respect to the Danish equity market. The correlation analysis given in this chapter will show the true benefits of international diversification for Danish pension funds.

5.0 Home Equity Bias

In this chapter the reader will be introduced to the concept of home bias. We will further provide a literature review on the previous work that has been done on identifying and explaining home bias. This chapter will provide possible explanations that will be investigated further in chapter seven.

6.0 Identifying the Home Equity Bias

In this part of the thesis, we investigate home equity bias in Danish pension funds. We start by introducing the reference models that will serve as a theoretical foundation in the analysis of home bias. Thereafter, we provide an introduction of the Danish pension fund's asset allocation over time. This constitutes the foundation for our home bias analysis and we then go on to present the results, followed by a discussion of the results.

7.0 Explaining the Home Equity Bias

In this part, we will investigate some of the earlier empirical explanations on home equity bias in regards to Danish pension funds. This will hopefully enable us to explain some of the results found in chapter six.

1.4 Data

For our correlation and mean-variance analysis in chapters four and six we have relied on MSCI indices. The data was obtained through DataStream. The data, denominated in USD, covers daily price quotes for the period 1.1.2003-31.12.2012 for the indices; MSCI Denmark, MSCI AC Asia Pacific, MSCI Europe Ex Denmark, MSCI South Africa, MSCI North America, MSCI EM Latin America, MSCI FM Africa and

MSCI Russia. Some of these indices were created in the middle of 2002, like MSCI FM Africa, and thus prohibited us from covering a longer time period. These indices constituted our benchmark for the world market, and notable exceptions of countries included are Turkey and Saudi-Arabia, who are the only countries in the top 20 ranking of country GDP that are not represented in our analysis. Due to our broad range of countries included we do not however believe that this will affect our results in any notable way. Below we provide a short description of the indices that include more than one country.

MSCI AC Asia Pacific tracks the performance of approximately 85 percent of the free float-adjusted market capitalization across five developed countries and eight emerging markets in the Asia Pacific region. The countries included in the index are; Australia, Hong Kong, Japan, New Zealand, Singapore, China, India, Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand.

MSCI Europe Ex Denmark tracks the performance of 15 countries in Europe, and the countries included in the index are; Austria, Belgium, Finland, France, Germany, Ireland, Israel, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

MSCI North America tracks the performance of Canada and the US and includes 705 of the biggest companies located in these two countries.

MSCI EM Latin America includes five of the emerging economies located in Latin America; Brazil, Chile, Colombia, Mexico and Peru.

MSCI FM Africa covers four of the frontier economies located in Africa; Kenya, Mauritius, Nigeria and Tunisia.

The data applied to estimate the market capitalization and GDP benchmark portfolios in chapter 6 were gathered from The World Bank's DataBank. In order to make the analysis comparable, the same 42 countries mentioned above constituted our world portfolio.

Investment data on foreign and domestic equity investments for Danish pension funds are gathered from annual reports from 2003-2012. In total we collected annual reports for 18 Danish pension funds. A full overview of included pension funds and market share covered is given in section 1.5.2. With a 10 year analysis horizon and 18 pension funds this equals 180 annual reports. However, some of the pension funds

were segmented into different corporations later back[1]. These pension funds had to be identified and aggregated so that the data was comparable through the whole data period. Some of the pension funds did not have electronic annual reports back to 2003 so we had to visit them and take copies of their local paper originals.

In section 7.1.7 we applied MSCI World and OMX Copenhagen in order to calculate the excess returns that the Danish pension funds obtained on their investments. The data on these indices were obtained through DataStream. The choice of OMX Copenhagen instead of MSCI Denmark was because OMX is the benchmark that the Danish pension funds use to evaluate their investments on the domestic market, while the same holds for MSCI World as a benchmark for foreign investments.

In order to conduct our home equity bias analysis in section 7.1.9, 7.1.11 and 7.1.12, the indices that constituted our benchmarks had to be altered in order to make them comparable to the pension funds' investments. Data was obtained through DataStream, and the indices applied were; MSCI Denmark, MSCI AC Asia Pacific ex Japan, MSCI Europe Ex Denmark, MSCI Japan, MSCI North America, MSCI EM Latin America, MSCI FM Africa. The difference between this analysis and the one in section 6 was the exclusion of Russia and South Africa, as well as a separate index for Japan.

1.5 Delimitations

To be able to fully focus on home equity bias and provide the reader with a thorough analysis on this topic, we have chosen to limit the scope of the thesis. This chapter will present which limitations that have been taken and the reasoning behind these limitations.

1.5.1 Limiting the scope of home bias

In this thesis, we will only focus on home equity bias. We will therefore only focus on the equity part of the portfolio. Hence, an analysis of the non-equity part of the portfolios of Danish pension funds is not included in this thesis. There are several reasons for this choice.

Equity markets have some desirable characteristics, which make them suitable for this kind of study. First of all, equity markets are highly standardized and globalized. Stock markets are global markets that are accessible to the whole world. This increases the availability of both national and international data. This

[1] See section 1.5.2

enables us to get equity data that can provide a foundation for a thorough analysis. Equity holdings are also the asset class which Danish pension funds provide the most specific overview of in their annual reports. This enables us to get reliable data on actual domestic and foreign equity holdings. This makes equity more suited for the purpose of this thesis than other asset classed, such as international bond holdings. Secondly, we believe equity will play an increasingly important role in Danish pension funds. With interest rates at historic lows, there is not much room for interest rates to fall further. The interest rates are expected to stay low, but as the world economy slowly recovers and optimism increases in financial markets, the interest rates are expected to increase in both Denmark and the USA. If rates are to increase, bonds will go into a significant bear market, possibly wiping out any short-term gains in the portfolio. According to Davis, Ph, Aliaga-díaz, & Ph (2013), investment-grade bonds are predicted to only return 1–2 percent over the next ten years. This means that they have to rely more on their equity portfolio to pay the guaranteed return to their members.

1.5.2 Limiting the scope of Danish pension funds

In this thesis we have chosen to focus solely on Danish pension funds. Firstly, pension funds are professionally managed funds that we assume have the needed resources and knowledge to fully exploit the possibilities of international diversification. The pension funds are managed by people with higher education and the skills needed to allocate the assets in an efficient manner. We are therefore able to assume that these people have knowledge of the theoretical aspect of investments. The same could not be expected for small size investors. We therefore assume that these large institutional investors should act in accordance with the theory. Secondly, pension funds are major players in financial markets and of high importance to the overall economy. This makes it particularly interesting to look at the asset allocation as we know that a sub-optimal asset allocation will represent a serious cost, not only for Danish individuals, but for the whole Danish society. Thirdly, Danish pension funds are under various regulatory supervisions and must comply with accounting standards. This ensures available data and transparency, on both aggregated as well as individual level. This has enabled us to access and apply the data needed for this analysis.

The scope of Danish pension funds has been limited to the statutory pension funds (ATP and LD) as well as all non-company pension funds with a market share over 1 percent[2]. The pension funds Magistre og psykologer and Lægerne had to be excluded from the analysis since data for the whole period of interest

[2] Based on market shares from Danish Financial Supervisory Authority (2012)

was not available. Our sample represents a total market share of 90.2 percent, excluding ATP and LD. Company pension funds are excluded from this analysis because of their low importance in the Danish pension market. In total 18 pension funds are included in this analysis. The full list of included pension funds is found below. The list is sorted by equity size.

1. Industriens Pension
2. ATP
3. Danica Pension
4. Lærernes Pension
5. PFA
6. LD
7. SEB Pension
8. Pensam
9. Nordea Liv & Pension
10. Sampension KP
11. Sygeplejersker
12. Jurister og Økonomer
13. TopDanmark
14. Sundhedsfaglige
15. AP Pension Liv
16. Socialrådgivere og Socialpædagoger
17. PBU
18. PensionDanmark

It should be noted that some of these pension funds consist of multiple corporations:

PFA Pension: PFA Pension, PFA Soraarneq, Funktionærpension

PenSam: PenSam Liv, Portører, Sygehjælpere, Trafikfunktionærer

SEB: SEB Link og SEB Pension

Topdanmark: Topdanmark Link, Topdanmark Liv, Topdanmark Liv II, Topdanmark Liv III, Topdanmark Liv V, Nykredit Livsforsikring

1.5.3 Limiting the scope of the analysis framework

The analysis of home equity bias will be based on Modern Portfolio Theory and the theoretical aspects of diversification. Models included are Capital Asset Pricing Model (CAPM), International Asset Pricing Model (InCAPM) and mean-variance model (MVM). The theory behind the two former models constitutes the foundation for our market capitalization benchmark. In addition, we have also chosen to include a Gross Domestic Product (GDP) model in our home equity bias analysis. These models are highly recognized and widely used in portfolio management. Each model will be described in its full depth later in this thesis.

These theoretical models serve as a benchmark when analyzing home bias in Danish pension funds. They enable us to have a theoretical foundation to compare the actual portfolio weights of Danish pension funds with. The purpose of this thesis is not to calculate optimal portfolio weights in order to determine whether Danish pension funds have maximized the risk-return relationship. The reader should note that the weights suggested by the GDP and market capitalization models do not represent optimal weights. We will only use these models to calculate an efficient portfolio based on diversification theory. The mean-variance model will suggest weights that give the highest Sharpe ratio. Consequently, as this model maximizes the risk-return relationship, it will provide the optimal portfolio. As we do not assess the historical risk-return relationship of Danish pension funds, our focus will only be on the domestic and foreign allocation weights suggested by the model.

1.6 Previous master theses on Home Equity Bias

To ensure that we bring new aspects into this field of research, it has been important for us to look at past master theses. This enables us to identify new research opportunities and separate us from previous research.

The most central master theses are Eriksson (2001), Skov & Meyer (2006) and Nørregaard (2010). These are all studies of home equity bias in Danish pension funds even though they vary in terms of scope and research question.

In terms of data we have chosen to base our analysis on sector data as well as micro-level data of individual pension funds. This ensures good quality data and increases the credibility of the data relative to for example questionnaires, such as used in Eriksson (2001). This also enables us to do analyses specifically on the Danish market instead of relying on data from studies that are based on other international markets, which therefore might not be comparable. The data used represents the same data foundation as Nørregaard (2010), however with newer and more comprehensive data.

In recent years it has been suggested by researchers that the benefits of international diversification is often overstated, as a result of increasing correlations between international markets and financial contagion. We have therefore included a correlation analysis of Denmark and international markets. This enables us to quantify the true benefits of diversification for Danish pension funds and investigate how this has changed over time. This also makes the home equity bias analysis more interesting as it allows us

to investigate the change in home equity bias in relation to changing correlations between Denmark and international markets. A correlation analysis has not been conducted by any of the earlier studies. However, this type of analysis was suggested by Peter Skov & Meyer (2006) as an idea for future academic research.

To identify and measure the home equity bias of Danish pension funds we have applied three reference models. This includes a market capitalization-, GDP- and mean-variance model. We believe this better captures the theoretical aspects of international diversification than relying solely on a mean-variance model such as in Nørregaard (2010). Skov & Meyer (2006) included both the market capitalization- and the mean-variance model. However, the framework of this thesis is based on the framework of French & Poterba (1991) and therefore differs from ours. Nørregaard (2010) relies on data from MSCI World and MSCI Denmark. We have chosen to include eight non-overlapping MSCI equity indices to cover each of the individual international markets. This enables us to investigate the asset allocation in each international market. We have further improved the estimates of the mean-variance model by using a shrinkage method. The time horizon of our analysis home equity bias analysis is 10-years, and the market capitalization and GDP model enables us to investigate how the home equity bias has changed over time. This differs from earlier studies, as these have solely focused on one year.

We have also included a part that aims to explain the observed home equity bias. This section relied on frameworks from the most acclaimed studies on home equity bias. These sections have often been qualitative and more on a level of discussion in earlier studies. There are similarities between our approach and the one applied by Peter Skov & Meyer (2006), though our investigation is based on different frameworks that we feel are better to reflect its relevance on the home equity bias in Danish pension funds.

2.0 The Danish Pension Fund Sector

The purpose of this chapter is to give the reader a basic knowledge about the Danish pension fund sector and its importance for the economy. We start by giving a general introduction to pension funds, followed by an overview of the Danish pension system. The next section focuses on the importance of Danish pension funds. The last section presents the legal environment in which the Danish pension fund sector operates and its implications for the investment decision.

2.1 Introduction to Pension funds

Pension funds are established to facilitate and organize the investment of employees' retirement funds contributed by the employers and employees. The main goal of the pension funds is to generate stable long-term returns to provide pensions to employees when they reach the end of their working years. This is normally done by investing a common asset pool in financial markets through the acquisition of financial and non- financial assets. Professional fund managers control the common asset and are responsible for investing the money in an appropriate and responsible way. Based on a level of risk, they strive to maximize the return to their pension savers. As we will see in section 2.3, pension funds are major players in the financial industry and of great importance to the overall economy.

2.2 Danish Pension System

In this section we will look at the set-up of the Danish pension system and have a closer look at the pension schemes offered by Danish pension funds. This will provide the reader with a good understanding of the Danish pension system.

2.2.1 The multi-pillar system

Denmark has a multi-pillar pension system. The Danish system is one of the most well developed pension systems in the world and is highly recognized internationally. Each year, the Melbourne Mercer Global Pension Index is published. This index ranks each country's pension system using more than 40 indicators. Denmark was included in this index in 2012 and has after that ranked number one each year, as well as being the first country to obtain an A-grade[3].

The general objective of the multi-pillar system is to ensure welfare for individuals when they reach the end of their working years and enter retirement. The system ensures diversification by relying on three segmented sources of retirement income. This is done by relying on a combination of both statutory and private pension funds. This multi-pillar system is believed to be more effective than having one statutory pension system to serve all individuals. The Danish pension system ensures economic stability and predictability, both on a state and individual level. Consequently, the government has a great interest in having a well working pension system. The Danish pension system builds on three fundamental pillars, as illustrated in figure 2.

[3] Melbourne Mercer Global Pension Index report (2013)

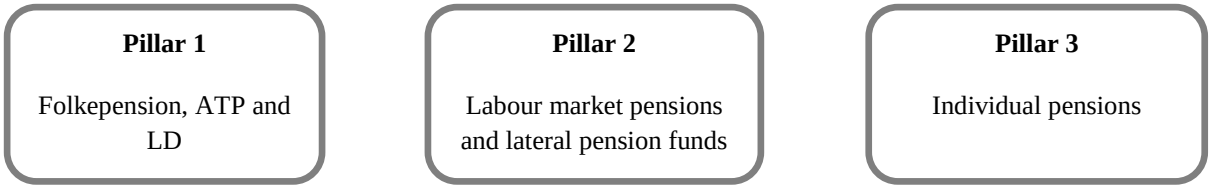

Figure 2: Shows an overview of the three-pillar system in Denmark. Each pillar represents different types of pension savings.

The first pillar is based on the pension funds that are established by law. This includes Folkepension, Arbejdsmarkedets Tillægspension (ATP) and Lønmodtagernes Dyrtidsfond (LD). The people's pension ensures a minimum level of wealth to all retired individuals, and the pension payments are financed through taxes. ATP serves as a supplementary pension. ATP Livslang Pension is a mandatory pension savings scheme for Danish wage earners and salaried employees. The pension payments are financed in collaboration by the employee and the employer. In addition, ATP also administers a number of other schemes that ensure supplementary pension for unemployed people receiving sickness benefits and disability pensioners. With total assets worth about 600 billion DKK, ATP ranks among the largest pension investors in Europe[4].

LD is another pension fund established by law. The Danish parliament decided to found LD at the end of the 1970s with the object of managing Denmark's "frozen cost-of-living allowances". This concept was a way of automatically adjusting the wages to cover the increase in the cost of living[5]. However, the pension fund has not received any contributions or new members since 1980.

The second pillar is mainly based on labor market pensions as well as lateral pension funds. Labor market pensions are pension funds for those who are engaged in active employment. Labor market pensions are typically negotiated as part of collective agreements between the parties. These labor market funds include both company pension schemes as well as occupational pension schemes. Company pension schemes are pension funds which only employees in a specific company can be a member. The company pays a contribution of the employees' salary to a common asset pool that ensures the workers an income after retiring. The company pension schemes have a relatively low market share in Denmark, which reflects the Danish industrial structure with many small and medium-sized companies. Occupational pension funds are financed by both the employer and the employee. Both parties pay a contribution at fixed time intervals, and the total contribution is invested and paid out at retirement. The various labor pension funds

[4]ATP (2014)
[5] LD (2014)

do not compete for members because membership is mandatory and determined according to education, employment and labor union. Examples of such pension funds are Lærernes Pensionskasse and Jurister og Økonomer. These pension schemes are normally established either within life insurance companies or through pension funds. The lateral pension funds administer contributions not specified through collective agreements. Many companies have an agreement with a specific pension fund. However, the pension contributors are free to move their retirement savings to another pension fund. Examples of these are PFA Pension, Denica Pension and Nordea Liv.

The third pillar contains all schemes where individuals voluntarily pay a contribution independently of their employer or labor union. These pension schemes are set up based on the individuals personal needs, and serve as a supplement to the first and second pillar. These pension schemes can be set up within a pension fund or a bank. This enables the individual to take control over their future income to ensure that they do not have to rely solely on the State pension.

Table 1 shows the market share of each of the individual pension funds. ATP and LD are excluded as these are established by law. Company pension funds are also excluded as they represent a non-significant part of the market. Note that the four largest pension funds represent over 50% of the total market share. PFA Pension is the largest individual provider with a market share of approximately 17%. We note that the labor pension funds on average are much smaller than the lateral pension funds.

Pension Fund	Market Share
PFA Pension	17,33 %
Danica Pension	13,41 %
Nordea Liv A/S	11,25 %
PensionDanmark Pensionsforsikringsaktieselskab	8,58 %
Sampension KP A/S	6,31 %
Industriens Pension	5,64 %
AP Pension Liv	5,54 %
PenSam	4,01 %
SEB	3,53 %
Lærernes Pension	3,40 %
Magistre og psykologer	2,67 %
Topdanmark	2,55 %
Sygeplejersker	2,03 %
Børne- og Ungdomspædagoger	2,00 %
Jurister og Økonomer	1,97 %
Socialrådgivere og Socialpædagoger	1,55 %
Lægerne	1,55 %
Sundhedsfaglige	1,06 %
Skandia	0,90 %
Alm. Brand Liv	0,73 %
Bankpension	0,70 %
Danske civil- og akademiingeniører	0,62 %
PKA+Pension A/S	0,41 %
Lægesekretærer	0,38 %
Kontorpersonale	0,34 %
ALKA Liv II	0,34 %
Teknikum- og Diplomingeniører	0,29 %
Jordbrug og Dyrlæger	0,29 %
Arkitekter	0,23 %
Farmakonomer	0,15 %
Arbejdstagernes Pensionskasse	0,12 %
Apoteker/Farmaceuter	0,05 %
PBU Livsforsikringsselskabet A/S	0,02 %
Bankpension, livs- og pensionsforsikringsselskab A/S	0,01 %

Table 1: Shows the market share of Danish pension funds. ATP and LD are not included. Source: Finanstilsynet and own contribution

2.2.2 Danish pension schemes

Danish pension funds offer a variety of pension schemes. The different pension schemes vary in terms of both complexity and distribution of risk. We will not go in depth on all these individual schemes, but we will give a short overview of two main types, namely "traditional pension schemes" and "unit-link schemes". Traditional pension products are most widely used in Denmark today. However, the demand for unit-link schemes or so-called hybrids has increased sharply over the last years[6].

Traditional pension schemes are entirely managed by the pension funds. This means that the pension funds are fully responsible for the investment decision. The retirement savings are collected into one large asset pool and then invested in one mutual portfolio. However, the pension funds are subject to some basic principles. These are called the principle of average interest rate (AIR) and the principle of interest rate guarantee (IRG). These principles protect the pension savers against market fluctuations and ensure stability and predictability.

The AIR principle balances accumulated reserves and the interest paid to pension savers. The objective of AIR is to guarantee a stable interest on retirees invested savings. This is done by allocating return between periods. The pension funds set the AIR lower than the full annual asset return. This allows the pension funds to set aside money in periods with high return, and later use this money to average out years with lower returns. This minimizes the average interest volatility and ensures a stable return to pension savers. Pension savers are also protected against market fluctuations through the principle of IRG. IRG ensures a minimum fixed interest on the pension savings. This is done by setting a basis rate that the pension funds guarantees each year. The basis rate varies between pension savers depending on time of initial agreement. If the annual return is lower than the guaranteed rate, the gap will be covered by reserve funds. This principle guarantees a certain future return that all pension funds with this guarantee are legally required to pay out.

Unit-link schemes are based on a market rate principle. In schemes based on an AIR principle, members assume the risk collectively, whereas in market rate schemes the individual bears the full risk. This means the funds are not subject to AIR and IRG. These pension schemes do not therefore guarantee any future income. The return is solely dependent on the market fluctuations, and retirees might experience higher returns in periods, but lower returns in other periods. Consequently, the risk of these pension schemes is

[6] Numbers from Danish Insurance Association "Unit-link insurance" (2012)

higher than the traditional pension schemes. One of the main attractions of these schemes is that they allow the individual retirees to have free choice in the investment decision. The individuals have the possibility of individualizing the pension scheme. The pension funds are responsible for selecting investment pools, but the customer is responsible for choosing the investment pool that suits their own risk preference. However, this also places the full market risk on the individuals. Consequently, these schemes impose a major risk on the retiree as the savers are fully exposed to market fluctuations.

There has also been an increasing popularity for so called Unit-link hybrids. Many new unit-link products have been developed during the last few years, and these often come with different types of hedging options. Most often, these are unit-link schemes embedded with IRG or some other kind of minimum interest guarantee such as guarantee against negative returns. These allow the retirees to hedge risk and thereby reduce the volatility of the investments. This places exposure to both the savers and the pension funds.

2.3 Importance of Danish pension funds

The Danish pension fund sector is an integral part of the Danish economy. First of all, pension funds are capital intensive and represent large institutional investors in the financial markets. Professionally managed institutions help ensure that the capital markets are well functioning. Institutional investors are known to improve price discovery, increase allocative efficiency, and promote management accountability[7]. Institutional investors provide capital to businesses and provide stock markets with liquidity. Because of the long-term nature of their financial liabilities, pension funds are a unique source of long-term capital. Secondly, institutional investors have a lot of influence in the management of individual companies or corporations because, as shareholders, they are entitled to exercise voting rights in a company. Consequently, Danish pension funds ensure good health and competitiveness in the financial markets. Well-functioning financial markets are essential for economic growth.

Figure 3 shows the relative size of the Danish life-insurance and pension funds, investment funds, non-life insurance companies and banks as measured by financial assets. We note that the pension fund sector is twice as big as investment funds in terms of assets. This confirms the dominating market position that pension funds possess when they engage in investments.

[7]SEC (2013)

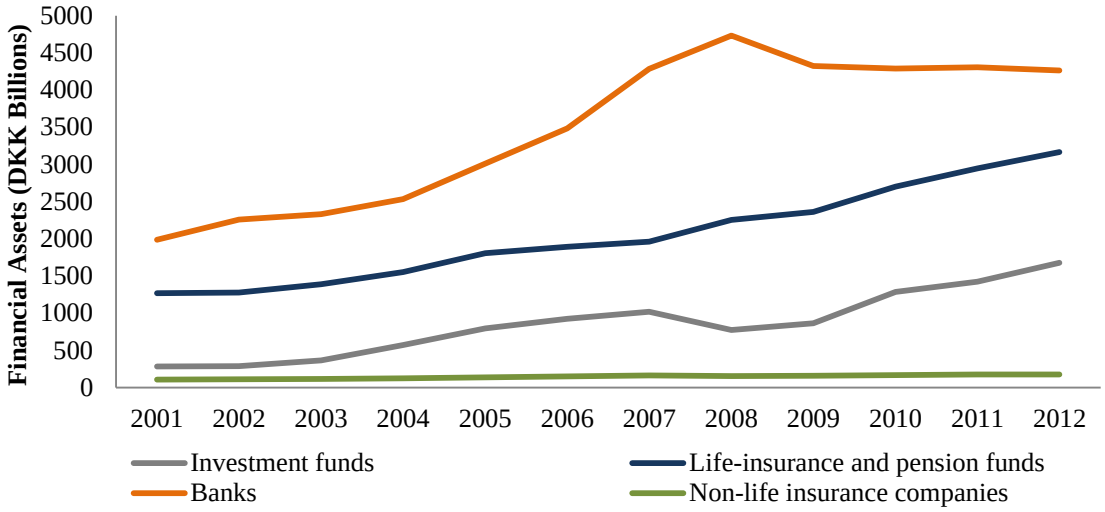

Figure 3: The graph shows the relative sizes of the life-insurance and pension fund compared to investment funds and banks in terms of total financial assets. Source: Statistics Denmark and own contribution

In 2012 the total pension assets consisted of over 3600 DKK billions[8], almost double the Danish GDP. This shows the relative importance of Danish pension funds. Approximately 2/3 of these assets are managed by individual pension funds, while ATP and banks manage the last 1/3. Figure 4 shows the size of the pension sector, measured as total assets as a percentage of GDP over the last 10 years. This graph shows how the growth in total pension assets has outgrown GDP since the beginning of the century.

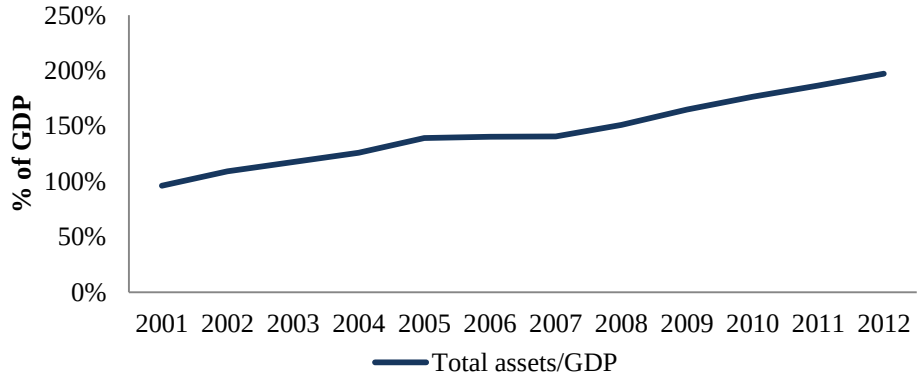

Figure 4: Shows the total assets as a percentage of GDP. Source: OECD and own contribution

The asset allocation in Danish pension funds has varied over time. This is a natural consequence of financial markets that are in constant change. The professional fund managers will always try to invest in

[8] OECD Statistics: Pensions statistics

a combination of assets that gives the highest risk-return ratio. As asset returns change considerably over time, the asset allocation will also differ. However, the risk management is extremely important in pension funds, so we should only observe small changes in asset allocations. All Danish Pension funds are supervised by The Danish Financial Supervisory Authority (The Danish FSA). In addition, the pension funds are under strict legal regulation from the government, including specific restrictions on portfolio investments. This will be covered in the next section.

Figure 5 shows the asset allocation in Danish pension funds from 2002-2012. We can see that the most important asset classes are equity and fixed income (bills and bonds). The equity allocation has been considerably reduced since the subprime crisis in 2007. The allocation of bills and bonds had an all-time high in 2009, but has been reduced somewhat in the past few years. However, it is still by far the biggest asset class. The high asset allocation to fixed income is natural. Life-insurance companies and pension funds usually have long-term liabilities that they wish to hedge, which requires low risk and predictable cash flows.

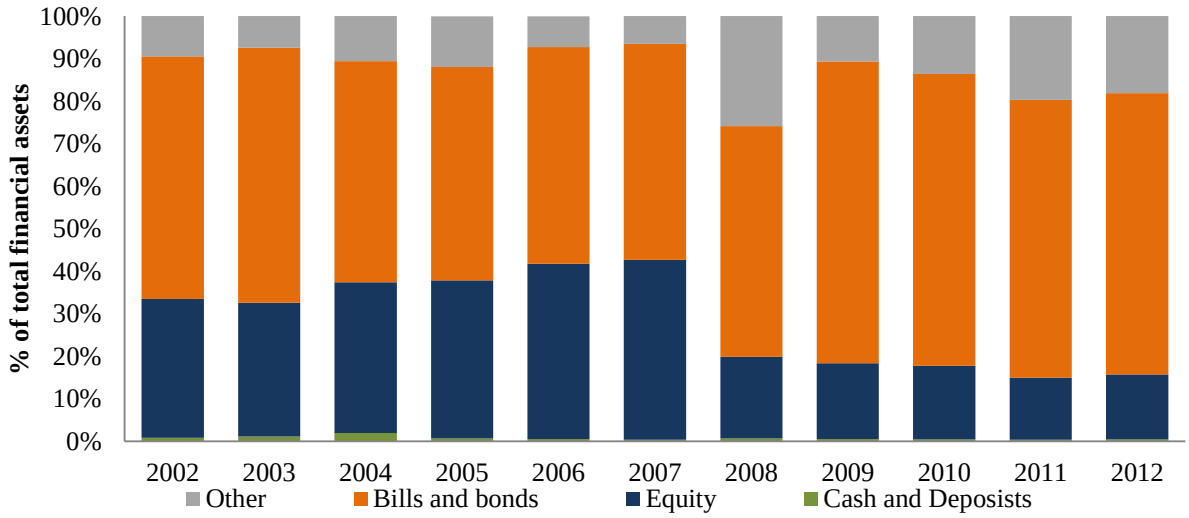

Figure 5: Shows the historical asset allocation in Danish pension funds. Equity and fixed income represent the largest asset classes. Source: OECD Statistics and own contribution

In addition, pension funds play an important role for social security and people's everyday life. First, pension funds enable individuals to smoothen out consumption. The individuals transfer consumption from their productive years to their retired years. This ensures that people have the available capital when it is needed the most, thus contributing to stabilizing the purchasing power of the population. Furthermore, statutory pension funds ensure a minimum level of wealth for all retired individuals. This contributes to

social and macroeconomic stability. It also relaxes the tax system, as it enables the government to bring in tax revenue, even after individuals have retired. This evens out the taxable income and makes it more predictable. The government has recognized this importance by providing pension savings with beneficial tax treatment.

The long-term liabilities of Danish pension funds mean that they will be an important factor in determining the future economy of Denmark. Most Danish individuals are extremely dependent on their private retirement savings and how these contributions are managed. If Danish pension funds goes into a financial crisis, where large parts of the assets are wiped out, this could have fatal consequences for the overall economy. It would lead to higher government costs and funding needed to cover the massive investment losses. This could result in tax increases or reductions in funding for other government programs. Pension savings levels, buying power and social wealth are likely to be affected. In short, it could have a devastating effect on the Danish economy.

It is also a fact that Denmark has an increasingly elderly population. The increase in elderly people is significantly higher than the increase in working-age people. This means that there will be relatively more people claiming pension benefits and less people working and paying pension contributions. Table 2 shows that the dependency ratio[9] is expected to increase from today's 26 percent to 43 percent in 2050.

Age group	2013	2020	2030	2040	2050	Increase 2013-2050
Total	5 602 628	5 725 179	5 923 334	6 055 717	6 135 809	10 %
0-9 years	642 476	604 760	694 975	690 894	664 459	3 %
10-19 years	693 344	668 696	613 750	704 080	700 090	1 %
20-29 years	681 847	761 145	731 152	679 924	772 205	13 %
30-39 years	700 034	659 887	772 091	746 769	698 115	0 %
40-49 years	815 894	742 148	648 974	762 359	738 782	-9 %
50-59 years	727 751	790 489	718 582	626 199	740 446	2 %
60-69 years	693 516	663 657	743 447	681 548	596 966	-14 %
70-79 years	415 083	563 265	576 064	664 524	621 653	50 %
80-89 years	192 051	223 957	360 846	388 171	472 284	146 %
90-99 years	39 623	45 964	61 624	108 278	125 003	215 %
100 years or more	1 009	1 211	1 829	2 971	5 806	475 %
Dependency ratio	26 %	31 %	37 %	43 %	43 %	

Table 2: Shows the forecasted population growth in Denmark. The dependency ratio is expected to increase. Source: Statistics of Denmark and own contribution

[9] Dependency ratio is calculated as the non-working population divided by the working population

This mismatch will be one of the biggest challenges facing the pension industry in the years to come, and it is putting extra pressure on the profitability of the funds' investments. This will also have serious consequences on the general economy, as it will lower both labor-force participation and savings rates. There will be less people paying income taxes and this will put extra pressure on the current, shrinking workforce. This brings major concerns about the economic growth in the future.

2.4 Legal Implications

This section will give the reader a general overview of the legal regulation. However, the focus will be with regards to asset allocation in pension funds. The legal framework surrounding the pension system is of high importance as it lays restrictions on the investment strategies in the pension funds. This limits the investment opportunities in Danish pension funds and affects both return and risk.

Danish pension funds are under extensive regulation .The purpose of the legal regulation is to limit the pension fund sectors' exposure to risk. This is done by forcing restrictions on the risk profile of each pension fund. The overall objective is to protect pension contributors against losses, so they can be certain of the pension returns. The law also ensures transparency in the market, intended to result in a well-functioning pension system that contributes to financial stability.

The Danish FSA is responsible for the supervision of pension funds in Denmark. The Danish FSA ensures compliance with financial legislation. The Danish FSA reports to the minister, the Ministry of Business and Growth as well as the financial council. The main activities of The Danish FSA include supervision, regulation and information gathering. The Danish FSA publishes sector health reports on a regular basis. The most important supervisory activity is monitoring that undertakings have adequate own funds to cover their risks (supervision of solvency)[10]. This ensures financial stability and confidence in financial undertakings and markets.

In addition, life insurance and pension funds are subject to the "Lov om finansiel virksomhed" (FIL), which also includes directives issued by the European Union. FIL is a joint act for financial institutions and also include rules for mortgage lenders, insurance companies and investment companies. This law includes many restrictions regarding liquidity and solvency as well as placement of capital. Examples are how much can be invested in different assets groups, as well as restrictions on the amount that can be

[10] Danish Financial Supervisory Authority (2012)

invested in different currencies. However, this section only focuses on the most central ones. It should be noted that these restrictions only apply to pension fund with interest rate guarantee, as regulated in § 166. Interest rate guarantee is pension products with a guaranteed rate of return, often referred to as traditional pension products[11].

Article **§ 158** and **§ 159** are general regulations. Article **§ 158** states that capital must be invested in an appropriate and suitable way so that there is a sufficient security to ensure that the company is able to meet its future obligations. Article **§ 159** further states that all insurance companies and pension funds must have a group of assets with a total value, at any time, that minimum equals the value of the company's future liabilities. Article **§ 162** further regulates what kind of assets can be included amongst the assets covered by **§ 159**.

The most important restriction in regards to equity allocation is article **§ 163**. It states that a minimum of 30 percent of the assets needs to be invested in safe assets[12]. That leaves a maximum 70 percent of the total assets to be invested in equity. However, the 70 percent limit only applies to a selection of pension funds. These pension funds are stress tested to ensure their financial strength. Further, only 10 percent of the total assets are allowed to be invested in non-zone A[13] countries, and a maximum of 10 percent can be invested in non-listed limited companies.

Article **§164** limits the maximum share in individual assets. The most important restrictions include a maximum of 40 percent share in mortgage bonds. Further, a maximum of 3 percent can be invested in one and the same company, if the company is located and listed in a Zone-A country, and has an equity value of minimum 250 million DKK. Lastly, maximum of 5 percent can be invested in real estate.

Article **§165** sets further limitations on the asset allocation. A minimum of 80 percent of assets should be placed in the same currency (DKK) as the liabilities. However, if the assets are placed in either Euro, or one of the countries not included in European Monetary Union (EMU) only 50 percent of the 80 percent have to be invested in DKK. Consequently, 60 percent of the assets can be invested in foreign currencies.

[11] See section 2.2.2
[12] Low risk investments such as government bonds in Zone A, mortgage bonds in EU, index bonds in EU, and real estate.
[13] Zone A countries: Australia, Belgium, Canada, Cyprus, Denmark, USA, UK, Estonia, Finland, France, Greece, Ireland, Iceland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Saudi Arabia, Switzerland, Slovakia, Slovenia, Spain, Sweden, South Korea, Czech Republic, Turkey, Germany, Hungary, Austria. Source: The Danish Financial Supervisory Authority

It should be noted that a foreign stock with a forward contract, is considered a hedge against the currency risk, and is therefore not limited by the legal restrictions.

In October 2008 a ban on short selling was imposed in Denmark. The ban was introduced in the context of the general government guarantee to ensure financial stability, reduce the stock market turbulence and avoid short-term speculation in price declines that may have a cumulative effect[14]. The EU lifted the ban in November 2012. However, the EU Regulation still bans naked short selling of shares and sovereign debt. Furthermore, all companies and individuals of short positions are obliged to notify the Danish FSA. For pension funds, this does not affect the asset allocation, as numbers[15] from The Danish FSA shows that Danish pension funds do not engage in leveraged positions.

It is important to note that the restrictions of FIL only apply to the overall portfolio of Danish pension funds and not specifically to the equity part of the portfolio. As the larger part of the overall portfolio consist of other asset classes than equity[16] the legal restrictions introduced in this section will not be included in the men-variance model. However, the short sell ban will be included in the model. This will be explained in section 6.1.3.

3.0 Modern Portfolio Theory and International Diversification

To be able to fully understand the problem of home equity bias in portfolio allocation, an understanding of international diversification is required. This chapter explores the fundamental theory behind, and the benefits of international diversification.

3.1 Modern Portfolio Theory

Modern Portfolio Theory (MPT) was first introduced by Harry Markowitz in 1952[17] through his mean-variance model. Thirty-eight years later, he shared a Nobel Prize in Economics with Merton Miller and William Sharpe for what has become a cornerstone of portfolio theory and the dominant asset allocation model.

[14] Danish Financial Supervisory Authority (2012a)
[15] The Danish FSA Company Announcement Database
[16] See figure 5
[17] Harry Markowitz (1952)

The fundamental goal of portfolio management is to optimally allocate investments between different assets. MPT introduced the trade-off between risk[18] and expected return[19] in portfolio allocation. MPT states that assets in an investment portfolio should not be chosen based on their individual characteristics. Instead, an investor should consider how the asset changes in value relative to the other assets in the portfolio. An investor should diversify and spread his wealth over a variety of assets. This allows investors to maximize returns while minimizing risk.

MPT focuses on the assets' correlation coefficient[20], which give rise to diversification effects. Before Markowitz's work in 1952 there was no theoretical foundation to validate the effects of diversification. Correlation estimates are today required in most applications in finance such as asset pricing models, capital allocation, risk management, option pricing and hedging. By combining different assets whose returns are not perfectly positively correlated, the total variance of an investor's portfolio return can be minimized.

$$\sigma_p^2 = \sum_{i=1}^{N} X_i^2 \, \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} X_i \, X_j \sigma_i \sigma_j \, \rho_{ij}{}^{21}, \quad \text{where } \rho_{ij} = \frac{\sigma_{ij}}{\sigma_i \sigma_j} \quad (1)$$

From equation (1) we can see that the portfolio variance is a function of proportion in each asset weight (X), standard deviation of each asset (σ) and the correlation between the assets (ρ). Correlation is measured from a scale from -1 to +1, where -1 represents perfect negative correlation and maximum diversification effect and +1 represent no benefits of diversification. Consequently, non-perfect correlations give rise to potential diversification effects and thereby reduce risk. This can be done without compromising the expected return of the portfolio. Hence, in selecting an optimal portfolio, the investor need to consider how the co-movement of individual asset returns affects diversification opportunities.

Variance is the basic measure of the risk of a financial asset. The greater the variance of a portfolio, the greater the uncertainty or risk of the portfolios is. It is common to express the level of risk as standard deviation. The standard deviation is the square root of the variance.

[18] Risk is defined by the asset volatility, i.e. the variance of the asset (σ^2).
[19] Expected return: $E(R_{p)} = \sum_{i=1}^{N} X_i E(R_i)$ Elton et al (2013), p. 132
[20] Correlation coefficient: $\rho_{ij} = \frac{\sigma_{ij}}{\sigma_i \sigma_j}$, Elton, Gruber, Brown, & Goetzmann (2013), p. 143
[21] Elton et al (2013), p. 127

$$\sigma_i = \sqrt{\sigma_i^2} \quad (2)$$

3.1.1 Diversification and the elimination of unsystematic Risk

The purpose of diversification is to reduce the standard deviation of the overall portfolio. As non-perfect correlated assets are added to the portfolio it will spread out exposure and thereby reduce the total risk[22]. To fully understand diversification it is important to differentiate between systematic and unsystematic risk. Unsystematic risk, also referred to as firm-specific risk, is the unique risk that faces each company. With portfolio diversification, the unsystematic risk can be reduced to arbitrary low levels. This can be showed mathematically by writing the portfolio variance as a function of the number of assets (n). For simplicity we assume that all assets have a common standard deviation (σ) and that all asset pairs have a common correlation coefficient (ρ). $\rho\sigma^2$ represents the covariance between all pairs of securities.

$$\sigma_p^2 = \frac{1}{n}\sigma^2 + \frac{n-1}{n}\rho\sigma^2 \quad [23] \quad (3)$$

Equation (3) shows that as n becomes greater, the risk of the portfolio will approach $\rho\sigma^2$. The lower limit of risk is therefore the $\rho\sigma^2$, which will be the systematic risk. As a result, all unsystematic risk will be eliminated.

A completely diversified portfolio such as the market portfolio has all the unsystematic risk eliminated. Though, even with a large number of assets it is not possible to avoid risk altogether. The risk that remains even after extensive diversification is called systematic risk, often referred to as market risk. This is the risk that is attributable to market wide risk sources, such as common macroeconomic factors. This can be shown graphically:

[22] Total risk = Unsystematic risk + systematic risk
[23] Zvi Bodie, Alex Kane (2011), p. 246

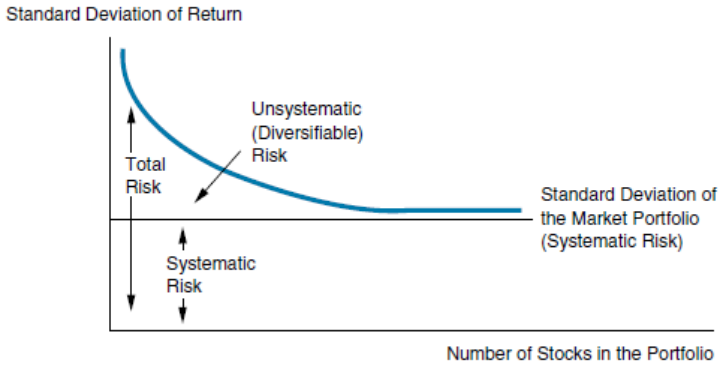

Figure 6: Diversification eliminates unsystematic risk, but the systematic risk cannot be eliminated. Source: Reilly & Brown (2003), p. 245

3.1.2 Efficient frontier – benefits of diversification

The benefits of diversification can be illustrated by the Markowitz efficient frontier[24]. The full mean-variance framework will be covered in section 6.1.3 of this thesis, as it will serve as one of the reference models for our home equity bias analysis. Based on expected return (E(r)), variances (σ^2) and covariance's (σ_{ij}), the efficient frontier of risky assets can be calculated. The efficient frontier is a selection of assets that deliver the greatest return for a given level of risk. Figure 7 shows graphically that a lower variance is achieved by holding a combination of individual assets.

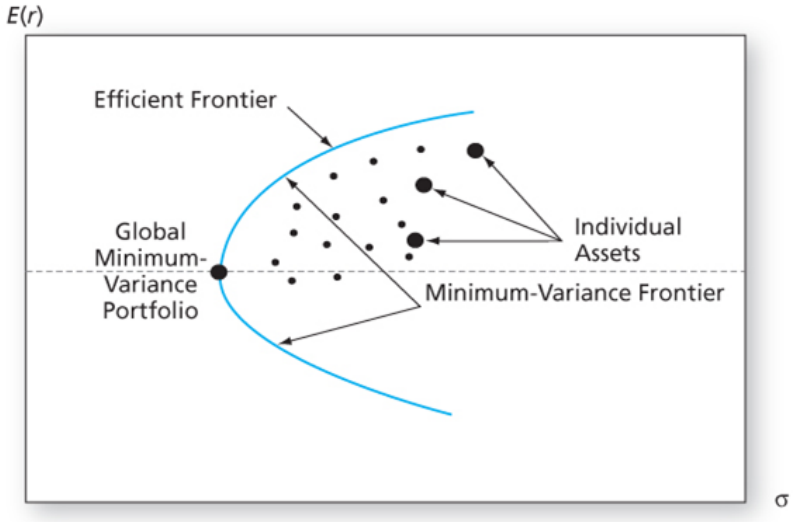

Figure 7: The figure shows the efficient frontier. Only portfolios on the efficient frontier are optimal as they provide the best risk-return combinations. Source: Zvi Bodie, Alex Kane (2011), p. 239

[24] Harry Markowitz (1952)

The efficient frontier shows the lowest possible variance that can be achieved for a given expected return. The lowest variance is achieved by holding the minimum-variance portfolio. The figure shows that diversifying investments lead to portfolios with higher expected returns and lower standard deviations. It should be clear that only portfolios lying on the efficient frontier are optimal as they provide the best risk-return combinations. These portfolios are called efficient portfolios.

3.2 International diversification and correlation of global markets

One will not obtain an optimal portfolio through a combination of domestic assets. Empirical studies build a strong case for international diversification. Investors should diversify their portfolio across industries, currencies and nations. Early research by Lessard (1974) found that only a small proportion of the variance of national portfolios is common in an international context, which gives rise to considerable risk reduction through international dimension. As D. Lessard (1983) later points out, a significant part of risk that cannot be diversified within a single country can be removed through international diversification. Further, B. H. Solnik (1995) concluded that the gains from international diversification are substantial. The study found that, in terms of variability of return, an internationally well-diversified portfolio would be one-tenth as risky as a typical security and half as risky as a well-diversified portfolio of U.S. stocks, with the same number of holdings. It should be clear that investors who do not take full advantage of international diversification bear risk that easily could have been diversified away.

Risk reduction is possible through international diversification because the returns of different stock markets around the world are not perfectly positively correlated[25]. Economic, political, institutional and even psychological factors affecting equity returns tend to vary greatly across countries. We therefore expect smaller return correlations between investments in different countries than between investments within a given country. This non-perfect correlation relationship between global markets gives rise to high diversification effects, and hence greater efficiency. Several studies have investigated the correlation between international markets. All of them have found support of the hypothesis of non-perfect correlation between international equity markets. Grubel (1968) investigated correlation between different markets compared to the US. He found that U.S. investors could achieve better risk and return opportunities by investing part of their portfolio in foreign equity markets. Further, Levy & Sarnat (1970) analyzed international correlations for 28 countries. The study found less than perfect correlation between all

[25] Prenhall (2013), p. 16

markets. Further, Grubel and Fadner (1971) showed that industry correlations within countries exceed industry correlations across countries.

The effects of international diversification can be illustrated by comparing the domestic efficient frontier with the international efficient frontier. Figure 8 shows that diversifying internationally makes it possible for an investor to even further reduce risk and gain a higher return.

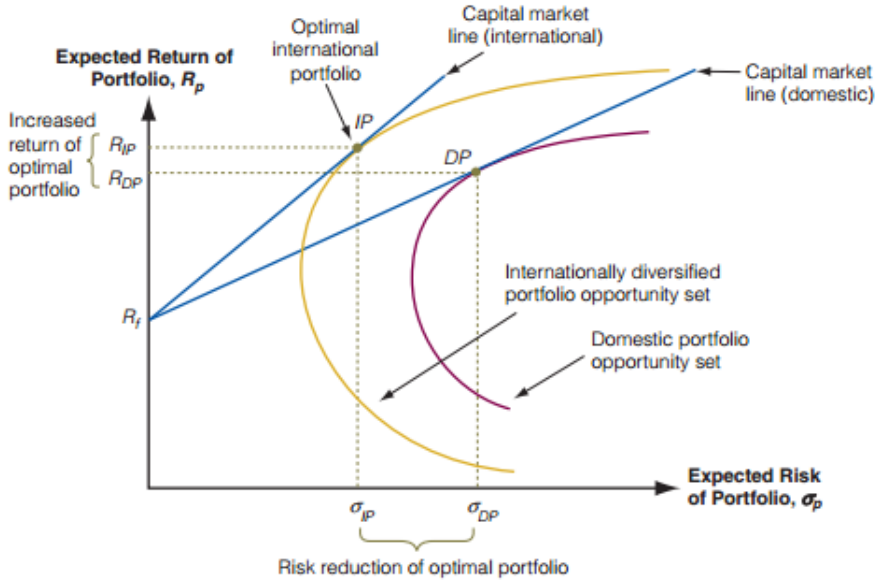

Figure 8: The internationally diversified portfolio opportunity set shifts leftward of the purely domestic opportunity set. The optimal international portfolio is superior to the optimal domestic portfolio. Source: Prenhall (2013), p. W-8

At any point on the efficient frontier of the internationally diversified portfolio opportunity set, the investor can find a portfolio of lower expected risk for each level of expected return. By comparing the domestic optimal portfolio (DP) with the international optimal portfolio (IP) it is clear that the international portfolio possesses both higher expected return and lower standard deviation compared to the domestic portfolio.

3.3 Capital Asset Pricing Model and the Capital Market Line

Markowitz' idea of the efficient frontier, however, did not take into account the risk-free asset. Based on the work of Harry Markowitz (1952), Sharpe, (1964) and Lintner (1965) introduced and formalized the Capital asset pricing model (CAPM). The attraction of the CAPM is that it offers powerful and intuitively

pleasing predictions about how to measure risk and the relation between expected return and risk[26]. CAPM represents an important perspective to modern choice of asset allocation and is widely used in portfolio management.

The model includes a number of simplifying assumptions. Among the main assumptions is that all investors are rational, they have equal access to information, they have the same expectations and equal utility functions. Further, there are no transaction costs, taxes or exchange rate risks. The CAPM has been criticized for several reasons, especially in regards to the reality of these assumptions. The CAPM is still useful because it provides an analytical representation of the theoretical properties of equilibrium in capital markets. The model can be shown mathematically as:

$$E(R_i) = R_f + \beta_i\big(E(R_m) - R_f\big)^{27} \text{ , where } \beta_i = \frac{Cov\big(R_i, Rm\big)}{Var\,(R_m)}^{28} \quad (4)$$

This formula expresses the expected return on a financial asset as the sum of the risk-free rate and a risk premium$(E(R_m) - rf)$, which compensates the investor for the systematic risk of the financial asset (β_i). A high beta indicates a steep slope, and thus the asset has a higher expected return due to the corresponding higher risk due to high co-variation with the market. The opposite can be said by a low beta. The CAPM assumes that investors hold fully diversified portfolios, and investors are therefore only rewarded for bearing systematic risk because it cannot be diversified away. The CAPM further assumes that all investors can borrow and lend as they please at the same risk free rate. This increases the allocation opportunities of the investor and makes the investor able to obtain an even higher risk-return ratio than otherwise possible.

J. Tobin incorporated the risk free asset in the efficient frontier in 1958[29]. This made it possible to leverage or deleverage portfolios on the efficient frontier. This is done by combining the risk free rate with the tangent portfolio. The tangent portfolio is the portfolio with the highest Sharpe ratio[30]. The slope of this line is exactly the Sharpe-ratio of the risky portfolio. This can be shown graphically by the capital

[26] Fama & French (2004), p. 25
[27] Zvi Bodie, Alex Kane (2011), p. 321
[28] Zvi Bodie, Alex Kane (2011), p. 322
[29] Tobin (1958)
[30] $Sharp\ ratio = \frac{E(r_p) - r_f}{\sigma_p}$ Zvi Bodie, Alex Kane, 2011, p. 200

market line (CML). The intuition from CAPM implies that all investors should simply hold portfolios that lie along this line. To be somewhere on the CML, you initially need to invest in the market portfolio (M).

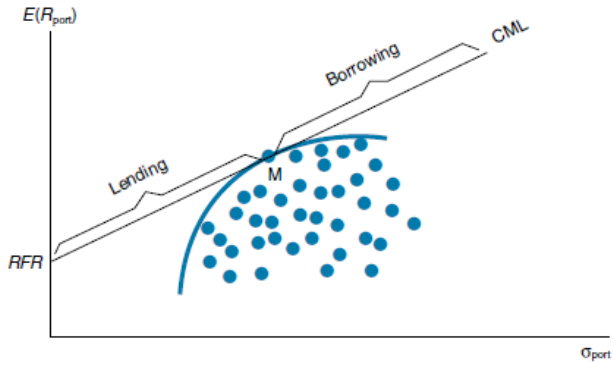

Figure 9: Shows the efficient frontier, including risk free asset illustrated by the CML Source: Reilly and Brown (2003), p. 243

From the figure it is easy to see that an investor will hold a combination of the risk free rate and the tangent portfolio, choosing a proportion in each that will satisfy the risk tolerance of the specific investor. The risk averse investor will lend some part of the portfolio at the risk free rate (RFR) by buying some risk free securities and investing the remainder in the market portfolio of risky assets. The more risky investor will borrow funds at the RFR and invest in the market portfolio, thereby increasing expected return while simultaneously increasing risk.

According to CAPM, all investors should hold the market portfolio. This market portfolio includes all traded assets. If all investors select the same portfolio, then in equilibrium that portfolio must be the market portfolio. All investors will choose to hold a portfolio of risky assets in proportions that duplicate representations of the assets in the market portfolio. This automatically implies that each asset has a weight corresponding to the assets overall market capitalization as a percentage of the entire market value. The market portfolio is therefore a value-weighted portfolio comprised of all risky assets in the market.

3.4 International Capital Pricing Asset Model

Solnik (1974) and Sercu (1980) developed an extension of the capital asset pricing model. This model is called the International Capital Pricing Asset Model (InCAPM). The standard CAPM assumes that all investors measure risk and return in the same currency. This is obviously not realistic in an international perspective and the model is therefore not applicable to international investments. Therefore, the InCAPM

takes exchange rates into account. The model takes into account that investors "think" in different currencies. In the model investors have homogeneous expectations to exchange rate variations and returns. The model can be written as:

$$E(r_j) - r_f = \beta_j * [E(r_w) - r_f] + \sum_{i=1}^{N-1} \delta_{j,s_i}[E(s_i + r_i) - r_f] \quad [31] \quad (5)$$

Where $E(r_j)$ is the expected return on asset, $E(r_w)$ is the expected return on the world portfolio, β_j is a measure of the systematic risk, N is the number of countries in the world, s denotes the exchange rate change, r is the risk-free rate of reference country N and δ is the relative exposure to each exchange rate.

The model implies that risk and returns are influenced by different currencies, i.e. it allows deviations from purchasing power parity[32]. Movements in exchange rates will therefore influence the portfolio allocation decision. However, the model assumes that each country's currency risk can be perfectly hedged by a domestic risk-free bond. Consequently, all investors will hold the world market portfolio of risky assets. The results of the InCAPM will coincide completely with CAPM if purchasing power parity holds at all times, because the expected real return will not be affected when measured in a common currency.

The model assumes perfect capital markets, including no barriers such as transaction costs, capital controls, taxes and asymmetric information. Although the assumptions in the model are strict, the model provides important intuition. This model will also work as a reference model when we later discuss the home equity bias. First of all, InCAPM suggest that all investors should hold a globally diversified portfolio. Secondly, in the model currency risk can be perfectly hedged by investors' own risk-free asset, implying that all investors hold a portfolio of risky assets that exactly equals the world market portfolio. The world market portfolio is the portfolio of all securities in the world weighted by their share of the total market capitalization. Consequently, domestic asset allocation should equal the relative country share in the global market share.

[31] Sercu & Vanpée (2007), p. 3
[32] Purchasing power parity: Nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries.

4.0 The Case against International Diversification

From the previous chapter we know that low correlation between international markets give rise to benefits of diversification. We therefore expect Danish pension funds to fully exploit these opportunities and hold international portfolios in accordance with the theory. However, it is often argued that the benefits of international diversification are overstated because markets tend to be more interconnected than previously suggested. More recent research suggests that international correlations are rising, because economies and financial markets are becoming increasingly integrated. In addition, several studies have found that international correlations are higher in periods with higher market volatility. If these findings also apply to Denmark they might represent reduced benefits of international diversification for Danish pension funds.

This chapter will investigate the main critique against international diversification. We will start by giving an overview of the evolution of global financial markets, as well as presenting some of the most prominent research. Further, we will perform a correlation analysis between Denmark and international markets for the period 2003-2012. The purpose of this analysis is to investigate the hypothesis of increasing correlations, and correlation breakdown effects during the subprime crisis. This allows us to identify the true benefits of international diversification for Danish pension funds and how this has changed over time.

4.1 Globalization and increasing correlations

One of the main critiques against international diversification is that correlations are rising over time as the globalization evolves and the world economy becomes increasingly integrated. Correlations are influenced by factors such as international trade, economic growth, fiscal policy and monetary policy. These factors change over time, and we therefore expect correlations to change over time as well. Global integration of international markets has become more and more prominent over the last decades. Globalization has provided a foundation for more interaction between different markets and has opened up the opportunity to invest in global markets. Domestic boundaries are becoming less important as the world becomes increasingly integrated. Domestic markets that used to be segmented are now globally interconnected. International trade and cross-border investment flows are the main elements of this integration.

This evolution has mainly been driven by technological advances, reduced cost of making transactions across borders and distances, as well as the increased capital mobility. As international markets become globally integrated, corporations become increasingly global in their operations. This has allowed companies to take advantage of global opportunities. Consequently, more and more firms are multinationals, pursuing global strategies. As a result of the increasing integration of the world economy, tremendous growth of international trade has been observed since 1950. Numbers from WTO shows that world trade has grown twenty-seven fold in volume terms since 1950, three times faster than world output growth[33]. Consequently, the share of international trade in world GDP has risen from 5.5 per cent in 1950 to 20.5 percent in 2006[34].

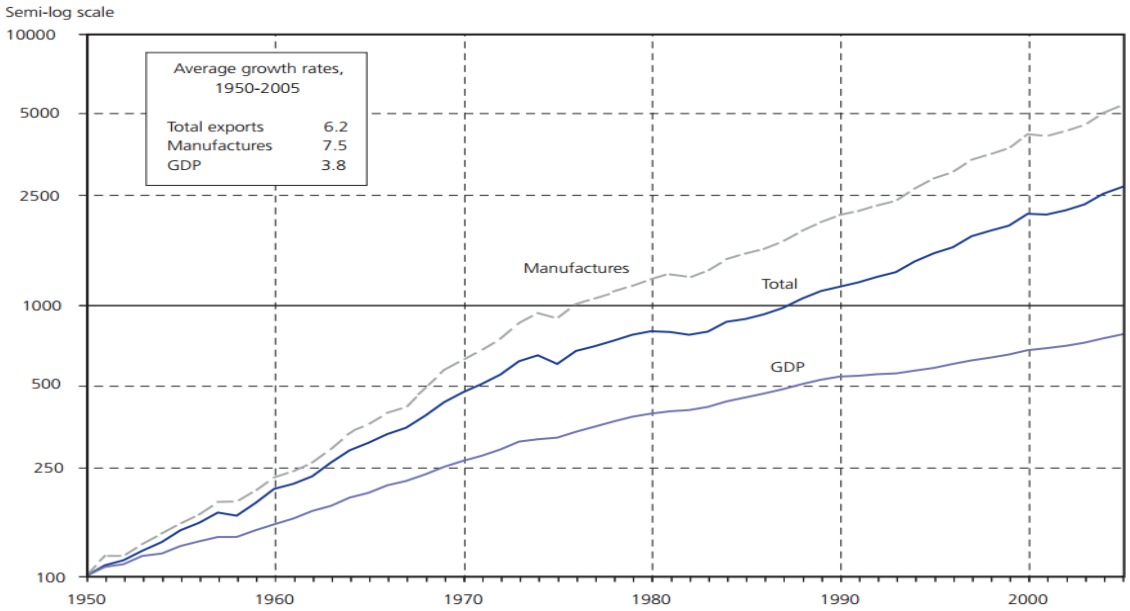

Figure 10: World trade has grown twenty-seven fold in volume terms since 1950, three times faster than world output growth Source: WTO (2007), p. 44

Financial globalization has also evolved at a rapid pace over the past few decades. Numbers from McKinsey Global Institute shows that the global asset market has more than quadrupled since 1990, and has now a total value of 225 trillion U.S. dollars[35].

[33] WTO (2007), p. xxxii
[34] WTO (2014)
[35] McKinsey Global Institute (2013), p. 2

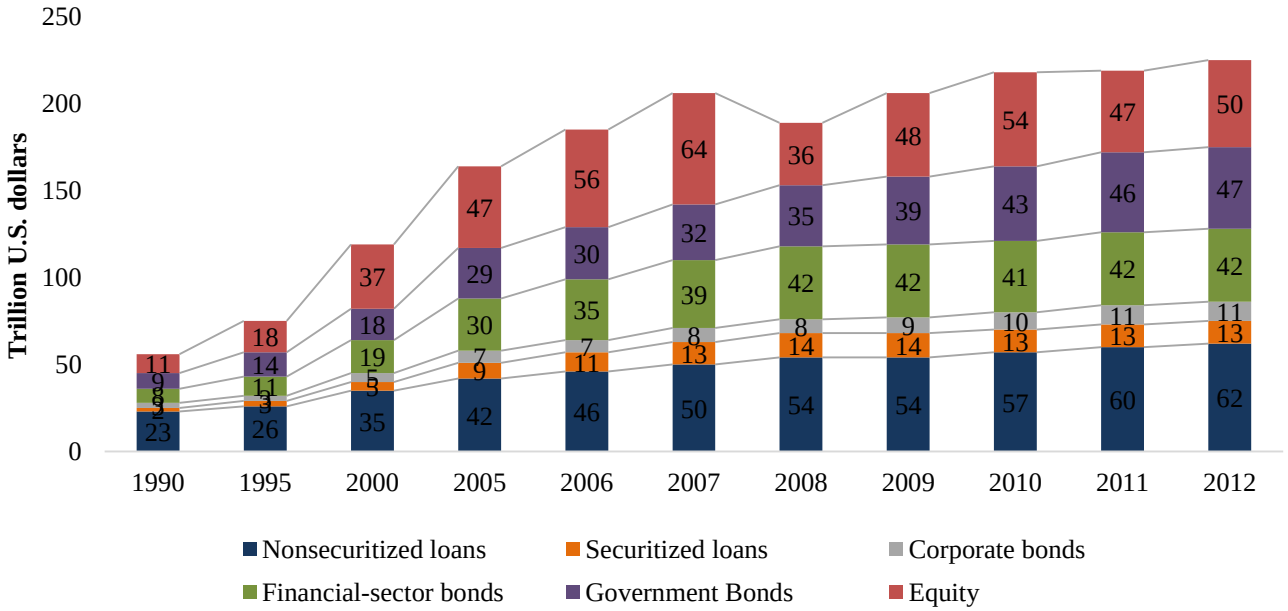

Figure 11: The global asset market has more than quadrupled since 1990, and has now a total value of 225 trillion U.S. dollars. Source: McKinsey Global Institute (2013) and own contribution.

Capital markets have been deregulated and opened to foreign investors. This has allowed investors to allocate resources globally in an efficient way. Economic growth and development of new foreign financial markets have resulted in endless global investment alternatives. The economic growth of emerging markets and increasing interest in emerging markets by companies in advanced economies have further boosted this development. Developments in information technology have made it possible for investors to get accurate and updated information about foreign markets, at a low cost. Further, transaction costs associated with purchase of foreign assets have been greatly reduced. There has also been a convergence of accounting standards and other legal rules. This has reduced the barriers to investing abroad. Consequently, many portfolio managers are now pursuing global investment strategies.

Denmark is a small and open economy highly dependent on trade with other countries. Foreign trade amounted to 103.8 percent of the gross domestic product (GDP) in 2012[36]. Further, Denmark is ranked number 6 of 187 in the KOF Index of Globalization. This index measures globalization based on actual economic flows, economic restrictions, information flows, personal contact and cultural proximity. Further, Denmark joined the European Union (EU) in 1973 and this has contributed to the integration of Denmark with other European countries. Trade with other EU countries accounts for almost 69% of its

[36] Santander Group (2014)

exports and 74 percent of its imports[37]. Denmark is also a member of The Organization for Economic Co-operation and Development (OECD) and The World Trade Organization (WTO). The overall goal of these economic organizations is to stimulate economic progress and trade between the member countries. As a result, national economies are becoming increasingly synchronized. There is therefore no doubt that Denmark is highly integrated in the world economy, especially the European economy. Further, the Danish stock market is small compared to the market capitalization of other stock markets (appendix 1). This gives us reason to believe the Danish stock market does not offer sufficient investing opportunities alone and therefore Danish investors' need to look abroad when choosing investing strategy.

Numbers from statistics of Denmark show that Danish equity assets in foreign countries have more than doubled since 2003, which reflects the growing interest for foreign equity.

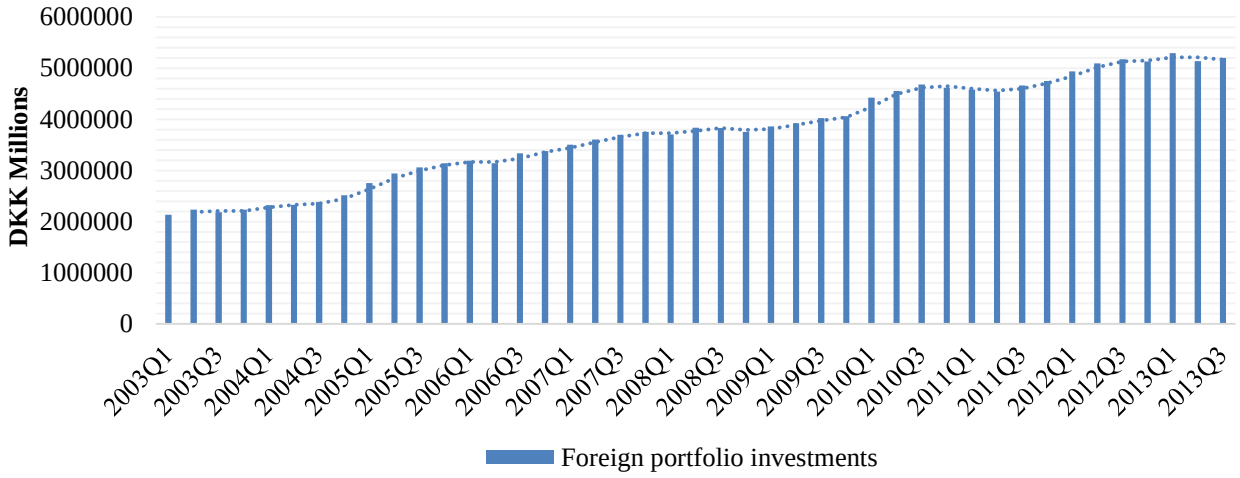

Figure 12: Shows the development in foreign equity holdings of Danish investors. The graph suggests an increasing interest in foreign equity. Source: Statistics Denmark and own contribution

As corporations become more global, it is not surprising to see the correlations between their stock prices increase. The shift towards a more integrated and interdependent global economy has increased the investment opportunities for investors. The number of markets is an important factor in determining the benefits of international diversification. However, it might also represent reduced benefits of international diversification.

[37] Practice Forex Trading (2014)

Several researchers have investigated this issue. Longin & Solnik (1995) studied eight major stock markets from 1960 to 1990 using a GARCH model. They found evidence that correlations are not constant and found a modest, but significant increase in international correlations over the period. Solnik, Boucrelle, & Fur (1996) studied correlations between U.S stock market and other international stock markets from 1958 until 1995. They find that the correlations have generally increased over the past 37 years, however not during the past 10 years. They also found that the growth of new markets partly offsets the trend toward increasing correlations. Solnik & Roulet (2000) found a positive trend for correlations between 15 developed stocks markets in the period from 1971-1998, but the regression is quite weak. Further, Goetzmann, Li, and Rouwenhorst (2005) investigated correlations of international equity markets over the period from 1850 to 2005. The researchers found that the international diversification potential in the twentieth century is very low compared to the rest of capital market history, as a result of higher correlations. However, there is still evidence of positive effects of international diversification. It is clear that there are observations that suggest increasing correlations, but the evidence is not clear-cut. This might be a possible issue for Danish pension funds. The hypothesis is that correlations between Denmark and international markets are increasing over time, which in turn affects the risk-return relationship for the international portfolio adversely.

4.2 Correlation breakdown

Another critique against international diversification is that correlations are increasing dramatically in periods of high market volatility. In other words, high volatility in the domestic stock market tends to be associated with high volatility in foreign stock markets. If this is true, the benefits of international diversification will be lower when they are needed the most. If all markets crash when the domestic market is crashing, there is little benefit to be internationally diversified. This phenomenon is often called "financial contagion" or "correlation breakdown".

Several studies have investigated this issue and found support for the hypothesis that correlations are increasing in periods of high market volatility. Solnik et al (1996) found support of volatility contagion across markets. However, despite the link between correlation and volatility it is important to note that they never found negative effects of international diversification. Later research by Longin & Solnik (2001), based on extreme value theory, found that correlation increases in bear markets but not in bull markets. Goetzmann, Li, and Rouwenhorst (2005) investigated correlations of international equity markets over the period from 1850 to 2005. They found that international equity correlations peaked in the

late nineteenth century, the great depression and the late twentieth century. Hwang, In, & Kim (2010) used a more advanced DCC-GARCH model to investigate contagion effects of the U.S subprime crisis on international stock markets. They found evidence of financial contagion during the U.S. subprime crisis as the correlations significantly increased during the crisis and these higher levels persisted for the remaining period of the crisis. Asgharian & Nossman (2011) examined the risk spillover from the U.S. market and the regional market to a number of European countries' equity markets. They found that correlation between European countries and the U.S has increased since the 1980s and that the increase is highest in times with high volatility. Gallegati (2012) examined whether contagion occurred during the US subprime crisis of 2007. Based on a wavelet correlation analysis they provide evidence of international contagion effects from the U.S. during the subprime crisis.

4.3 Correlation Analysis

In this section we present a correlation analysis between Danish equity assets and other international equity markets to investigate the two issues that we have previously presented. The first hypothesis we want to investigate is whether correlations between Denmark and international markets are increasing over time. The second hypothesis we want to investigate is that correlations are increasing in periods of high market volatility. In order to examine these hypotheses, we break the 10-year sample period of 2003–2012 into three sub periods. The first subset covers 2003-2006, the second covers the U.S. subprime crisis during 2007-2009, and the last one covers 2010-2012. This is the same approach as Goetzmann et al (2005).

To provide the reader with insight of how the general correlation between international equity markets has developed, we will start this part with a correlation matrix of all markets covering the selected sub periods. After a brief discussion of these results we move on to investigating hypothesis one, which focuses on the development in correlation between the Danish equity market and the international indices. Lastly, we do a comparison of the development in correlations between different sub periods to identify whether there was a larger increase during the period of the U.S. subprime crisis compared with the other sub periods, thereby checking if there is an indication of financial contagion.

For this analysis we have chosen to use the Pearson product-moment correlation (PPMC) method to calculate the correlation coefficients. Our reasoning for this choice of method is because of its wide use in economics and finance and for simplicity reasons. The correlation coefficient is calculated as:

$$r = \frac{\sum x_i y_i}{\sqrt{(\sum x_i^2)(\sum y_i^2)}} \quad [38] \qquad (6)$$

The correlation coefficient shows the linear relationship between two sets of data. The correlation coefficient is mathematically defined as the covariance of the two variables divided by the product of their standard deviations.

When applying PPMC, there are four assumptions that must be fulfilled in order for the analysis to be unbiased. These assumptions are (1) data is measured at interval level, (2) there is a linear relationship between the variables, (3) there should be no significant outliers and (4) that the data is normally distributed[39]. The first assumption is fulfilled as our data is numerical returns over time, and in appendix 3 you can see that the same conclusion holds for the second assumption. There are however two potential drawbacks with our analysis of correlation amongst returns. Firstly, we know that there are significant outliers as our data contains a period of financial crisis, thus violating assumption three. Although the assumption is violated, our large number of observations will minimize this effect. Of greater importance is the normality assumption, and in order to investigate whether this holds true for our data we have applied the same approach as Karoglou (2010). Specifically, he applied the Jarque-Bera (JB) test for normality of daily returns for 27 OECD-countries from 1994-2006. He found that for the 27 selected stock markets, all had the null hypothesis of normally distributed returns rejected, with corresponding p-values of less than 0.01 percent for all markets.[40]

In order to calculate the JB-statistics we need to obtain a measure for both the skewness and the kurtosis of the returns. The skewness can be measured through the following equation:

$$Skew = \frac{E(X-\mu)^3}{\sigma^3} \quad [41] \qquad (7)$$

where skewness measures the lack of symmetry of the probability distribution in the data.

[38] Gujarati & Porter (2009), p. 77
[39] Lund & Lund (2013)
[40] Karoglou (2010), pp. 85-86
[41] Gujarati & Porter (2009), p. 815

Kurtosis can be measured as:

$$\text{Kurtosis} = \frac{E(X-\mu)^4}{[E(X-\mu)^2]^2} - 3 \quad [42] \qquad (8)$$

where the value obtained indicates whether there are fat tails in our distribution, measuring if there is more probability mass in the tails of the distribution than predicted by the normal distribution.

The JB-test allows us to test numerically whether our return series are normally distributed, and the appropriate measure is:

$$JB = n * \left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right] \quad [43] \qquad (9)$$

Where n is the number of observations, S is the skewness and K is the kurtosis. The JB-test follows the chi-square distribution with two degrees of freedom, and the joint hypothesis is that S and K are 0 and 3, respectively.

	Jarque-Bera Statistics							
	MSCI DENMARK	MSCI AC ASIA PACIFIC	MSCI EUROPE EX DENMARK	MSCI SOUTH AFRICA	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI RUSSIA
Period	2003-2012	2003-2012	2003-2012	2003-2012	2003-2012	2003-2012	2003-2012	2003-2012
Skewness	-0,28	-0,43	-0,09	-0,32	-0,40	-0,48	-0,03	-0,58
Kurtosis	7,41	5,52	7,07	4,78	10,44	9,86	4,96	14,10
Jarque-Bera	2150,17	769,98	1802,06	390,20	6079,44	5209,74	417,43	13536,82
Critical Value	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99
H0 rejected	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Period	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012
Skewness	-0,47	0,03	-0,33	-0,33	-0,26	-0,09	-0,54	-0,04	0,07	-0,44	-0,57	-0,46	0,41	-0,12	-0,60	-0,41
Kurtosis	2,32	1,44	2,15	1,40	1,91	2,15	3,17	1,82	1,66	3,77	2,06	3,16	7,21	2,10	4,60	2,39
Jarque-Bera	58,12	79,19	50,01	97,38	63,11	24,46	51,99	45,25	78,77	43,94	93,54	28,13	797,53	28,22	174,20	33,55
Critical Value	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99	5,99
H0 rejected	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Table 3: Shows the Jarque-Bera statistics for the return data covering the period 2003-2012 Source: Own contribution and DataStream.

Similar to Karoglou's findings, we reject the null hypothesis of normally distributed returns for all our indices. The JB-statistics obtained are way above the critical level, mainly driven by the kurtosis. Thus, our series are far from normally distributed. Because of the financial crisis that occurred in the U.S. from 2007-2009 we would expect the market volatility to influence our statistics. In order to examine whether this has had a large effect on the distribution, we also calculated the JB-statistics for the sub period 2003-2006 and 2010-2012 (appendix 4). Subsequently, our JB-statistics are improved but are still not

[42] Gujarati & Porter (2009), p. 815
[43] Gujarati & Porter (2009), p. 132

sufficiently low for the data to follow a normal distribution. The implication from this result is that our findings from the correlation analysis will not be very robust, and should be interpreted with the knowledge that our data does not fulfill all of the assumptions of the model.

It should be noted that academic papers such as Zimmerman, Zumbo, & Williams (2003) claim that the standard Pearson correlation measure might be biased. The paper suggests that one should apply the Fisher correction method to stabilize the variance of the sampling distribution of the correlation coefficients. However, we used the Fisher approach and it did not alter our correlation estimates. Zimmerman showed that the bias decreases with sample size and this is most likely because of the large sample size we are using. It is also shown that the bias is estimated to be a maximum of 0.03-0.04. We do not therefore believe the bias will be large enough to alter the conclusion of our estimates anyway.

There are alternative estimation methods, such as the use of Spearman rank correlation, which avoids the assumption of normal distribution and outliers in the data. We applied this measure on our correlation estimates, which can be found in appendix 5, and it had a 10-15 percent negative effect on them. It did not alter our conclusions, as the trend was the same for both correlation estimates, with differences only in the level of correlation. However, Zimmerman showed that the Spearman estimates yielded an increased biased when applied to Monte Carlo estimates compared to the PPMC estimates[44], even for large sample sizes. Consequently, we do not focus our analysis based on this method on our data. Another alternative is suggested by Solnik & Roulet (2000), where they introduced the concept of cross-sectional correlation as a method to estimate global correlations. They argue that dynamic cross-sectional data gives a better estimate than time-series estimates. It has been shown that this model is hard to implement in practice, and we have therefore chosen not to pursue this methodology.

4.3.1 General development in correlation amongst international markets during the last then years

Table 4 shows the correlations between different equity indices. The correlation matrix was calculated by using return data over the prior 10 years 2003-2012, and all returns are denominated in U.S. dollars. We apply daily observations for different stock indices, as described in section 1.3. The returns are calculated using continuous compounding[45], and average correlations are calculated as moving average based on the three subsets. See appendix 6 for correlation calculations for each year.

[44] Zimmerman et al (2003), pp. 141-143
[45] Calculated as: $return_{t+1} = \ln (return_{t+1} / return_{t})$

2003-2006	MSCI Denmark	MSCI AC Asia Pacific	MSCI Europe ex Denmark	MSCI South Africa	MSCI North America	MSCI EM Latin America	MSCI FM Africa	MSCI Russia	Average
MSCI Denmark	**1,000**	0,394	0,656	0,515	0,238	0,454	0,019	0,316	
MSCI AC Asia Pacific		**1,000**	0,389	0,442	0,116	0,364	-0,040	0,248	
MSCI Europe ex Denmark			**1,000**	0,553	0,473	0,554	0,033	0,337	
MSCI South Africa				**1,000**	0,189	0,487	-0,001	0,400	
MSCI North America					**1,000**	0,555	0,013	0,155	
MSCI EM Latin America						**1,000**	0,025	0,359	
MSCI FM Africa							**1,000**	0,002	
MSCI Russia								**1,000**	
Average	0,370	0,273	0,428	0,369	0,248	0,400	0,007	0,259	0,294
2007-2009									
MSCI Denmark	**1,000**	0,529	0,869	0,746	0,464	0,712	0,031	0,672	
MSCI AC Asia Pacific		**1,000**	0,484	0,566	0,164	0,370	0,053	0,510	
MSCI Europe ex Denmark			**1,000**	0,791	0,580	0,771	0,019	0,709	
MSCI South Africa				**1,000**	0,408	0,680	0,045	0,706	
MSCI North America					**1,000**	0,747	-0,008	0,428	
MSCI EM Latin America						**1,000**	0,012	0,637	
MSCI FM Africa							**1,000**	0,013	
MSCI Russia								**1,000**	
Average	0,575	0,382	0,603	0,563	0,398	0,561	0,024	0,525	0,454
2010-2013									
MSCI Denmark	**1,000**	0,466	0,828	0,695	0,573	0,649	0,129	0,689	
MSCI AC Asia Pacific		**1,000**	0,480	0,497	0,287	0,444	0,217	0,502	
MSCI Europe ex Denmark			**1,000**	0,786	0,727	0,780	0,125	0,774	
MSCI South Africa				**1,000**	0,548	0,714	0,128	0,751	
MSCI North America					**1,000**	0,785	0,058	0,604	
MSCI EM Latin America						**1,000**	0,116	0,697	
MSCI FM Africa							**1,000**	0,144	
MSCI Russia								**1,000**	
Average	0,576	0,413	0,643	0,588	0,512	0,598	0,131	0,594	0,507

Table 4: Correlation matrix showing correlations between international markets for three sub periods covering 2003-2012 Source: Own contribution

A look at the first sub period 2003-2006 provides some interesting insights. For instance, the correlation between North America and Asia Pacific is only 0.116, implying large diversification opportunities. The same holds for the African market, with an average correlation of 0.007 with the other equity indices. At the other end, Europe and Latin America drive the average correlation coefficient upwards, with both markets showing an average correlation of approximately 0.4. The reasoning behind this observation is that these markets are more integrated with the rest of the world economy, thus resulting in higher correlations. The average correlation coefficient for all markets is 0.294. In part 3.1 we showed the impact of correlation on portfolio risk. With a coefficient of 0.294 being far away from 1, which represents no diversification opportunities, the implication is that dispersing equity allocations across indices will significantly lower the portfolio variance.

The second sub period covering the U.S. subprime crisis of 2007-2009 shows noticeably higher correlations than the first sub period. The correlation between Latin America and Europe ex Denmark was 0.771, implying that there has been an increasing interaction between these economies. Russia had generally high levels of correlation with all markets except Africa, with Europe ex Denmark again obtaining the highest correlation coefficient of 0.709. The African market still appears to be very remote from the rest of the world economy, with an average correlation coefficient of 0.024. Returning to our discussion of reducing portfolio risk, the correlation indicates that allocating investments to the African market would significantly reduce overall portfolio variance. Overall, the average correlation coefficient

increased to 0.454. Although this is markedly higher than the first sub period of 0.294, the coefficient is still far from 1 and thus provides a rationale for international diversification.

Lastly, the third sub period 2010-2012 shows a continuing trend of higher correlations, although at a slower pace than from the first to second sub period. The correlation coefficient between North America and Europe ex Denmark was 0.727, a large increase from the first sub period where the correlation was 0.473. Most noticeably is the high correlation for Latin America with international markets, which may reflect the significance of the emerging countries on the world economy. These emerging countries have experienced increasing cross-border equity flows and trade, which makes them more interrelated with the rest of the economy[46]. One noticeable observation from the last sub period is that correlation between Europe ex Denmark and Denmark is 0.828, implying that within the Euro zone the diversification benefits has been significantly reduced. The average correlation for all markets is 0.507, still some way of the perfect correlation coefficient of 1.

Overall, table 4 shows an increase in the average correlation from 0.294 to 0.507. This coincides with our predictions, because the globalization of the world economy should make international markets more interrelated. The implication for portfolio choice is that although correlation has been increasing during the last decade, there are still risk-reducing benefits of allocating investments across different markets.

4.3.2 Development in correlation between Denmark and international markets

Although we have just seen that the correlations amongst international markets has been increasing during the last decade, investigating the development in the correlation between Denmark and other equity markets is more relevant for our thesis. The lower the correlation between Denmark and other equity markets, the higher the diversification benefits will be for Danish pension funds. This section examines whether the development in correlation indicates a rejection of the hypothesis that Denmark's correlation with international markets has been increasing over time.

[46] MSCI Research (2012), pp. 8-9

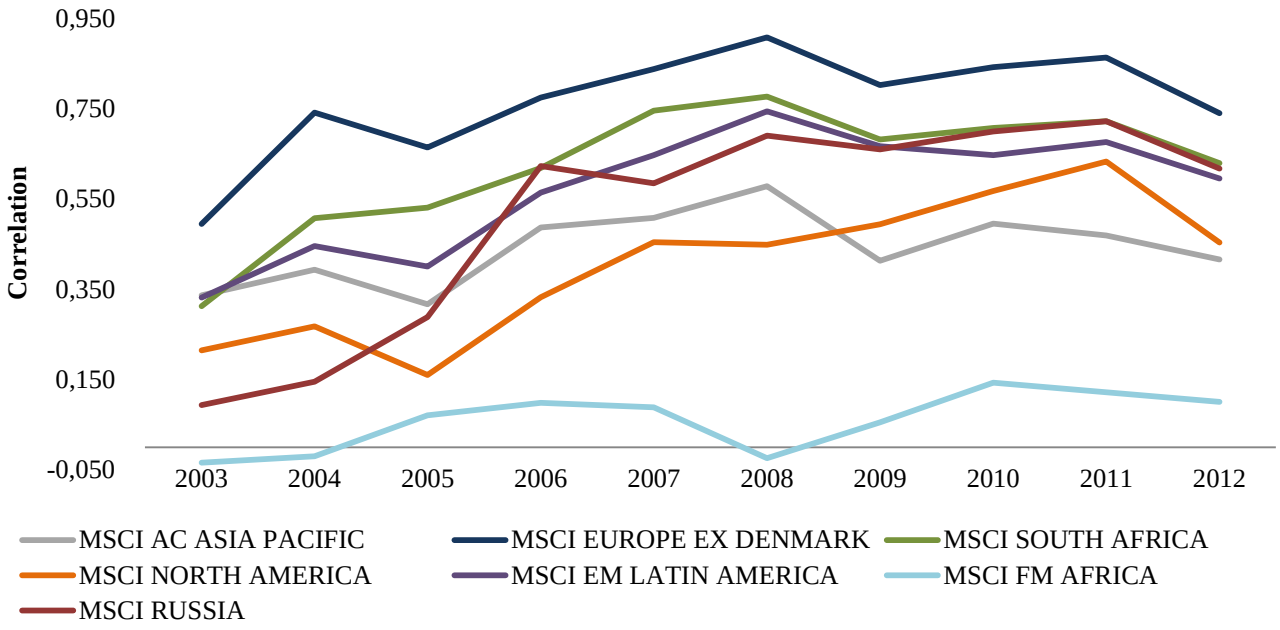

Figure 13: Graph showing correlations between Denmark and other international markets from 2003-2012. Source: DataStream and own contribution.

From figure 13 it is clear that Denmark's correlation with international markets has had a large increase over time. For Europe, Asia Pacific, South Africa and Latin America, the correlation was at its peak in 2008, before decreasing after the financial turmoil in the U.S. The three other markets, North America, Africa and Russia, appear to follow a different pattern as they peaked in 2010-2011. Another noteworthy observation is that all markets have had a decrease in correlation from 2011 to 2012. The reason behind this is unclear; although it might be driven by a reversion back to levels prior to the financial crisis.

The correlation between Russia and Denmark stands out, with an increase from 0.093 in 2003 up to 0.618 in 2012. This represents an increase of 561 percent, implying that Danish investors have had a significant reduction in their diversification opportunities in Russia. Oppositely, the correlation between Denmark and Asia Pacific has only increased from 0.337 in 2003 up to 0.416 in 2012. This result indicates that these markets are only moderately interdependent, and from the graph we can see that there has been a downward trend from 2008 to 2012. Europe ex Denmark and Denmark has had the highest correlation in each year of our analysis period. At its peak in 2008, the correlation coefficient was 0.908, implying that there were practically no diversification benefits for the Danish pension funds of investing in the European market. This result is not surprising, as most countries represented in this index share the same currency

and are largely affected by the development in the Euro zone. In 2012, the correlation is still the highest for all our international markets, represented through a coefficient of 0.741. Relating this finding to our analysis of home equity bias in Danish pension funds in chapter 6, we would therefore expect the portfolio managers to allocate their investments to other international markets when investing abroad.

On average, Denmark's correlation with international markets has, on average, increased from 0.250 in 2003 to 0.508 in 2012. Thus we cannot reject our first hypothesis, and from the graph we observed that all correlation estimates are higher in 2012 than they were in 2003. This development is strikingly similar to the development of the world market as a whole, and the implication for investment allocation is therefore unchanged. Danish pension fund managers have had a reduction in their diversification opportunities in the world market, but there still seems to be benefits to international diversification. This will be showed in section 4.3.4.

4.3.3 Evidence of financial contagion

In order to examine whether the data supports our second hypothesis, namely that the high market volatility during the U.S. subprime crisis contributed to a higher correlation amongst the Danish and other international markets, we take a closer look at the development within our three sub periods.
The changes in correlation will then be measured against each other, and we expect there to be a significantly larger increase from the first to the second sub period, than from the second to the last.

Correlation Between Denmark and	Average correlation 2003-2006	Average correlation 2007-2009	Increase from 2003 to 2009	Change	Average correlation 2010-2012	Increase from 2007 to 2012	Change
MSCI AC Asia Pacific	0,394	0,529	0,135	34,3 %	0,466	-0,063	-11,8 %
MSCI Europe ex Denmark	0,656	0,869	0,213	32,5 %	0,828	-0,041	-4,7 %
MSCI South Africa	0,515	0,746	0,231	44,8 %	0,695	-0,051	-6,8 %
MSCI North America	0,238	0,464	0,226	94,9 %	0,573	0,109	23,4 %
MSCI EM Latin America	0,454	0,712	0,257	56,7 %	0,649	-0,063	-8,8 %
MSCI FM Africa	0,019	0,031	0,012	61,4 %	0,129	0,098	319,7 %
MSCI Russia	0,316	0,672	0,356	112,9 %	0,689	0,017	2,5 %

Table 5: Table showing the change in correlations between Denmark and international markets for three sub periods covering 2003-2012 Source: Own contribution

From table 5 we observe that, on average, all of the correlation estimates had a positive increase from the first to the second period. Most notably is the increase of the correlation between Denmark and North America, as the latter market is where the subprime crisis occurred.

If we look at the development from the second to the third sub period, the results differ. Four out of the seven market indices had a decline in their correlation with the Danish market, although at relatively low levels. Again we observe an increase for the North American market, as well as Russia and Africa. We

choose not to focus on Africa as this market is very remote from the Danish market, thereby not offering any implications on the impact of high market volatility on correlations.

Comparing the calculated changes in correlation for our sub periods, we observe that the increase during the U.S. subprime crisis was higher than in the following period for all markets except Africa.
If we look more closely at the numbers, we can see that in North America the increase during high market volatility was $\frac{(0{,}226-0{,}109)}{0{,}109} = 108$ percent higher than the increase during the last sub period. This result holds for all but the African market, the corresponding number for the development between Denmark and the European market was 617 percent, and the numbers do therefore not provide any indication that our hypothesis should be rejected.

In order for us to check if our findings are statistically significant we have performed t-tests on the non-overlapping periods 2003-2006 − 2007-2009, and 2007-2009 − 2010-2012 (see table 6). This test enables us to see if the average correlation is significantly higher during the subprime crisis than in rest of the sample period.

$$t\ value = \frac{X_1 - X_2}{\sqrt{\sum Variance}} \quad (10), \qquad \text{where } H_0 = No\ change\ in\ average\ correlation$$

Where X_1 and X_2 are the average correlations for each subperiod. $\sqrt{\sum \text{Variance}}$ is the standard deviation of the sum of the variances.

Subperiod	2003-2006 - 2007-2009	2007-2009 - 2010-2012
t-statistics	-0,5948	-0,0029
Critical value	2,5706	2,5706
Significant difference?	No	No

Table 6: Table showing the results of the t-test on average correlations. The increase during the subprime crisis is non-significant between both sub periods. Source: Own contribution

The results show a non-significant difference in both periods. For the first period we obtained a t-value of -0.5948. For the second period the results were even weaker with a t-value of -0.0029. We can therefore not reject the hypothesis of no change in average correlations. Even though the numbers in table 5 might suggest higher average correlations during the subprime crisis, the t-test shows that this increase is not significant. The analysis shows that we find no evidence of higher equity correlations during the subprime crisis.

4.3.4 Justifying the case for international diversification

We have shown that international correlations have been increasing over time, but that there are still large benefits of international diversification. This can be shown graphically by looking at the efficient frontier of international assets.

Figure 14 shows the efficient frontier for international diversification. On the efficient frontier, the investor combines equity from all the international markets, represented by the MSCI indices. Holding Danish equity alone is represented by the red dot. It is clear that the international diversified frontier dominates the solely Danish market. An efficient investor will never hold Danish equity alone.
By combining international equities, an investor has the possibility of reducing the standard deviation of the portfolio by 10 percent while simultaneously increasing return by 0.44 percent, by holding the tangency portfolio. This represents a reduction in volatility of 40 percent relative to holding only Danish equity. Alternatively, an investor could reduce the standard deviation with 12.8 percent by accepting a 1.3 percent lower return, by holding the minimum-variance portfolio. This represents a reduction in volatility of over 50 percent relative to holding only Danish equity. The capital market line (CML) is represented by the green line.

The risk free rate is assumed to be zero throughout this thesis. The reasoning behind this choice is both for simplicity and due to the risk free rate having a restricted effect on the level of home equity bias. The mean variance framework only allows for a constant risk free rate. Alternatively, we could have used the rate of a 10-year zero-coupon government bond. However, we concluded that this choice would not affect our results in a greater extend. For our thesis, a risk free rate of 1 percent reduces the Sharpe ratio to 0.81, with a corresponding increase in the portfolio allocation to Denmark of approximately 0.5 percentage points. Furthermore, a risk free rate of 2 percent reduces the Sharpe ratio farther down to 0.74, while the change in asset allocation for Danish equities is approximately 0.3 percentage points from our original estimate with an interest rate of 0 percent. In other words, while the choice of risk free rate has implications for the portfolios' expected return and standard deviation, it does not have any major influence on the asset allocation to Danish equities and will thus not alter the conclusions that we draw in chapter six. A table with summary statistics of each portfolio is given in appendix 7.

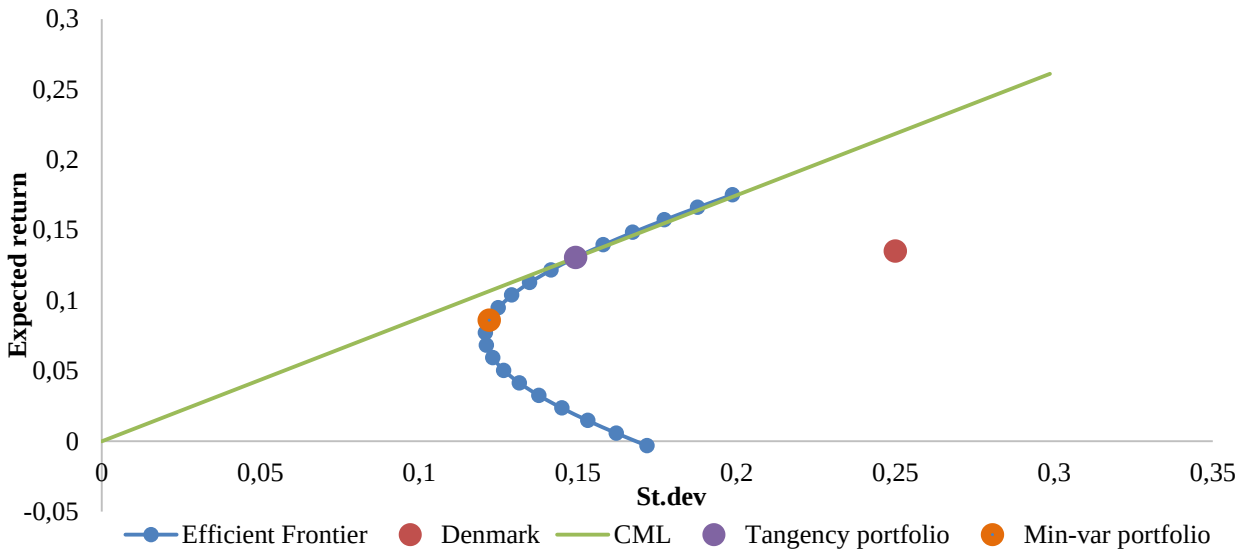

Figure 14: The figure shows the efficient frontier of international diversification. The international diversified frontier dominates the Danish market. Source: Own contribution

The figure clearly shows the positive effects of international diversification. We can therefore conclude that the case for international diversification is justified. There are large benefits to international diversification, not only in theory, but also in real life. Knowing that the benefits of international diversification for Danish investors are significant makes it very interesting when we later investigate how Danish pension funds actually invest internationally.

4.3.5 Sub-Conclusion

Based on the results of this analysis we can conclude that the correlations over the period 2003-2012 have increased. More specifically our results showed that Denmark has had a large increase in correlation with other international markets, with the same results holding for the correlation between international markets in general. However, by comparing the increasing correlations over different sub periods we found no evidence of higher correlations during periods with higher market volatility. The t-test showed non-significant increases in correlations, even though table 5 might suggest the opposite.

Although capital market integration has decreased some benefits of international portfolio diversification, the correlation coefficients between markets are still far from 1.0. For Danish pension funds, the implication is that international diversification could still yield a significant decrease in portfolio variance. Even though financial globalization results in markets becoming more interrelated, we have shown that

the financial theory of international diversification is highly justified. Before we examine the actual home equity bias in Danish pension funds we will provide a review of the previous literature that has tried to explain why investors neglect the diversification benefits of investing abroad.

5.0 Home Equity Bias

Although the benefits of international diversification are well known, it has been properly documented that investors still prefer to invest in their home market. In this chapter we will provide a presentation and a discussion of the previous work that has been done on identifying and explaining why investors continue to overweight their portfolios with domestic assets.

5.1 What Is Home Equity Bias?

According to Lewis (1999), home equity bias occurs when investors hold too little of their equity in foreign assets. With correlation being non-perfect amongst international markets, holding foreign assets will decrease the overall risk-level of the equity portfolio. When investors bear unsystematic risk that could easily be diversified by increasing the amount of foreign assets, it leads to an inefficient allocation of investments. As we have already seen, the efficient frontier for the domestic market lies to the right of the international, representing portfolios with a lower risk-return relationship.

5.1.1 Previous estimates of the home bias

In order to illustrate the magnitude of home bias, this section will present some of the previous estimates on the level of home bias. In order to determine whether there is evidence of home equity bias, one needs to calculate a benchmark portfolio that yields the theoretically optimal level of foreign assets in a portfolio, and then compare this to the actual level of foreign assets. If the benchmark portfolio is based on the InCAPM framework, the level of home bias can be calculated as:

$$HB_{InCAPM} = \text{Domestic Assets}_{\text{Actual percentage}} - \frac{\text{Domestic market capitalization}}{\text{World market capitalization}}^{47} \quad (11)$$

Thus, the level of home bias will range in the interval of 0-1, with 1 representing the maximum distance between the level of domestic assets and the level that would yield the highest diversification benefits.

[47] Sercu & Vanpée (2007), p. 3

All the following findings are based on the market capitalization measure, which also constitutes one of our benchmark models that are presented in chapter 6. Several studies have instigated the magnitude of home bias, and Ahearne et al (2004) reported a home bias of approximately 80 percent for U.S. investors in each year from 1992 to 2000[48]. Although the home bias has improved over time, MSCI made the same calculations for both the U.S. and the U.K in 2010, and they reported that the home bias in both countries was approximately 52 percent in 2010[49]. Similarly, Cooper et al (2012) calculated a home bias of 55 and 76 percent, respectively, for Denmark and Japan in 2010[50]. Focusing on investment funds rather than the average investor, Anderson et al (2011) reported a home bias in Denmark, the U.K. and the U.S. of 12, 21 and 42 percent, respectively[51].

These studies reflect the magnitude of the home bias, and how it is also present in professionally managed investment companies. This subject has attracted many scholars to attempt to identify the main reason why investors neglect the diversification benefits, but so far there has not been any single, adequate, explanation. This is the reason why home bias is often referred to as the home bias puzzle. Rather, the consensus is that there are combinations of institutional- and macroeconomic factors along with behavioral factors that drive this continuing bias in equity portfolios.

5.2 Literature review

In this chapter we will follow the framework of Cooper, Sercu and Vanpée (2012), where we present and discuss the most acclaimed explanations for the bias. The explanations can be divided into six subgroups; 1) hedging domestic risk, (2) explicit costs and barriers for foreign investments, (3) information asymmetries, (4) familiarity stemming from trade, (5) governance and transparency issues and (6) behavioral biases[52].

5.2.1 Hedging domestic risk

The intuition behind this argument is that domestic stocks will provide a natural hedge against domestic risk factors such as inflation, real exchange rate and non-tradable wealth components like human capital and consumption[53].

[48] Ahearne, Griever & Warnock (2004), p. 315
[49] MSCI Research (2012), p. 6
[50] Cooper, Sercu, & Vanpée (2012), p. 330
[51] Anderson, Fedenia, Hirschey & Skiba (2011), p. 921
[52] Cooper, Sercu, & Vanpée (2012), p. 351
[53] Cooper, Sercu, & Vanpée (2012), p. 351

5.2.1.1 Domestic inflation

If an investor holds an internationally diversified portfolio and the domestic inflation rises, there will be a deviation between the nominal and real return. This has given rise to hedging domestic inflation risk as an explanatory factor for home equity bias, as it is proposed that domestic equity returns should be correlated with domestic inflation, and thus provide a natural hedge. Therefore, investors can have a rational for overweighting their portfolio with domestic equities.

However, Cooper and Kaplanis (1994) showed that domestic investors have no hedging motive with regards to domestic inflation. By doing a study of the correlation between inflation and domestic equity returns on ten different countries, they find that the relationship is insignificant in all countries, and that the correlation coefficient is zero in four out of ten countries. [54]

Furthermore, Giofré (2009) supports Cooper and Kaplanis results (1994). By investigating a dataset on 19 different countries through a regression analysis, she concludes that hedging is non-significant with varying positive and negative coefficients. Additionally, she also finds that investors do not view stocks as a tool for hedging inflation, but rather confirms earlier findings that index-regulated bonds would be used for inflation hedging[55].

It has also been shown that the removal of inflation-adjusted index bonds did not result in a change in the demand for domestic stocks, thus indicating that hedging domestic inflation is not attributable to the overweight of domestic stocks in portfolios[56]. Since there are several other studies showing that the proposed correlation is absent between inflation and domestic stocks[57], the inflation argument lacks a foundation in the empirical results.

5.2.1.2 Real exchange rate

Another proposed explanation is hedging risk stemming from the real exchange rate. Similarly to the inflation argument, real exchange rate risk could contribute to change the behavior of investors. Purchasing Power Parity (PPP) states that a country's currency value will be on a level that ensures the same purchasing power in another country. [58]If this is true, then the exchange rate risk should not be an

[54] Cooper & Kaplanis (1994), p. 47
[55] Giofré (2009), p. 251
[56] Ian Cooper, Sercu & Vanpée (2012), p. 303
[57] See for instance Fama and Schwert (1977)
[58] Taylor & Taylor (2004), p. 135

explanation for the home bias. However, it has been documented that PPP does not hold in the short term, although there are indications that it might hold in the long term, and that exchange rate therefore will affect the level of wealth for short-term investors.[59] As profits stemming from an international portfolio will be affected by foreign currencies, a domestic investor will experience deviations in the nominal and real return. As mentioned earlier, the international CAPM states that currency risk can be perfectly hedged. However, it does not incorporate transaction costs and therefore there might be deviations between the theoretical model and what is observed in the real world. In the context of providing a rationale for home equity bias, the real exchange rate appears to offer a probable explanation.

Fidora, Fratzscher and Thimann (2007) investigate the effect of the real exchange rate volatility (R.E.R.V) on the home bias in portfolios. By applying a mean-variance framework on investment data for 70 countries over four years, they find that the R.E.R.V explains 20 percent of the bias in equity portfolios and 60 percent in bonds[60].

Additionally, Schoenmaker and Bosch (2008) estimate the effect of the introduction of the Euro, hypothesizing that it removed the exchange rate volatility for investors located within the euro-zone and that there should thus be a permanent decline in the home bias. They find that the home equity bias has declined by nine percent in the period of 1997-2004, more than the five percent decline in the rest of the world, and that this effect is permanent. In addition they also show that there has been a convergence amongst euro-zone countries to invest in equities denominated in Euro, thus expanding the area that was previously viewed as the home market.[61]

Furthermore, Coeurdacier and Martin (2009) find that the introduction of the euro has lowered transaction costs within the euro-zone, and that countries from this region therefore hold less equity located outside of Europe than previously. Conversely, they only find a significant effect on the removal of exchange rate risk on bonds, not for equities.[62]

To conclude, the exchange rate risk has some foundation through studies as an important explanatory factor for home equity bias. The findings do however indicate that the importance of this factor is higher for non-equity allocations, which is not within the scope of our thesis.

[59] Taylor & Taylor (2004), pp. 136-140
[60] Fidora, Fratzscher & Thimann (2006), p. 27
[61] Schoenmaker & Bosch (2008), p. 96
[62] Coeurdacier & Martin (2009), pp. 101-102

5.2.1.3 Nonfinancial income

Lastly, nonfinancial income can induce investors to prefer domestic over international equities. If there is a negative correlation between nonfinancial income such as labor income, and domestic equities, then the home equity bias might be explained by a hedging motive. Alternatively, if there is a positive correlation then domestic investors should short domestic equities and thus lower the home equity bias in order to hedge the nonfinancial risk.[63]Either way, the proposition is that investors pay attention to these risk aspects and account for them in their choice of portfolios.

Massa and Simonov (2006) conducted a study on Swedish investors through a dataset covering a five-year period for 98 percent of the investments of the total Swedish market capitalization. Through a regression analysis they find that there is a positive and significant relationship between correlation of nonfinancial income and equities, and the investment in equities. Although the correlation with the general market was negative, investors actually tilted their portfolio in a way that removed the natural hedging effect that would have occurred if they held the market portfolio. Consequently, they rejected the hypothesis that investors hedge nonfinancial income through domestic equities.[64]

Baxter and Jermann (1997) investigated annual data in the period of 1960-1993 for the U.K., the U.S., Japan and Germany and found a positive covariance between labor income and capital returns, implying that in order to hedge nonfinancial income investors should go short on domestic equities.[65] Because the observed investment behavior contradicts this finding, their study also offers support to rejecting hedging human capital as an explanation for the home equity bias.

Conversely, Julliard (2002) corrected for estimation errors in Baxter and Jermann's (1997) article by allowing for countries to be economically and technologically integrated. His finding was that they overestimated the domestic correlation between nonfinancial income and domestic equity returns, reflected in a negative correlation in Japan. He further claims that for Japan to hedge its human capital risk, investors need to hold 99 percent of their portfolio in domestic assets.[66]

An article by Craft (2006) investigates whether there actually is a home bias for U.S. pension funds. Through an asset/liability model, in which pension managers seek to maximize their risk-adjusted surplus

[63] Massa & Simonov (2006), p. 636
[64] Massa & Simonov (2006), pp. 660-661
[65] Baxter & Jermann (1997), pp. 176-177
[66] Julliard (2002), pp. 10-15

while minimizing the variance, he argues that there is a rationale for holding a pure domestic equity portfolio. His argument is based on a higher correlation for domestic equities than international equities with the pension liabilities (highly affected by labor income levels), 0.29 compared to -0.03, and that international diversification thus will not provide a hedge for the pension fund.[67]

While Julliard (2002) claims that the home bias in Japan is justified, he also finds that U.K. investors need to short-sell domestic equities in order to be hedged[68]. Although there is some contradiction in the previous work done on human capital as an explanatory factor, there appears to be a consensus that it is not one of the most important factors to focus on.

5.2.2 Explicit costs and barriers for foreign investments

Proponents for this explanation claim that tax differences, trading costs and formal barriers, such as corporate restriction on assets available to foreigners, will negatively affect the amount invested in foreign equities.[69]

5.2.2.1 Taxes

If an investor is faced with higher taxes when holding foreign equity it can induce a preference for domestic equities. The rationale behind this argument is that the implied additional costs stemming from taxes will outweigh the diversification benefits of holding an internationally diversified portfolio.

An early paper by Black (1974) studies the effect of taxes on portfolio holdings. By incorporating barriers on investments reflected through taxes on foreign holdings in the minimum variance framework, he shows that portfolios will be dominated by domestic equities with short positions in foreign equities[70].

Desai and Dharmapala (2007) investigate the extent to which foreign tax-levels affect U.S. investors' portfolio choice. Based on seven-year data they show that a 10 percent reduction in a foreign country's tax level corresponds to an increase of 21 percent of equity held by U.S investors[71]. The result implies that tax rates matter in portfolio choices and thus provides support to taxes as an explanatory factor.

[67] Craft (2006), pp. 29-30
[68] Julliard (2002), p. 18
[69] Cooper, Sercu, & Vanpée (2012), pp. 354-355
[70] Black (1974), p. 348
[71] Desai & Dharmapala (2007), p. 15

One recent study confirms the findings above (Mishra and Ratti (2013)). Based on a dataset from IMF obtaining investment data for 23 countries for the period 2001-2011, they run a regression to test for the significance of taxation of dividends on foreign equity investments. They find a statistical and significant coefficient for both tax credit on foreign dividends and the domestic tax rate.[72] The results again offer support to taxes as an explanatory factor.

There is however a limitation with these studies and that is the degree to which they are able to explain the home bias. For instance, Mishra and Ratti (2013) find that a 10 percent increase in the tax dividend credit on foreign equity investments will only increase cross-border equity investments by approximately 1 percent[73]. This number is nowhere near high enough to be one of the main reasons for the home bias.

5.2.2.2 Trading costs

Similar to the tax argument, trading costs have been claimed to contribute to a preference for domestic equities as investors are faced with additional costs when they acquire foreign equities. As mentioned earlier, the CAPM assumes perfect market conditions without transaction costs, and therefore the outcome of optimal portfolio allocation might be different when these costs are included.

Although the paper originally examines over opportunism with regards to behavioral bias, French and Poterba (1991) reject transaction costs as an explanation for home bias. They find that Japanese and British investors have 98 and 82 percent, respectively, of investments in domestic equities. As the NYSE has lower trading costs, all investors should be driven towards the most liquid markets, not their domestic market. [74]

Martin and Rey (2004) build a theoretical two-country model that incorporates transaction costs through a percentage cost on dividends and shares. They are able to show that demand for foreign assets decreases in a nonlinear way with transaction costs, with a transaction cost of 5 percent corresponding to an 89 percent home equity bias[75].

Examining whether the data actually support transaction costs as helpful with solving the home equity bias puzzle, Ahearne, Griever and Warnock (2004) ran a regression based on both survey and actual data.

[72] Mishra & Ratti (2013), pp. 14-15
[73] Mishra & Ratti (2013), p. 15
[74] R. French & Poterba (1991), pp. 222-224
[75] Martin & Rey (2004), pp. 353-354

Their findings were counterintuitive, in the sense that U.S. investors would invest more in countries with high trading costs. After introducing an interactive variable between listings and transaction costs however, they found that listing on the NYSE would reduce home bias due to lowered transaction costs, although with little economic significance.[76]

Although trading costs offer an intuitive explanation to the bias, as the increased transaction cost would be easily observable for all investors, it does not appear to have satisfactory evidence from the studies. As we shall explain later in this section, it also suffers from one major limitation.

5.2.2.3 Formal barriers

If governments have imposed restrictions on how much foreigners are allowed to invest in a country, or alternatively how much capital that is allowed to flow in and out, it could be a contributing factor in explaining the home bias.

Stulz and Wasserfallen (1995) study the Swiss market in relation to self-imposed corporate restrictions on foreign assets. Through examining eight of the largest companies in Switzerland, they find that foreigners face a premium when acquiring Swiss equity[77]. They also studied the event where Nestlé increased the amount of dividend-paying stocks available to foreigners, which resulted in a large price increase.[78] This price change was driven by an increased demand, demonstrating that foreigners wanted to buy more shares. In relation to the home bias, it offers support to formal barriers limiting the diversification available to foreigners.

Furthermore, Hietala (1989) examined the Finnish market, where domestic investors were not allowed to hold foreign assets, and its implication for asset prices. They show that price premiums originate from domestic and foreign investors having a significant difference in required returns, driven by differences in betas[79]. When we take into account that these kinds of laws existed in the past, it is easy to understand that origin of formal barriers as an explanation.

However, as reported by Cooper, Sercu and Vanpée (2012), the Finnish laws were removed in 1986. Additionally, a recent report by MSCI states that most of the capital control restrictions have been

[76] Ahearne, Griever & Warnock (2004), pp. 328-330
[77] Stulz & Wasserfallen (1995), pp. 1042-1043
[78] Stulz & Wasserfallen (1995), pp. 1051-1052
[79] Hietala (1989), pp. 706-709

abolished and that capital markets are now easily accessible for foreigners. As an example, total FDI flow has increased from approximately $20 billion in 1970, to more than $1000 billion in 2010.[80] Therefore, as markets become more efficient and integrated, and formal barriers no longer relevant, these arguments appear to be outdated.

Although explicit costs and barriers had many proponents earlier on, the actual data on cross boarder equity flows remains a major limitation. As Tesar and Werner (1995) show, the numbers do not support the theories. If these costs and barriers were able to explain the observed home bias, then it should also be reflected through a lower turnover rate for foreign equity. They study financial transaction data covering the U.S., U.K., Canada, Germany and Japan, and find a much higher turnover rate for foreign equity than domestic equity. For instance, for U.S. investors they find a turnover rate that is twice as high as the domestic equity. In addition, they calculate a loss on investments of 60 basis points due to withholding taxes based on average tax rate of 15 percent, and conclude that it is not sufficient to neglect the diversification benefits. [81]

Even though Tesar and Werner's (1995) calculations have been disputed and later recalculated, yielding a turnover rate of 1.3 for U.S. foreign equity[82], the number is still slightly higher than the domestic portfolio. This observation refutes the argument that direct costs associated with investing abroad are able to explain the home bias.

5.2.3 Information Asymmetries

One of the most acclaimed explanations for the home bias is information asymmetry[83]. As mentioned earlier, the CAPM assumes that investors across the globe possess the same information, but in reality this is not the case. Information asymmetries between foreigners and domestic investors can arise through several sources, such as a lack of understanding the business, translating a balance sheet or not obtaining important information quickly enough. If domestic investors have better and more accurate information than foreigners on domestic assets, the rational response would be to invest more in the home country.[84] The reasoning is that evening out the information asymmetries, for instance through extending research budgets, will make foreign assets more costly. If they are not evened out, then the foreign assets could be

[80] MSCI Research (2012), pp. 8-9
[81] Tesar & Werner (1995), pp. 479-481
[82] Warnock (2002), pp. 801-802
[83] Cooper, Sercu & Vanpée (2012), p. 359
[84] Gehrig (1993), p. 98

perceived as more risky. If the argument holds for the general population of investors then it could provide a rationale for overweighting domestic assets.

Coval and Moskowitz (1999) examine the domestic portfolios of U.S. mutual funds to see if there is a preference for investing in firms located nearby even within the same country. They rely on the CAPM-framework to investigate the distance from the benchmark portfolio through a regression, and find that portfolio managers are on average investing in securities located 9 to 11 percent closer than the benchmark portfolio. Additionally they also find that regional funds exhibit a local bias between 42 and 53 percent for local securities, suggesting that portfolio managers prefer to invest in nearby firms where it is easier to obtain information quickly and directly from the company.[85] The result implies that information asymmetry might have an even stronger influence in an international setting, as this analysis avoids cultural and language barriers.

Furthermore, Gehrig (1993) develops a two-country model where the domestic investor has a slight information advantage on firms' earnings signals. He shows that, in equilibrium without exchange risk, the average investor will have a preference for domestic equities because foreign equity will be perceived as more risky[86]. Although the model is purely theoretical, it highlights information about a firm's prospects as an important contributor in portfolio selection and that it could induce home bias.

Returning to the article by Ahearne, Griever and Warnock (2004) introduced above, their study also sheds new light on the aspect of information asymmetry. Specifically, while listing on the U.S. stock exchange was found to lower the home bias through reduced trading costs, they also found a strong and negative relationship between home bias and listing on the U.S. stock exchange through reduced information costs. As firms become listed in the U.S. they also have to adapt to the U.S. regulatory regime, such as GAAP and disclosure requirements, which removes some of the uncertainty involved with foreign assets. The strong effect of this is reflected through their estimates, where the U.S. home bias would fall from 80 to less than 50 percent, respectively, if all foreign firms were listed on the U.S. stock exchange. [87]

In addition to examining whether there is a preference for investing in firms located nearby domestically, Coval and Moskowitz (2001) also study if fund managers obtain higher returns on nearby investments.

[85] Coval & Moskowitz (1999), pp. 2055-2058
[86] Gehrig (1993), pp. 104-106
[87] Ahearne, Griever & Warnock (2004), pp. 327-329

Their data consists of equity holdings for almost all mutual fund managers in the U.S. in the period 1975 to 1994. Calculating risk-adjusted returns and comparing them to a value-weighted benchmark portfolio, they find that local[88] investments significantly outperform distant investments by 118 basis points per year. Moreover, they also calculate the performance of local stocks not held by the fund manager, and find a significant underperforming effect of 3 percent per year. [89] Both these findings confirm that in addition to preferring local assets, investors also have a rational for investing locally and are able to exploit their informational advantage.

Although there are many other proponents of information asymmetry as an explanation for home bias[90], it also has its shortcomings. Jeske (2001) argues that if domestic investors have superior knowledge regarding local equities, then there should also be periods where they hold lower allocations of local stocks than foreigners, especially in periods where they obtain negative signals. As the home bias is something that has persisted over decades, and transaction costs failing to explain why investors do not tilt their portfolios toward more promising markets when the local market is going downwards, he refutes the argument.[91]

An alternative view is that foreign investors could hold country index funds and thus eliminate information asymmetries. Brealey, Cooper and Kaplanis (1999) argue that this especially applies to institutional investors who could hold index futures in combination with cash denominated in domestic currency, thus removing any exchange rate risk[92]. There is an intuitive appeal to this argument, which is that the advantage of superior knowledge regarding local investments would have to outweigh the diversification benefits, which is hard to imagine. For instance, Brealey, Cooper and Kaplanis (1999) show that in a two-country model, where both investors hold a fully domestic portfolio, the information disadvantage of one of the foreigners would have to be double his subjective standard deviation of the foreign market to make his domestic portfolio optimal[93].

Lastly, Coval and Moskowitz's (2001) findings have been disputed. Although they found a superior performance for local investments, Grinnblatt and Keloharju (2000) conversely showed that foreigners

[88] Defined as within 100 km of the fund's headquarters
[89] Coval & Moskowitz (2001), pp. 819-821
[90] See for instance Cooper, Sercu & Vanpée (2012) or Grinnblatt and Keloharju (2001)
[91] Jeske (2001), pp. 37-41
[92] Brealey, Cooper & Kaplanis, (1999), p. 108
[93] Brealey, Cooper & Kaplanis, (1999), p. 107

outperform locals on the Finnish market, even after controlling for behavior differences[94]. However, this analysis does not pay attention to what type of investor they were comparing. Later, Bae, Stulz and Tan (2008) found compelling evidence in favor of domestic investors. By comparing forecasts made by foreign and local analysts in 32 different countries, they found a significant advantage for the domestic analysts[95]. As the relevant measure would be to do a peer-comparison, like in Bae.et.al's article, we cannot refute the information asymmetry explanation because the numbers show that locals have an advantage.

Information asymmetry is still one of the most acclaimed explanations for the home bias, but as we have shown above, it does not offer a complete explanation. Although some have tried to refute the argument entirely, there is compelling evidence that it is one of the most important factors to focus on. Some aspects still leave questions open, like why do foreigners not hold country index portfolios? The reason may be a combination of several factors, some of which will be explored later in this section.

5.2.4 Familiarity stemming from trade

The logic behind this argument is that trade in goods will correlate with trade in financial assets[96]. When countries are closely linked through trade, it becomes more natural for citizens to invest in the other country as they become familiar with the foreign economy. However, the estimates on the effect of trade on home bias are not easy to interpret, as they might capture aspects of reduction in information asymmetry[97].

Anderson, Fedonia and Hirschey (2011) investigated the effect of cultural variables on home bias, but they also included a variable for bilateral trade between the countries. They obtained a negative relationship between trade and home bias in all regressions, although with varying levels of significance[98].

A study by Lane and Milesi-Ferretti (2008) was aimed at identifying the drivers of foreign equity investments. Through a regression analysis based on investment data for 67 countries, they obtained a positive and significant coefficient on bilateral trade, especially for emerging markets[99]. Of particular interest is the strong result for emerging markets, as this supports the theory behind this explanatory

[94] Grinblatt & Keloharju (2000), p. 64
[95] Bae, Stulz & Tan (2008), pp. 590-593
[96] Cooper, Sercu, & Vanpée (2012), p. 363
[97] Cooper, Sercu, & Vanpée (2012), p. 386
[98] Anderson, Fedenia, Hirschey & Skiba (2011), pp. 923-925
[99] Lane & Milesi-ferretti (2008), pp. 546-547

factor. Many investors have less knowledge about emerging markets, but the familiarity obtained through trade will diminish the uncertainty of these countries.

Supporting the argument, Aviat and Coeurdacier (2007) study the relationship between trade and asset holdings and whether they are mutually reinforcing. They developed a regression model and showed that a 10 percent increase in bilateral trade will increase bilateral asset holdings by approximately 6 to 7 percent, respectively. The reverse effect, bilateral asset holdings on bilateral trade is however much smaller, with an elasticity of somewhere in the region of 0 to 0.2. [100]

Although all the studies support trade as an explanatory factor, Cooper, Sercu, & Vanpée (2012) show that the numbers only support the theory for developed markets. Examining the relationship over time, they find that the developed countries have decreased home bias along with increases in trade, while the emerging markets have had a substantial increase in trade, followed by a marginal reduction in home bias[101]. Though bilateral trade can increase international asset holdings, it does not have the same intuitive appeal as the information asymmetry or market barriers, as it is hard to imagine that the absence of trade will be one of the driving forces behind the bias. The fact that the developing economies still have a large degree of bias, simultaneously with increasing trade, leads us to consider other alternative explanations.

5.2.5 Governance and transparency issues

Closely related to information asymmetry, governance and transparency affect the home bias. For instance, if foreign investors are less protected against management expropriation of a firm's assets, the natural response would be to look elsewhere for investment opportunities. Similarly, poor transparency will make information more costly to obtain and less reliable, which in turn will reduce the expected return on the investment. The result of both these examples is that foreign investments become less attractive, which in turn increases the home bias in the country with poor governance and transparency.

Dahlquist, Pinkowitz, Stulz and Willaimson (2003) study the effect of corporate governance on home bias. In difference to our previously presented studies, they apply the free float market capitalization percentage as the benchmark portfolio[102]. Under these conditions, countries with few block holders should have a higher weight in a diversified portfolio and thus have less home bias than previously calculated, with the

[100] Aviat & Coeurdacier (2007), pp. 44-45
[101] Cooper, Sercu & Vanpée (2012), pp. 365-366
[102] The free-float portfolio is calculated by subtracting concentrated ownership shares from the market capitalization for each country.

allocation to the U.S. market increasing from 49.6 to 58.3 percent, respectively. Furthermore, they conducted a firm-specific study on the Swedish market, and found that there was a negative and significant relationship between controlling shareholders and that firm's weight in foreign portfolios.[103] The result implies that, as expected according to theory, foreigners will avoid shares where there are controlling shareholders and therefore contribute to home bias in portfolios.

Supplementing this finding, Stulz (2005) studied the interaction of both corporate- and state expropriation on financial decision-making. He argued that as state expropriation increases, management can bribe the state rulers who do not adhere to the legal system to take advantage of minority shareholders, which makes these agency-problems reinforcing. Through a regression analysis on the U.S. market he showed that there is a significant relationship between both minority shareholder's legal rights and the state's respect for property rights, and the likelihood that a firm is widely held. As a result of this twin-agency problem, he proposed that countries with worse governance have less foreign ownership and that the same rule applies to countries with higher state expropriation.[104]

Supporting both the theories above, Leuz, Linz and Warnock (2008) examines which factors influence the U.S. foreign portfolio investments. Using data on more than 4000 firms from 29 countries, they conducted a regression analysis. They obtained significant results that insider control, a country's legal institutions and disclosure and investor protection rules negatively affect foreign investments if they are not at a satisfactory level[105]. Returning to our initial argument, this finding shows that not only is management expropriation important, but also the role played by disclosure and its implications for information flow.

There is as appealing thought behind this argument, and it has gained widespread recognition that it is important for the home bias[106]. To our knowledge there has not been any articles refuting this argument, but it still does not offer a complete explanation. If it were true, then countries should have adapted their legal systems accordingly in order to attract foreign capital and induce cross-border investments. Alternatively, the home bias is still present even in countries where the legal system is weaker than in the U.S., but if corporate governance was able to offer a complete explanation then these countries should

[103] Dahlquist, Pinkowitz, Stulz & Williamson (2003), pp. 100-107
[104] M. Stulz (2005), pp. 1619-1624
[105] Leuz, Lins, & Warnock (2008), pp. 3263-3272
[106] See for instance Giannetti and Simonov (2006) or Gelos and Wei (2005)

have a higher allocation of equity abroad.[107] The reason might be that there are other factors that make investors divert from the rationality assumption in financial theory, which will be explored next.

5.2.6 Behavioral bias

All of the theories that we have presented so far have been based on conventional finance theory, which assumes that the economic agents act rationally. In reality however, investors are affected by several factors that influence their decision-making.[108] This has given rise to behavioral finance, which examines the effects of psychological factors on economic decisions. For instance, if investors are over-optimistic with regards to domestic market returns, the choice of neglecting the diversification benefits of an international portfolio might seem rational when the decision is made. Similarly, other psychological factors like overconfidence, familiarity, patriotism and herding can affect an investor's portfolio choice, and might explain why portfolios are skewed towards domestic equities. In the following section we will explore each of these factors and examine whether they are able to offer an explanation for the home equity bias.

5.2.6.1 Overconfidence

Examining the relationship between overconfidence and home bias, Karlsson and Nordén (2007) conducted a study on Swedish investors. Through a regression analysis they obtained a significant coefficient on gender, stating that men have a higher degree of home bias driven by overconfidence. The reason is due to a perceived information advantage, and the optimal choice is therefore to overweight the portfolio with domestic equities.[109] Unlike our previous presentation of articles on information asymmetry, this finding does not conclude that there is an information advantage, but rather that men believe their choice is optimal because of a behavioral bias.

Contradicting this finding, Dorn and Huberman (2005) used survey data and trading records to examine what drives diversification and trading activities. Through regression analysis, they conclude that self-reported risk aversion is the main determinant and obtain insignificant coefficients for overconfidence[110]. Although their findings were contradicting, it might also reflect the problem with estimating the effect of behavioral bias on portfolio choice. The lack of observable data means that one has to rely on proxies, and

[107] For instance, French and Poterba (1991) stated a domestic ownership in Japan of 95.7 percent.
[108] Zvi Bodie, Alex Kane (2011), p. 410
[109] Karlsson & Nordén (2007), p. 329
[110] Dorn & Huberman (2005), pp. 464-471

these proxies might be measuring the same thing[111]. Thus, In Dorn and Huberman's article, the proxy for self-reported risk aversion could also be measuring overconfidence.

5.2.6.2 Over-optimism

Closely related to overconfidence is the degree to which investors are over-optimistic. French and Poterba (1991) conducted a famous study on portfolio choice for investors from the U.S., Japan, Germany, the U.K., France and Canada. Relying on the mean-variance framework they calculated how much higher the expected return on the domestic market had to be in order to make the home-biased portfolios an optimal choice. Their findings implied an extreme degree of over-opportunism in favor of the domestic market. The most prominent example was U.K. investors, who needed an annual expected return of 500 basis points higher on the U.K. market compared to the U.S. market in order to justify their portfolio choice. Similarly, Japanese investors needed to expect their domestic market to outperform the U.S. market by more than 300 basis points.[112] If this holds true across the world, then part of the home bias may be explained by investors' expectance that their home market will outperform foreign markets.

Using survey data on portfolio managers' views from the U.S., the U.K., Japan and Continental Europe, Strong and Xu (2003) compare differences in estimates of market outlook. The data show that, on average, 66 percent of U.K. portfolio managers had a bullish outlook on the British market, whereas the corresponding figure for European, U.S. and Japanese managers were 58 and 50 percent, respectively, bearish. The same holds true when they compared the outlook on the U.S. market, with domestic managers on average being 52 percent bullish, while U.K., European and Japanese portfolio managers all had a majority for a bearish outlook on the U.S. market. [113] The study supports the findings of French and Poterba, as it confirms that investors are more optimistic towards their domestic markets than foreigners. The results imply that the higher expected returns will drive the weight of the domestic equities upwards in the portfolio model, thereby resulting in a home bias.

5.2.6.3 Familiarity bias

Another proposed behavioral explanation that has been brought forward is the familiarity bias, which claims that people are more likely to invest in firms that are more familiar to them. To see if there was a link between investments and familiarity, Huberman (2001) conducted a study of the shareholders of

[111] Cooper, Sercu & Vanpée (2012), p. 371
[112] R. French & Poterba (1991), pp. 223-224
[113] Strong & Xu (2003), pp. 310-311

seven Regional Bell Operating Companies (RBOC). He found that investors had an overweight of the local RBOC stock in 47 out of 48 states, and that people will invest, on average, 1.84 times more in the local RBOC than if they invest in the out-of-state RBOC[114]. Furthermore, as there were no states where the local RBOC had a lower weight than the average out-of-state RBOC, he argues that the evidence from this study cannot be down to information advantage. If that were the case, then shorting or avoiding the local RBOC based on negative information should also be observed. There is a close link to this observation and our discussion on information asymmetry, and the lack of observations where investors exploit negative signals on local companies[115] offers support to people investing in what is familiar to them. The driver behind this, as Huberman argues, could be that investors perceive local stocks as more likely to deliver high returns, and that they attribute a lower risk to these familiar companies[116].

5.2.6.4 Patriotism

Morse and Shive (2011) argue that there is another behavioral bias helpful with explaining the home bias, namely the degree of patriotism in a country. Using data from World Values Survey covering 53 countries over a six-year period they examine whether countries with a higher degree of patriotism have more home-biased portfolios. The question used to measure patriotism was:

- *How proud are you to be (insert nationality)?*

After correcting for transaction barriers, diversification benefits, information and familiarity, they obtained strong and significant coefficients for patriotism on home bias. According to their estimates, a one standard deviation decline in patriotism would increase the foreign investments by $18 to $31 billion, which corresponds to a 4.8 percentage point increase in foreign asset allocation in the investment portfolios[117]. Furthermore they also ran a second regression based on other measures for patriotism:

- *Would you be willing to fight for your country?*
- *Do you think employers should give jobs to nationals first over immigrants?*

A one standard deviation decline in the fighting- and job variable corresponded to a 6 and 4 percent, respectively, decline in the home bias, both of which were statistically significant at the 1 percent level[118].

[114] Huberman (2001), pp. 669-673
[115] See Jeske (2001), introduced under section 5.2.3
[116] Huberman (2001), p. 677
[117] Morse & Shive (2011), pp. 429-430
[118] Morse & Shive (2011), p. 432

Investors believing that the domestic equities will outperform those in the foreign market have rationalized all the other behavioral explanations introduced so far. Interestingly, this study shows that investors are prepared to neglect diversification benefits in order to support their domestic market due to patriotism. When we take this into consideration it is not surprising that the arguments based on conventional theory were unable to fully explain the home bias.

5.2.6.5 Herding

The last behavioral bias explanation deals with herding amongst portfolio managers. The rationale behind this argument is that benchmark evaluation induces portfolio managers to adjust their portfolio to replicate the investment strategies of other institutions, and if these peers are heavily weighted in the domestic market, it results in home bias. Lakonishok, Shleifer and Vishny (1992) conducted a study to check whether institutional investors exert herding behavior in the U.S. over a four-year period. Overall they found only marginal results for herding, although amongst small stocks the result was slightly higher.[119] Conducting an identical analysis based on newer investment data for French mutual funds, Jallouli-Sellami (2007) conversely finds an economically and statistically significant coefficient on the herding effect on home bias. His findings imply that an average increase on domestic holdings for other domestic mutual funds will decrease the home bias by a factor in the range of 0.5 to 0.7 of the observed increase in domestic equity allocation[120].

In sum, there is a general agreement that these psychological factors all affect the observed home bias. As mentioned earlier, the problem with measuring its impact is that one needs to apply proxies, or alternatively survey data. If survey data is used, then there arises a new problem, namely that the result may not hold if extended to another population[121]. The importance of behavioral bias as an explanatory factor is highlighted when one understands that investors are incapable of making investment decisions with perfect rationality.

5.3 Sub-Conclusion

Through our review of the previous work on the home equity bias, the explanations with most support were information asymmetry, corporate governance issues and behavioral biases. Exchange rate risk had some support, as did familiarity stemming from trade, but they do not appear to be the main drivers of the

[119] Lakonishok, Shleifer & Vishny (1992), pp. 30-32
[120] Jallouli-sellami (2007), pp. 21-22
[121] Dorn & Huberman (2005), pp. 438

bias. In sone way or another, the three key-explanations are all closely related. A lack of transparency will make it harder for foreigners to obtain information regarding a firm, and behavioral biases can result in a perceived information advantage for investors. Alternatively, information asymmetry can result in a perceived lack of transparency as foreigners find it harder to obtain precise information than locals.

Behavioral biases provided many probable explanations, and the intuition behind some of them are very different from both transparency and information asymmetry. For instance, the argument behind both herding and patriotism is not due to investors misinterpreting signals or believing that domestic equities will yield superior returns or lower risk, rather they are based on a clear deviation from the rationality assumption. In both these cases, investors are prepared to forego international diversification benefits without taking the risk-return relationship into account. These three explanations will constitute the focal point of our analysis on home equity bias within Danish pension funds for the remainder of this thesis.

6.0 Identifying the Home Equity Bias

In this part of the thesis, we investigate home equity bias in Danish pension funds. We start by introducing the reference models that will serve as a theoretical foundation in the analysis of home bias. Thereafter, we provide an introduction of the Danish pension fund's asset allocation over time. This constitutes the foundation for our home equity bias analysis and we then go on to present the results, followed by a discussion of the results.

6.1 Reference models

In order to identify and measure the home equity bias of Danish pension funds we have applied three reference models. These are models that enable us to benchmark the actual portfolio weights of Danish pension funds to the theoretical weights suggested by our models, where deviations indicate home equity bias. The first model will capture the effects of the size of the market. The second model will capture the effects of the size of the economy. The last model will capture the effects of the risk-return ratio in each market. The first two models will be rebalanced for each year. This enables us to see how the index weights naturally evolve with changes in market capitalization and economic growth.

It should be noted that each of these models independently are not able to serve as a fully realistic benchmark. However, by relying on a combination of three models we believe we will be able to get a good overview of the level of home equity bias. These models will capture different aspects of the theory

and provide a good theoretical foundation when we are comparing the data of Danish pension funds. The scope of this paper is not to derive the formulas that will be applied and therefore we will only show the formulas being used.

6.1.1 Market Capitalization model

Our first reference model is based on the InCAPM framework by Solnik (1974) and Sercu (1980). As explained in section 3.4, the InCAPM suggests that all investors should hold a globally diversified portfolio. The implication of the model is that domestic asset allocation should equal the relative country share in the global market share. By building on this theoretical foundation, we can create a model that suggests portfolio weights based on the market capitalization. The market capitalization portfolio will reflect the available investment opportunity set in public equity markets. This is the same approach as used in Ian Cooper et al (2012). The model is also commonly used to weight assets in different indices. MSCI World Index and S&P500 are examples of market capitalization weighted indices.

6.1.1.1 Set-up of the model

In the model, market capitalization will be used as a proxy for the size of the equity market. This model will favor international markets with large stock markets. The equity invested in each country should equal the market capitalization of that country weighted by the total market capitalization.

$$w_i = \frac{Country_i\ Market\ Capitalization}{World\ Market\ Capitalization} \quad (12)$$

The world market capitalization includes the market capitalization of all countries included in the MSCI Indices used. A full list of these indices and countries included is given in section 1.3.

As we calculate the optimal portfolio on an index level, we will aggregate the country market capitalization for each country included in each index. The weight in each index should therefore equal the sum of each country's market capitalization weighted by the world market capitalization.

$$w_{index\ i} = \frac{\sum_{i=1}^{N} Country_i\ Market\ Capitalization}{World\ Market\ Capitalization} \quad (13)$$

6.1.1.2 Critique of the market capitalization model

First of all the empirical validity of the InCAPM is at best unclear. Previous empirical studies on the international CAPM models have found mixed evidence[122]. We showed in chapter 5 that the assumptions behind the InCAPM have been contradicted to a great extent, but in this section we wish to highlight some of the frailties of using market capitalization as a portfolio choice.

MSCI Research (2012) suggests that capitalization weighting is sensitive to price bubbles and other temporary price disequilibria. Thus, relying on stock market capitalization as a diversification tool can lead to increased exposure to markets with potentially high volatility. For instance, the stock market upswing that occurs prior to a crisis would lead the market capitalization model to suggest investors allocating most of their money to markets that are in a bubble. As a result, the weights suggested by the model might not represent the true wealth creation but rather inflated prices in stock markets.

Another problem is the level of correlation between stock market size and its contribution to economic growth. Levine & Zervos (1998) showed that stock market size and its influence on growth indicators such as gross domestic product (GDP), productivity and Capital stock is absent. This finding implies that, once again, allocating investments based on market size is not risk-return maximizing, as market size does not represent wealth creation in an economy.

Since the model only considers the size of the market, this might cause the model to overweight or underweight certain markets. A possible scenario is if P/E multiples are much higher in one market compared to another. Then the relative stock market capitalization of a particular country becomes greater than its economic output. Furthermore, some countries have large economies (as measured by GDP) but relatively small stock markets. Examples are Hong Kong and Switzerland[123]. This might cause economies with high growth, and attractive investment opportunities, to be underweighted because of their low market capitalization. This leads us to the next model, which will take into consideration the economy of the country.

6.1.2 GDP model

Our second model is a GDP weighted model. The reasoning is that GDP will represent the relative importance of a country's economy as opposed to the size of its equity market. This model will further

[122] Engel & Rodrigues (1989), Dumas (1994)
[123] The World Bank Statistics: Market capitalization of listed companies

capture the effect of fast growing economies. MSCI[124] has used GDP weighted indices for more than 20 years.

The model overweight (underweight) countries with economic weight greater (smaller) than the market capitalization weight, relative to the market capitalization model. Proponents of GDP weighting argue that GDP weights serve as a better proxy of the natural country weight in the CAPM total market portfolio. MSCI argues that holding countries in proportion of GDP may bring the weights of countries in the portfolio closer to the natural country weight as it incorporates the non-listed portion of the economy. MSCI further argues that as GDP weighting is not dependent on stock prices, countries that experience a temporary bubble will not be as heavily weighted as they would be in a market-cap-weighting scheme. Lastly, GDP weighting has historically provided increased exposure to emerging markets, thus benefiting from a significant emerging market risk premium.[125]

6.1.2.1 Set-up of the model

The intuition behind the model is exactly the same as the market capitalization model. However, in this model the portfolio weights are calculated based on GDP. Equation (13) turns into equation (14). The weight in each index should therefore equal the sum of each country's GDP weighted by the world GDP.

$$w_{index\ i} = \frac{\sum_{i=1}^{N} Country_i\ Gross\ Domestic\ Product}{World\ Gross\ Domestic\ Product} \quad (14)$$

The world GDP is comprised of the same benchmark countries as described in section 1.3, which is the same method as applied to the mean-variance and market capitalization models.

6.1.2.2 Critique of the GDP model

Overall, the equity market only partly contributes to GDP. GDP growth does not therefore necessarily imply higher equity returns. As a result, the GDP model can end up suggesting weights that do not represent the value creation of interest. GDP growth may translate into new enterprises, the raising of additional capital, or state or private shareholders selling their stakes, not necessarily market returns[126].

[124] MSCI Research (2012), p. 16
[125] MSCI Research (2012), p. 25
[126] MSCI Research (2012), p. 26

Research by Dimson, Elroy, and Marsh published in Credit Suisse Global Investment Returns Yearbook 2010[127] provides a regression analysis of the relationship between GDP growth and equity returns. They found a positive correlation of 0.41 between real GDP growth rates and real equity returns. However, this relationship cannot be used to predict investment returns. This is because GDPs are not published until after the quarter, and are subject to extensive revision, with revisions that are often of the same magnitude as the announced growth figure. They therefore conclude that accurate predictions of GDP growth could be informative about stock market movements, but realized GDP growth rates are of no use for predicting quarterly market returns. Further, Ritter (2005) investigated the correlation between real stock returns and per capita growth from 1900-2002. The study found that the correlation over this period was negative (-0.37).

MSCI Research (2012) suggests that additional consideration should be paid to instances where countries are in the early phases of liberalization. The relatively larger weight implied by GDP may be limited to a narrow slice of the economy. If the country has a small stock market, the investor may bear a large amount of concentration risk. Consequently, the investor will end up with a low diversified portfolio.

There is another problem that applies to both the GDP- and market capitalization model, which is that they do not account for the correlation between markets. Thus, hypothetically, if the largest economies had a correlation coefficient of 1, both these models would suggest a portfolio with very low diversification. Therefore we also chose to include a model that incorporates the covariance between markets when calculating the portfolio weights.

6.1.3 Mean –variance model

The mean-variance model of Harry Markowitz (1952) has long been recognized as the main contribution to modern portfolio theory. Most modern finance textbooks consider mean-variance efficiency the method of choice for optimal portfolio construction and asset allocation and as a means for rationalizing the value of diversification[128]. The framework does not seek to explain how investors select portfolios, but rather, how they should select portfolios[129]. The framework provides a mathematical model that investors can use to quantitatively allocate their wealth in different assets.

[127] Credit Suisse (2010), p. 16
[128] Michaud (1989), p. 1
[129] Sharpe (1967)

This model will serve as a reference model, when we in section 6.3 investigate the home equity bias in Danish pension funds. By calculating portfolio weights based on historical data we can use this as a benchmark to the actual investments of Danish pension funds. The reasoning for this choice is that the model is widely recognized and accepted in the academic field. Further, the model gives intuitive results that can easily be communicated to the reader. Several other studies such as Lewis (1999), Ian Cooper, Sercu, & Vanpée (2012) and Craft (2006) have used this same model in their analysis of home bias.

6.1.3.1 Set-up of the model

The objective of the model is to minimize the variance of returns for a certain level of expected return, and hereby create efficient portfolios. This section is based on the approach of Benninga (2008)[130]. We write the portfolio composition X and the vector of means E(r) as column vectors. X represents the proportions of wealth in each asset, and E(r) represents the expected returns of the individual assets. E(r) is based on historical data.

$$x=\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_N \end{bmatrix} \quad E(r) = \begin{bmatrix} E(r_1) \\ E(r_2) \\ E(r_3) \\ \vdots \\ E(r_N) \end{bmatrix} \qquad (15)$$

Expected return of the portfolio can then be calculated as a weighted average of the expected returns of the individual assets. This can be written mathematically as;

$$E(r_p) = \sum_{i=1}^{N} x_i E(r_i) = x^T E(r) = E(r)^T x \qquad (16)$$

In section 3.1 we explained how the correlation coefficient affects the variance of the portfolio. In the mean-variance the focus is on the covariance coefficient. (σ_{ij}). We therefore rewrite equation (1) to directly include the covariance coefficient. The intuition behind the formula is exactly the same as equation (1)

[130] Benninga (2008), p. 247

$$\sigma_p^2 = \sum_{i=1}^{N} X_i^2 \, \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} X_i \, X_j \sigma_{ij} \,, \quad \text{where } \sigma_{ij} = \sigma_i \sigma_j \, \rho_{ij} \quad (17)$$

As we can see from equation (17) we need to include all pair wise covariance coefficients when calculating the variance of the portfolio. In the Markowitz model this is done by creating a sample variance-covariance matrix with ith rows and jth columns. The diagonal line in the matrix will contain the variance of each asset as the covariance of a variable with itself is just the variance.

$$S = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & & \sigma_{1N} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} & \cdots & \sigma_{1N} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \cdots & \sigma_{3N} \\ \vdots & & & & \\ \sigma_{N1} & \sigma_{N2} & \sigma_{N3} & \cdots & \sigma_{NN} \end{bmatrix} \quad (18)$$

The sample variance-covariance matrix is calculated as $S = \frac{A^T A}{M}$ (19) where A is a vector of observed returns less mean value and M is the number of observations.

By incorporating the covariance matrix, the variance of the portfolio can be calculated as;

$$\sigma_p^2 = x^T S \, x \quad (20)$$

We are now able to set up the optimization problem for calculating an efficient portfolio. An efficient portfolio is the portfolio of risky assets that gives the lowest variance of return of all portfolios having the same expected return[131]. In this thesis we will focus on the tangency portfolio. This is an efficient portfolio that maximizes the Sharpe ratio[132]. The Sharpe ratio maximizes the ratio of expected excess return of a portfolio divided by the standard deviation of the return. We therefore end up with a portfolio that optimizes the risk-reward ratio. This portfolio will lie where the CML line is tangent to the frontier of risky assets, see figure 8.

$$Max = \frac{E(R_p) - R_f}{\sigma_p} \quad (21)$$

[131] Benninga (2008), p. 250

[132] $Sharp\ ratio = \frac{E(r_p) - r_f}{\sigma_p}$ Zvi Bodie, Alex Kane (2011), p.200

Subject to

$$\sum_{i=1}^{N} X_i = 1 \quad (22)\ and\ x_i \geq 0 \quad (23)$$

Constraint (22) assumes that the pension fund is always fully invested and therefore the sum of all weights equals 1. As described in section 2.4, there has been a short sell ban in Denmark since 2008. The ban was eased in 2012 after pressure from the EU. However, numbers from the Danish FSA[133] shows that Danish pension funds do not engage in short selling. The risk profile prevents the pension funds from taking extreme positions. We will therefore include a no short sale restriction in our model. Consequently, constraint (23) fulfills this requirement as it restricts the model from yielding negative portfolio weights. The short sell restriction further helps the model finding less extreme portfolio weighs and therefore suggest a more diversified portfolio.

To solve the optimization problem we have chosen to use the Excels Solver function, which is a powerful tool to use in portfolio optimization. In our case, we will maximize the Sharpe ratio by solving for portfolio weights, subject to the given constraints.

6.1.3.2 Shrinkage Method

Jobson & Korkie (1980) has shown that the sample variance-covariance matrix includes estimation errors. As described in section 6.1.3.3, Michaud (1989) has further shown that the assets with the largest estimation errors are those that are overweighted. These well-documented flaws make the estimation results unreliable. To reduce these negative effects we have corrected the sample variance-covariance matrix by applying what is called a shrinkage method. Shrinkage methods are methods for improving the estimate of the variance-covariance matrix. Shrinkage is a transformation of the sample covariance matrix that can be regarded as a form of regularization. This method tends to pull the most extreme coefficients towards more central values, and thereby systematically reducing estimation error where it matters most.

We have applied the constant correlation model suggested by Ledoit & Wolf (2004). The authors argue that this gives comparable performance, but is easier to implement than the other alternatives. The model assumes that the variance-covariance matrix is a combination of the sample covariance matrix (S) and some other matrix (F).

[133] Danish FSA Company Announcement Database

$$Shrinkage\ VarCovar = \delta^{*}\mathrm{F} + (1 - \delta^{*})\mathrm{S} \quad [134] \qquad (24)$$

Matrix F will serve as the shrinkage target. (F) is a matrix where all the pair wise correlations are identical. The average of all the sample correlations is the estimator of the common constant correlation. δ^{*} is the shrinkage constant. This is a number between 0 and 1 and represents the weight put on the structured estimator. The optimal shrinkage constant minimizes the expected distance between the shrinkage target and the true covariance matrix.

The authors supply a free and open source MATLAB code[135] (appendix 8) to calculate the shrinkage variance-covariance matrix (24). We have applied this code when calculating the variance-covariance matrix to be used in the mean-variance benchmark in section 6.3.

6.1.3.3 Critique of the mean-variance model

There is no doubt that the mean-variance model is highly recognized and accepted in the academic field. Still the model has received much criticism due to its approach and the underlying assumptions of the model. Newer models such as the Black-Litterman[136] have tried to mitigate some of the issues with the standard mean-variance model by including investors' subjective expectations about the future returns. However, as we only look at the historical portfolio allocation we will not cover this model. Several studies have investigated the validity of the mean-variance model and the reader should have the critique presented in this section in mind when the results of the mean-variance analysis are presented in chapter 6.

First of all, the mean-variance model implies normally distributed returns. As we showed in section 4.3, our data does not follow a normal distribution. The empirical evidence of normality in stock returns is very unclear and the evidence found differs a lot. However, given enough observations within a sample size, it is reasonable to assume that returns follow a normally distributed pattern on a long-term perspective, although this might not hold for all samples and historical periods. Haim Levy & Hanoch (1970) found that the normal distribution is not always a good approximation to reality. J.P. Morgan (2009) investigated how non-normality affects the mean-variance model. They found that the model actually increases risk and that it produces highly concentrated and impractical asset allocations.

[134] Ledoit & Wolf (2004), p. 113
[135] Wolf (2003)
[136] Black & Litterman (1992)

Furthermore, Michaud (1989) highlighted some of the practical problems with using the mean-variance model. In his study, he shows that the mean-variance optimization is error maximizing. The fundamental problem is that the level of mathematical sophistication of the optimization algorithm is far greater than the level of information in the input forecasts[137]. Risk and returns are parameters that the investor needs to estimate. This is a subjective and time-consuming process, which is often solved by using historical data as an estimate of the expected return. However, Black & Litterman (1992) show that historical estimates are often bad predictors of future behavior. This makes them subject to estimation error. The mean-variance model totally ignores the possibility of estimation errors. Michaud further suggests that the use of historical data to produce sample mean and use these as expected returns is not optimal. He claims that this actually contributes greatly to error-maximization in the mean-variance model.

Michaud (1989) also finds that the model often gives unstable optimal solutions as small changes in the input can lead to large changes in the solution. Assets that are estimated to have large returns, negative correlation and small variance will be significantly overweighted, or underweighted if the reverse holds. Since the assets with the largest estimation errors are over weighted, the MV-approach is error maximization. Best & Grauer (1991) investigated this issue in a sensitivity analysis of mean-variance efficient portfolios. The result was that there was extreme sensitivity to the individual means in these types of portfolios. The study shows that even a small change in an asset mean can eliminate half the asset from the original portfolio, hereby giving support to the findings of Michaud.

Black & Litterman (1992) claims that the use of the mean-variance model will result in portfolios that are highly concentrated. That is, portfolios with large long and short positions in only a few assets. This hypothesis is also confirmed by others such as DeMiguel (2009) and Lummer, Riepe, & Siegel (1994). These concentrated solutions are called "corner solutions". The model often recommends portfolios with a large negative weight in several assets. When adding a short-constraint in the model, the solutions often include portfolios with 0 percent weights for most assets or, in the extreme, 100 percent allocated to a single asset. This leads to counterintuitive and ultimately unacceptable portfolios for the investor.

Cooper, Sercu & Vanpée (2012) highlighted another important weakness of the mean-variance model. When they ran regressions on explanatory factors for home bias, the mean-variance measure had a very low overall fit with an R^2 of only 1.3 percent, whereas the market capitalization model had an explanatory

[137] Michaud (1989), p. 40

power of 73.9 percent. They further showed that the home bias is underestimated for several countries using the mean-variance benchmark model, due to its extreme portfolio weights.[138]

Furthermore, the Markowitz model does not account for the market capitalization weights of the assets. This implies that if an asset with low market capitalization has high-expected returns and negatively correlated to the other assets in the portfolio, then the model can suggest a high portfolio weight. This might be a problem since the model most likely will give very high weights in assets with low level of capitalization.

6.2 Asset allocation in the Danish pension fund sector

In order to investigate the level of home equity bias in Danish pension funds, we start by looking at the historical development of equity allocation for the pension sector as a whole. This overview will indicate the level of home equity bias in Danish pension funds and lay a foundation for the analysis in the next section.

The historical development of equity allocation in the Danish pension fund indicates a steady downward trend in domestic investments. In the 10 year period from 2003 to 2012, the proportion of domestic investments has fallen from 41.6 percent to 22.3 percent, respectively. Historical home equity bias for each individual pension fund can be found in appendix 9.

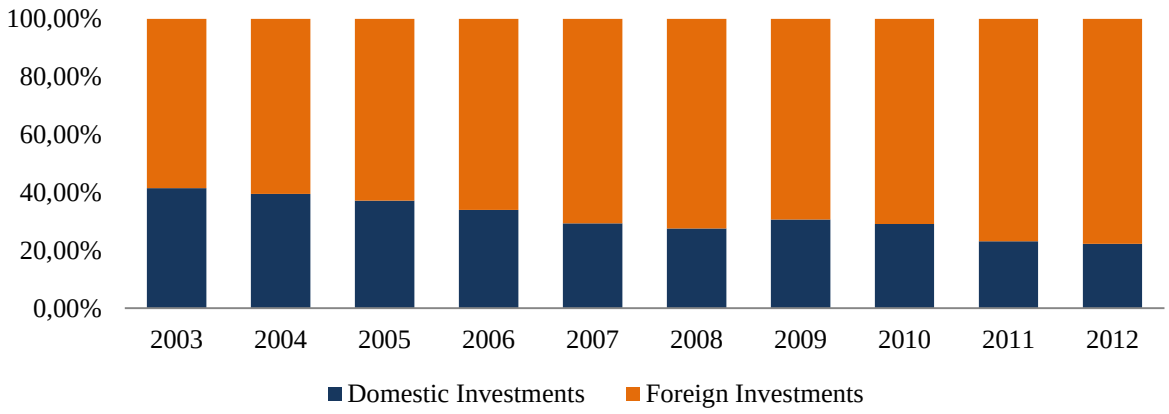

Figure 15: The figure shows the historical development of asset allocation the Danish pension fund sector as a whole. The figure indicates a sharp decline in domestic investments. Source: Annual reports and own creation.

[138] Cooper et al (2012), p. 381

From figure 15 we observe that the share of domestic equity in the pension fund`s portfolios have exhibited a steady decline over the last decade, with the exception of the aftermath of the U.S. subprime crisis. This clearly indicates that foreign markets have become an integral part of Danish pension funds' investment strategies. The observed tendency to look beyond the domestic market is as expected due to the benefits of international diversification. When in addition we consider the fact that pension funds have large research teams, investing outside of the domestic market is as one should expect. As shown in the correlation analysis in part 4.3, financial markets are becoming more and more interrelated. Therefore the identification of increasing investments in foreign markets could also be viewed as a natural expansion of where investors feel they have sufficient knowledge of the market to invest without fearing formal barriers and poor investor protection. It can also be interpreted as an indication that the Danish stock market does not offer sufficient investment opportunities for the average Danish pension fund.

Relating the decline of investment in the domestic market to our analysis on home bias, the development in investment allocations indicate that the level of home bias has been reduced over the last 10 years. However, as we will show later, this development does not necessarily hold for all pension funds. The asset allocation differs a lot between the pension funds, which may be attributable to several of the explanations we presented in part 5. In the next section, we calculate the optimal portfolio allocation and investigate the development of home equity bias in Danish pension funds, thus enabling us to determine whether there is in fact a home equity bias present.

6.3 Home Equity Bias Analysis

With the framework for calculating the benchmark portfolios in place, we are now able to determine whether the Danish pension funds have exhibited home equity bias. We start by presenting the investment allocations according to each benchmark model, followed by a discussion of what drives the differences between the models. Once this is done we compare the actual investments made by the Danish pension funds to the benchmark models, in order to identify whether there has been a home equity bias or not.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Weights According to GDP										
MSCI AC Asia Pacific	25,58 %	25,69 %	25,64 %	25,43 %	25,83 %	27,18 %	29,50 %	31,66 %	32,90 %	34,30 %
MSCI Denmark	0,61 %	0,63 %	0,62 %	0,61 %	0,62 %	0,64 %	0,60 %	0,56 %	0,54 %	0,50 %
MSCI Europe Ex Denmark	31,83 %	32,71 %	31,76 %	31,42 %	32,31 %	31,97 %	30,08 %	27,57 %	27,32 %	25,48 %
MSCI South Africa	0,48 %	0,56 %	0,59 %	0,58 %	0,57 %	0,50 %	0,55 %	0,65 %	0,65 %	0,61 %
MSCI North America	35,59 %	34,09 %	34,11 %	33,78 %	31,79 %	29,99 %	30,51 %	29,43 %	27,89 %	28,60 %
MSCI EM Latin America	4,34 %	4,43 %	5,04 %	5,50 %	5,79 %	6,11 %	5,91 %	6,86 %	7,10 %	6,77 %
MSCI FM Africa	0,33 %	0,36 %	0,41 %	0,47 %	0,48 %	0,54 %	0,49 %	0,56 %	0,54 %	0,57 %
MSCI RUSSIA	1,24 %	1,52 %	1,83 %	2,21 %	2,60 %	3,07 %	2,37 %	2,71 %	3,06 %	3,19 %
Sum Portfolio Weights	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %
Weights According to Market Cap										
MSCI AC Asia Pacific	20,75 %	20,99 %	23,25 %	24,03 %	29,31 %	30,56 %	31,35 %	31,80 %	29,72 %	29,26 %
MSCI Denmark	0,39 %	0,41 %	0,43 %	0,45 %	0,45 %	0,40 %	0,41 %	0,45 %	0,40 %	0,44 %
MSCI Europe Ex Denmark	27,10 %	27,19 %	26,38 %	28,04 %	26,59 %	24,61 %	23,55 %	22,14 %	22,61 %	21,99 %
MSCI South Africa	0,86 %	1,24 %	1,38 %	1,40 %	1,36 %	1,48 %	1,55 %	1,22 %	1,17 %	1,20 %
MSCI North America	48,59 %	47,57 %	44,88 %	41,28 %	36,09 %	38,26 %	36,89 %	37,19 %	39,27 %	40,48 %
MSCI EM Latin America	1,52 %	1,81 %	2,27 %	2,64 %	3,57 %	3,29 %	4,23 %	5,11 %	4,90 %	4,75 %
MSCI FM Africa	0,06 %	0,06 %	0,08 %	0,10 %	0,18 %	0,21 %	0,13 %	0,16 %	0,15 %	0,17 %
MSCI Russia	0,74 %	0,73 %	1,33 %	2,07 %	2,45 %	1,19 %	1,90 %	1,94 %	1,78 %	1,71 %
Sum Portfolio Weights	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %

Table 7: Table showing the portfolio weights calculated according to the market capitalization and GDP model. Source: Own contribution

From table 7 we can see that there are notable differences between the two models (market capitalization and GDP for each country is given in appendix 1 and 2). In the market capitalization model there are a few indices with very high weights, reflecting a lower dispersion across market indices. This is driven by the large stock markets in the U.S., Japan, China, France, Germany and the U.K. Over time, we observe that Asia Pacific has gained in influence on the world stock market, whereas North America and Europe have both had a decline. When the sizes of the economy are taken into account, the GDP model has an even higher weight in Asia, but a noticeably smaller weight in North America than in the market capitalization. The trend is the same for both models, with Asia Pacific growing at a faster rate than both Europe and North America. We also observe that Russia and Latin America has higher weights, thus underlining the increasing importance of emerging markets on the world economy. Both models do however predict very low, and similar, weights for Denmark, stating that Danish pension funds should have approximately 0.5 percent of investment located in their domestic market in 2012. As a result, we expect the estimates for home equity bias to be quite large when measured according to these benchmark models.

The mean-variance model requires a long time-series of historical data in order to improve the precision of the estimate. As described in section 1.3, the data on our indices is only available from 2002, and we are therefore unable to estimate the model for more than one period. Similarly to section 4.3.4, the risk free

rate is assumed to be zero. Data characteristics for each market and covariance matrix are given in appendix 10.

Weights	
MSCI DENMARK	16,06 %
MSCI AC ASIA PACIFIC	4,40 %
MSCI EUROPE EX DENMARK	0,00 %
MSCI SOUTH AFRICA	0,00 %
MSCI NORTH AMERICA	0,00 %
MSCI EM LATIN AMERICA	21,39 %
MSCI FM AFRICA	58,15 %
MSCI RUSSIA	0,00 %
Sum	100,00 %
Expected Return	13,06 %
Variance	2,23 %
Standard Deviation	14,93 %
Sharpe	0,87
Shrinkage constant	0,0141

Table 8: Table showing the portfolio weights for 2012 according to the MVP model. Source: Own contribution

Our estimate for the MVP model accords well with the critique presented earlier as we observe highly concentrated portfolio weights. The index for Africa and Latin America has outperformed the other indices according to the Sharpe measure which is what the MVP model maximizes. In addition, Africa has the lowest covariance with other markets, thus resulting in an extreme portfolio weight. One important difference between the benchmark models is the portfolio allocation to Denmark suggested by the MVP model. The reason behind this observation is that Denmark has the third highest Sharpe ratio, combined with being less interrelated with other markets compared to Europe or North America. Furthermore we also observe that Europe, South Africa, North America and Russia are all excluded from the MVP weights, which is hard to justify in an international portfolio setting. Both Europe and North America have some of the largest stock markets with well-known companies, which could thus alleviate the information asymmetry that may cause trouble for Danish pension funds.

6.3.1 The aggregated pension fund sector

In order to quantify the home equity bias we rely on equation 11 from part 5.1.1:

$$HB_{InCAPM} = \text{Domestic Assets}_{\text{Actual percentage}} - \frac{\text{Domestic market capitalization}}{\text{World market capitalization}}$$

Thus, the home equity bias will be in the range of 0 to 1, with 1 representing the maximum level of home equity bias. The aggregated pension fund portfolio allocation includes data for all but two pension funds with a market share above 1 percent, which represents a total market share of 90.2 percent[139]. As a result, the data should be representative for the pension fund sector as a whole.

It is important that the reader keeps in mind the weaknesses of the benchmark models, and that there may be reasonable explanations as to why the Danish pension funds have chosen not to hold the "optimal portfolios". In addition we would like to inform the reader that the annual reports applied to calculate the investment allocations may also include the company's life insurance business, and therefore there might be deviations between the legal restrictions applied to pension funds' investments and the equity allocation shown in table 9. These limitations are something that the reader should have in mind when presented with the results below.

Year	Domestic Investment allocation	Foreign Investment allocation	Home bias according to Market Cap model	Home bias according to GDP model	Home bias according to MVP model
2003	41,55 %	58,45 %	**0,412**	**0,409**	
2004	39,53 %	60,47 %	**0,391**	**0,389**	
2005	37,16 %	62,84 %	**0,367**	**0,365**	
2006	33,95 %	66,05 %	**0,335**	**0,333**	
2007	29,28 %	70,72 %	**0,288**	**0,287**	
2008	27,52 %	72,48 %	**0,271**	**0,269**	
2009	30,61 %	69,39 %	**0,302**	**0,300**	
2010	29,17 %	70,83 %	**0,287**	**0,286**	
2011	23,15 %	76,85 %	**0,228**	**0,226**	
2012	22,29 %	77,71 %	**0,219**	**0,218**	**0,062**

Table 9: Table showing the aggregated home equity bias measured according to our benchmark portfolios. Source: Annual reports and own contribution

From table 9 it is clear that the Danish pension fund sector has exhibited home equity bias according to all our benchmark models over the entire ten-year period. Although the pension funds have engaged in more international diversification throughout the analysis period, the domestic allocation is still far above what is recommended by both the market capitalization- and GDP model.

In 2003, the observed home equity bias was approximately 0.41, which represents a large deviation from the optimal portfolio allocation. In the following period from 2004-2008 the home equity bias declined at a sharp pace, with the development representing a decline in portfolio inefficiency according to the market capitalization measure of $\frac{(0,271-0,391)}{0,391} * 100 = -30,7\%$. This is a major improvement over a four year period, which implies that the Danish pension fund sector shifted their portfolio towards the optimal

[139] See section 1.5.2

international portfolio in figure 14 shown in part 4.3.4, representing an improvement in the risk-return relationship.

In the two following years there was a jump in the home equity bias, which may be attributable to foreign markets being perceived as more risky during a period of financial turmoil. Although we were unable to obtain statistically significant results under the correlation breakdown analysis, the numbers indicated that periods of high market volatility increased the international correlation. As a result, Danish pension funds might have reduced their international equity holdings in order to lower the portfolio risk even though the markets had a correlation below 1. In 2010, the home equity bias was approximately 0.285 according to both the market capitalization- and the GDP model. If we compare this number to our introduction of home equity bias, the observed home equity bias for both the U.K. and the U.S. was approximately 0.52 for the same year. So, although Danish pension funds display inadequate portfolio diversification, the implication is that portfolio allocation is much more efficient for Danish pension funds than for the average investor in the U.K. and the U.S. This is not very surprising given the research funds and portfolio sizes of the pension funds, but it indicates that some of the barriers that explain why the average investor forgoes international diversification might not hold for the Danish pension funds.

Lastly, in both 2011 and 2012 the foreign equity positions increased to the highest observed levels, which correspond to the lowest home equity bias estimates in our analysis period. Overall we can conclude that, according to the market capitalization- and the GDP model, the home equity bias in Danish pension funds has persisted in each year during the previous decade. Although the home equity bias has been declining at a steady pace, the bias still persists and thus represents an unnecessary cost for the investors.

The home equity bias for 2012 according to the mean-variance model is however much lower than the other two benchmarks. In fact, the domestic portfolio allocation is fairly close to the optimal portfolio, with a home equity bias measure of only 0.062. We have previously outlined the inaccuracy of this model, but the observation still offers one interesting insight. The MVP model estimated an allocation to Danish equities of 16.1 percent, while the average domestic allocation for pension funds amounted to 22.3 percent. This indicates that the risk return relationship in the Danish equity market is able to justify some of the observed home equity bias for 2012. Should this trend continue going forward, with the Danish market outperforming many of the renowned stock markets measured according to the Sharpe ratio, it implies that portfolio managers should slow down the convergence towards foreign portfolios.

If we compare the development in home equity bias over the analysis period with the measure from the MVP model, there appears to be a converging pattern. It is however important to remember that the MVP estimate is stationary, and if the optimal portfolio allocation is estimated based on a dataset covering a different time period, i.e. 2001-2010, the portfolio weights will differ. Therefore, in relation to the MVP model, we are unable to draw any conclusions on how the home equity bias has developed over time. It is however able to show that for 2012, Danish pension portfolios have not been far away from the optimal domestic portfolio allocation.

To conclude, our first two models show that Danish pension funds have had an inefficient portfolio allocation throughout 2003-2012, but this inefficiency has decreased rapidly in recent years. Depending on whether you apply the market capitalization- or GDP model, or alternatively the MVP model, there is a major difference in its implication for portfolio efficiency. Both the two former models suggests that Danish pension funds are bearing too much domestic risk which could easily be diversified away by holding an internationally weighted portfolio.

The MVP model offered a different intuition, namely that the Danish pension fund allocations to the domestic market almost correspond with the appropriate weight when maximizing the risk-return relationship. It is however important to differentiate between the optimal domestic- and foreign allocation. Even though the MVP estimate is close to the observed percentage invested at home, none of the pension funds had anything remotely close to 58 percent invested in the African market as suggested by the MVP weights in table 8.

6.3.2 Breakdown of individual pension funds

In order to identify which of the pension funds that drive the home equity bias upwards in Denmark, we have chosen to take a closer look at the individual pension fund's portfolio allocation for 2012.

As the previous section was based on aggregated numbers, the four largest pension funds in our analysis are of particular importance. Figure 16 shows that the four largest pension funds in terms of equity assets are Danica Pension, Lærernes Pension, Industriens Pension and ATP. All pension funds exhibit a home equity bias when measured according to both the GDP- and the market capitalization model, and the focus of the analysis will therefore be on the mean-variance benchmark.

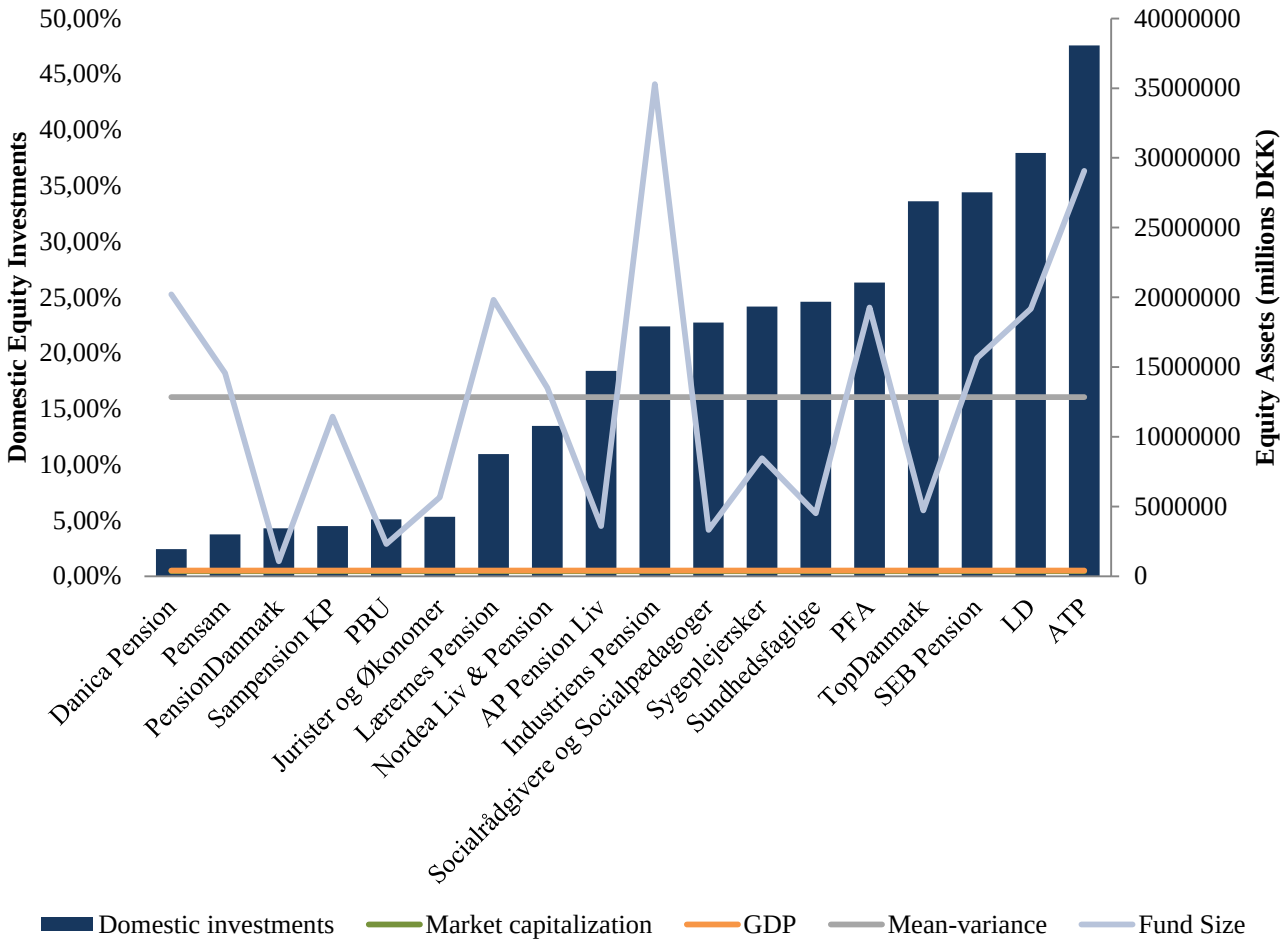

Figure 16: Figure showing the home equity bias for individual pension funds in 2012 measured according to our benchmark portfolios. Fund size in terms of equity assets is also included. Source: Annual reports and own contribution

From the figure it is clear that there are large differences between how Danish pension funds allocate investment to foreign and domestic markets, respectively. For instance, Danica Pension was the company with the lowest home equity bias in Denmark in 2012, with only 2.4 percent invested in domestic equity. At the other end of the scale we find ATP, who had 47.6 percent of equity investments placed in the Danish market. Asset allocation for each individual pension fund can be found in appendix 11. Oddly enough, Danica Pension had approximately 14 times more equity placed in unlisted foreign equities than in listed Danish companies, indicating that information asymmetry is not of great concern. This observation contradicts the predictions of the previous explanations for home equity bias, as obtaining

precise information on foreign unlisted companies would be more complicated than for companies listed on the domestic stock exchange, which again should be reflected in the portfolio weights.

Of the four largest pension funds, we can see that Lærernes Pension is the one closest to the mean-variance model with a domestic asset allocation of 11 percent. Approximately 25 percent of the foreign assets are invested in non-listed equity companies. The findings are consistent with what the size of fund indicates. The relative size of their equity portfolio suggests that the fund should have the necessary internal experience, resources and knowledge to exploit the advantages of international diversification.

Industriens Pension is the largest individual pension fund in our analysis in terms of equity assets. Similar to Lærernes Pension, they had a domestic allocation that was close to the mean-variance model with 22.4 percent invested at home in 2012. Again we observe contradicting evidence when we differentiate between Industriens Pension's investments made in listed and unlisted companies and compare them to the theoretical predictions. Foreign investments accorded well with the information asymmetry argument, as the majority was invested in listed companies. The same does not hold for domestic investments however, as the majority was invested in listed companies. If information asymmetry was a key driver behind the investment allocation, the ability to obtain precise information on unlisted foreign equities should have resulted in a larger portfolio weight if the information indicated positive future outlook.

The companies who contribute to moderating the home equity bias besides Danica Pension are Pensam, Pension Denmark, Sampension KP, PBU and Jurister og Økonomer. Oppositely, ATP, LD, SEB Pension and TopDanmark are the worst performers measured according to home equity bias. Again this latter finding contradicts our previous expectation, in particularly with regards to ATP. The first intuition from this observation is that there appears to be no link between the relative size of the pension fund and the level of home equity bias, reflected through the varying home equity bias measures in figure 16. Due to ATP's size we expected the research funds and internal experience and knowledge to be reflected through a larger equity allocation to international markets. The data showed that the majority of the domestic investments were allocated to listed companies, while the foreign investments were mostly unlisted companies. If this finding could be explained by a lower research fund than what we expected, the foreign investments should have been made in listed companies. If the finding could be attributed to information asymmetry, we should have observed the opposite, namely that the domestic investments were made in unlisted companies, while the foreign investments were made in listed. Conversely, up until 2007, the majority of foreign investments were made in listed companies. Thus, the observation might be

attributable to ATP having a lower expectation of returns on foreign stock exchanges after the financial crisis hit, and are now trying to generate excess returns by investing in less-known foreign equities instead.

Nordea Liv & Pension are also very close to the suggestion from the mean-variance model with 13.5 percent invested in domestic equities in 2012. From the data we observed that, again, the majority of foreign investments were made in unlisted companies. This accords well with Nordea having extensive internal knowledge about stock markets, which can diminish the information asymmetry, and are thus able to identify prosperous investments in unlisted foreign companies. In fact, the investments made in unlisted foreign equities were approximately 3.5 times higher than in listed foreign equities, and 6 times higher than in listed domestic equities. SEB Pension is another bank with a large internal research department and knowledge about stock markets, but from figure 16 we observe that they have the second highest home equity bias measure. We therefore cannot generalize anything with regards to investment banks and how they are able to diminish any perceived uncertainties with investing abroad through internal knowledge of stock markets.

To sum up, the level of home equity bias varies a lot between the different Danish pension funds. There does not appear to be any link between size and home equity bias, and the same indication is found when we took into account whether the pension fund was part of an investment bank with extensive access to information on foreign stock markets. Three of the six largest Danish pension funds (LD, PFA and ATP) exhibited the largest home equity bias, which contributes to increasing the home equity bias for the sector as a whole. We have not found any indication for information asymmetry playing a key role for investment allocations between foreign and domestic equities, rather the findings indicate that the pension funds follow investment strategies that vary a lot. This finding also indicates that we should not expect to find any evidence of herding within the Danish pension fund sector.

6.4 Sub-Conclusion

Based on our three benchmark models, GDP, market capitalization and mean-variance, we analyzed the Danish pension fund sector and found evidence of home equity bias in each year for the period 2003-2012. The historical development of equity allocation indicated that the home equity bias had declined steadily from 2003-2012, which was also confirmed when we measured the actual investment data to the benchmark models. In the first section we presented the models and their respective critique, which is

something that should be kept in mind before we draw any conclusions. The mean-variance model definitely has its flaws, most notably that the portfolio weights are extreme. Due to Denmark's strong stock market performance over our analysis period, the estimated home equity bias for 2012 was very low according to this model. Although the high domestic equity allocation might be justified based on the risk-return relationship, none of the pension funds had anything remotely similar to the foreign equity allocations that were suggested. Therefore, even though the domestic equity allocations coincided fairly well with the MVP model, the actual foreign equity holdings of Danish pension funds has not been risk-return maximizing.

The breakdown of individual pension funds revealed that there were major differences in the portfolio allocations, and most notably that three of the six largest pension funds had some of the highest home equity biases. This contradicted our initial expectation, where we expected to find that the size of the pension fund would be related to a lower home equity bias.

When we took a closer look at the separate pension funds, the interpretation of the results was not straightforward. We found no convincing evidence of information asymmetry or herding effect, which were two of the explanations that we expected to have a high explanatory power for the home equity bias. In the next section we discuss our findings so far in relation to the possible explanations for home equity bias. The most relevant explanations will be investigated to see if these are able to explain the observed home equity bias.

7.0 Explaining the Home Equity Bias

In the previous section the reader was presented with the results of the home equity bias analysis. The results showed that Danish pension funds exhibit significant home equity bias. Bearing in mind the documented positive effects of international diversification from chapter 4, it represents a "puzzle" that is interesting to investigate more in depth. Danish pension funds do not act in accordance with theory and neglect the positive effects of international diversification.

In chapter 5 possible explanations for home equity bias were presented that will form the foundation of this analysis. By investigating these explanations in depth, and in regards to Danish pension funds specifically, we seek to explain some of the results found in chapter 6. This chapter aims to identify why

Danish pension funds are home biased, thus bringing some clarity into the home equity bias puzzle for Danish pension funds.

7.1 Analyzing empirical explanations

This section focuses on the variables that have previously been brought forward for the general home bias. The variables that offer a probable explanation for the observed home equity bias in Danish pension funds will be analyzed in order to find supporting evidence. This section will therefore discuss the relevance of each explanation in regards to Danish pension funds and analyze the relevant explanations to see if they are able to explain some of the observed home equity bias.

7.1.1 Domestic inflation

The first possible explanation is that Danish pension funds hold domestic equity to hedge against domestic inflation. It is proposed that domestic equity returns should be correlated with domestic inflation, and thus provides a natural hedge. This explanation has low empirical support as there have only been found low and non-significant correlations between domestic inflation and equity returns in most studies[140]. This implies that equities do not offer a satisfactory hedge against rising inflation.

The relationship between inflation and individual equities is complex and idiosyncratic. There are no indications that this should be different for Denmark. Giofré (2009) did a study that included Denmark, which found a low positive correlation between domestic inflation and stock returns in Denmark. However, the correlation coefficient was non-significant implying no justification for a possible hedging motive. It is also important to remember that Danish pension funds are professionally managed institutions. We therefore believe that they would use other and more appropriate hedging instruments if hedging domestic risk was the objective, such as inflation adjusted index bonds. Lastly, as we showed in table 9, the home equity bias has been decreasing steadily over the last decade. Meanwhile, the inflation rate was fairly stable from 2003 to 2008 before an increase of approximately one percentage point in the period 2010 to 2012[141]. As the home equity bias declined from 2010-2012 simultaneously with an increase in the inflation rate, it supports our theory that Danish pension funds do not hedge domestic inflation with domestic equity. We will therefore not investigate this variable in more depth and discard domestic inflation as explanatory for the observed home equity bias.

[140] See section 5.2.1.1
[141] TradingEconomics,

7.1.2 Exchange rate risk

The second explanation is that real exchange rate affects the real return received by investors. This will in turn change the investment behavior by increasing the demand for domestic assets, in an effort to reduce currency risk. This explanation has some empirical support[142] and it might be of relevance for Danish pension funds.

Exchange rate fluctuations increase the level of portfolio risk. Figure 15 showed that the major part of the equity portfolio consists of foreign assets. The liabilities of Danish pension funds are in the local currency (DKK) as the pension funds both receive and pay its clients in DKK. This requires the assets to be liquidated and changed into the local currency (DKK). This suggests that Danish pension funds are highly exposed to exchange rate risk. On the one hand, Danish pension funds benefit from the Danish fixed-exchange-rate policy vis-à-vis the euro. The Danish kroner are pegged against the euro, implying only low currency risk. On the other hand, we also know that Danish pension funds hold large equity holdings in several other currencies[143]. This implies that Danish pension funds are exposed to significant currency risk unless they hedge against the underlying currency. We therefore believe that exchange rate risk represents a reasonable explanation that we will investigate further.

In order to analyze whether exchange rate risk can cause home equity bias we will start by looking at the geographic asset allocation of Danish pension funds and the volatility of the most prominent currencies. This will allow us to see if exchange rate represents a risk large enough to justify the overweight in Danish equity. Once this is concluded, we investigate whether Danish pension funds hedges this risk as this will give us a pin point to how exchange rate affects the investment decision. Danish pension funds hold significant amounts of equity in international markets. The 18 Danish pension funds included in the scope of this thesis hold a total of approximately 360 billion DKK in foreign equity[144]. Figure 17 shows the equity allocation of Danish pension funds (2012) based on geographic area.

[142] See section 5.2.1.2
[143] Based on investment data from annual reports
[144] Aggragated number based on annual reports of each individual pension fund

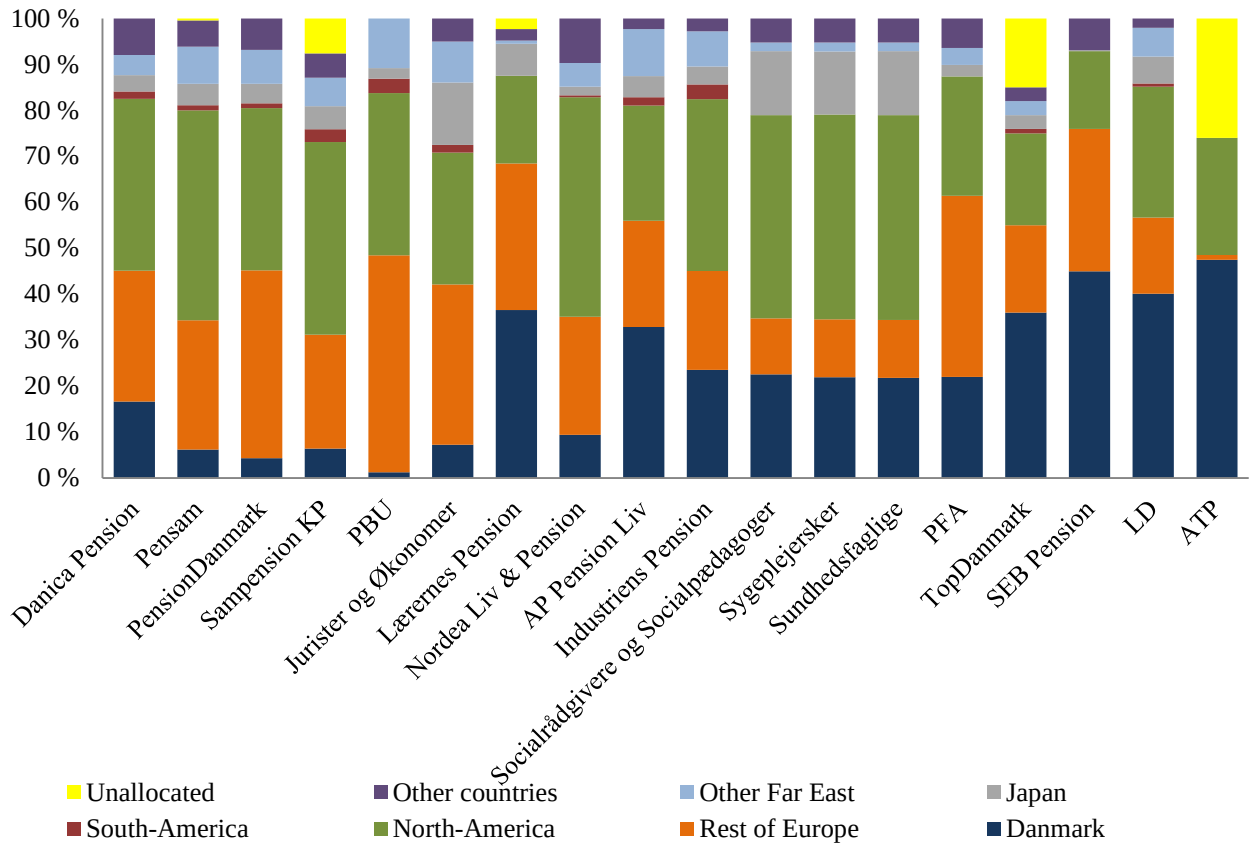

Figure 17: The figure shows the asset allocating (based on geographic area) for the Danish pension funds in 2012. Note that the numbers are based on market value of equity assets and therefore the individual asset allocation differs from figure 16. Source: Annual reports and own contribution

We note that the asset allocation varies greatly between the individual pension funds, suggesting different investment strategies. However, all pension funds seem to have a significant equity allocation in North-American, European and Danish equity. Table 10 shows the average asset allocation for Danish pension funds.

Average asset allocation	Danmark	Rest of Europe	North-America	South-America	Japan	Other Far East	Other countries	Unallocated
2012	22 %	25 %	34 %	1 %	6 %	5 %	5 %	3 %

Table 10: Average asset allocation (based on geographic area) for the Danish pension fund sector in 2012 Source: Annual reports and own contribution

The asset allocation suggests that Danish pension funds are significantly exposed to exchange rate risk, especially the US. Dollar, European currencies such as the Euro and Japanese yen. If these currencies are volatile against the Danish kroner it will greatly affect the real return on foreign equity and thereby increase the portfolio risk. Pension fund managers may be concerned with the risk of volatile currencies

and try to reduce the overall risk of the portfolio by overweighting domestic equity. We will therefore investigate the exchange rate volatility of the largest currencies to see if the volatility is high enough to justify a rationale for overweighting Danish equity.

Table 11 shows the monthly and annualized historical volatility of a selection of prominent currencies from 2003-2012. Most notably is the low exchange rate risk related to the Euro. This is a natural result of the Danish fixed exchange rate policy vis-à-vis the euro. The South African rand has the highest volatility of 25.9 percent, representing the highest exchange rate risk of all the currencies. In addition, the U.S. Dollar, Hong Kong dollar and the Russian ruble also exhibit significant exchange rate risk.

Exchange rate risk (St.dev)	**Monthly average**	**Annualized average**
DKK/EUR	0,1%	0,2%
DKK/USD	3,5%	12,1%
DKK/JPY	6,0%	20,9%
DKK/HKD	3,5%	12,1%
DKK/ZAR	7,5%	25,9%
DKK/RUB	4,1%	14,3%
DKK/BRL	4,5%	15,5%
US.Dollar (USD), Euro (EUR), Japanese yen (JPY), Hong Kong Dollar (HKD), South African rand (ZAR), Russian ruble (RUB), Brazilian real (BRL)		

Table 11: The figure shows the monthly and annualized historical volatility (St.dev) of each currency. Source: Nationalbanken and own contribution.

Relating this to the asset allocating in figure 17 it is clear that Danish pension funds are highly exposed to currency risk associated with the US. Dollar, Euro and Japanese yen. Exchange rate fluctuations increase the level of portfolio risk, unless Danish pension funds hedge against the underlying currency.

Looking at the annual reports of Danish pension funds it is clear that all of them hedge exchange rates to a greater or lesser extent. All of the Danish pension funds use a Value at risk (VaR) method to measure, quantify and control the level of exchange rate risk. This allows them to continuously maintain a desired exchange rate exposure. The hedging method used varies between the different pension funds, but most prominent are derivative hedges such as forward contracts and options. These instruments are often rebalanced periodically to adapt to the changes in equity value. While some hedge the main currencies only, other hedges an interval from 50-100% of the exposure to all foreign currencies[145]. Nordea Liv &

[145] Based on information from annual reports

Pension hedges the full exposure to the main currencies. PensionDenmark fully hedges the US. Dollar and Japanese yen. Sampension KP hedges 50-100% of all foreign currencies, except the euro. Lærernes pension hedges all currencies fully except the US. Dollar and Swiss franc.

We have now documented that Danish pension funds hedges the exchange rate risk by using forward contracts and options. The advantage of these financial instruments is that they are highly standardized products that are traded in large and liquid markets. This allows the pension funds to fully eliminate currency risk at a very low cost. Perold & Schulman (1988) has estimated the spread of forward contracts to generally be between 0.0016 and 0.06 percent, where transaction costs are half the spread. These costs are probably even lower today. Transaction costs for Danish pension funds are estimated to account for 0.1 percent of total assets[146]. Consequently, hedging costs represent a very low cost compared to the other costs of investing abroad.

To conclude, exchange rate risk is hedged by Danish pension funds using financial instruments. Exchange rate risk should therefore not affect the asset allocation in Danish pension funds. The currency risk can be eliminated at a much lower cost using financial instruments than holding a home bias equity portfolio. It is therefore not likely that exchange rate risk is one of the main drivers behind the home equity bias in Danish pension funds.

7.1.3 Nonfinancial Income

The third explanation is that domestic equity represents a hedge against non-financial income, such as labor income. The intuition behind this is that there is a negative correlation between non-financial income and domestic equity. The empirical support of this explanation is weak[147].

However, it should be remembered that these studies are based on the average individual investor. For Danish pension funds, managing the balance of assets vs. liabilities is of great importance and this might represent a rationale for holding domestic equity. Craft (2006) found support of higher correlation between domestic equity and pension liabilities (highly affected by labor income levels) than for foreign equity. In regard to Danish pension funds, higher labor income levels will increase the pension savings and thereby affect the balance between assets and liabilities. This would drive the future liabilities upwards, and if domestic equities are positively correlated with income levels then it would provide a

[146] Djuna Thurley (2014), p. 9
[147] See section 5.2.1.3

hedge for the Danish pension funds. If Danish pension funds applied domestic equities to hedge against a rise in pension liabilities, then the home bias should go up when labor income increases. However, this argument lacks a foundation in the numbers. While the average salary in Denmark has increased steadily through the last decades[148], the home equity bias has decreased significantly. It could also be that the Danish Pension Fund wanted to hedge against the increased costs of higher salaries to employees. However, looking at the annual reports of Danish pension funds it is clear that salary expenses only contribute to a small portion of the total expenses. The Danish pension sector is also one of the most cost effective pension fund sectors in the world[149], with operating expenses accounting for only 0.1 percent of total assets. It is therefore hard to believe that this cost alone represents a motive for overweighting domestic equity and we will not investigate this explanation any further.

7.1.4 Taxes

The next explanation is based on a rationale to minimize tax payments. If an investor is faced with higher taxes on foreign equity it can induce a preference for domestic equities. The rationale behind this argument is that the implied additional costs stemming from taxes will outweigh the diversification benefits of holding an internationally diversified portfolio. This theory has some empirical support[150].

However, pension funds are often under beneficial tax treatment, and comparing Danish pension funds to the average investor should therefore yield different results. Denmark has the highest total tax burden in the EU[151]. Even though Danish pension returns have beneficial tax treatment, taxed with a flat 15.3 percent tax rate on capital return, it is still one of the highest tax rates in the EU[152]. Therefore, it is highly unlikely that Danish pension funds hold domestic equity due to tax reasons. In 2010 the pension return tax (PAL) was made individual, meaning that the tax payments were moved from the pension fund to the individual pension holder. The tax is still gathered by the pension funds by pulling it from the individual pension holder's return. As a result, the tax rate should not affect the investment strategy of Danish pension funds. Denmark also has one of the most developed networks of signed treaties with more than 70 countries[153]. Tax treaties help to counter cross-border tax evasion and ensure that Denmark obtains a right to tax returns on foreign assets. It also eliminates the problem of double taxation which might occur when

[148] Statistics of Denmark: Labor, earnings and income
[149] OECD Statistics: Operating expenses as a % of total assets
[150] See section 5.2.2.1
[151] OECD Revenue Statistics
[152] Yoo & Serres (2005)
[153] Deloitte (2013)

tax laws consider an individual or company to be a resident of more than one jurisdiction. It is therefore unlikely that holding foreign equity will result in higher taxes than holding domestic equity, thus refuting the tax argument. Consequently, we will not analyze this explanation more in depth.

7.1.5 Trading costs

Another explanation is trading costs. The rationale behind this is that investors have a preference for domestic equities as they are faced with additional costs when they acquire foreign equities. The empirical evidence for this explanation does not appear to be satisfactory[154].

As we presented in chapter 5, capital markets are not perfect. However, trading costs have been significantly decreased throughout the last decades and capital markets have become increasingly integrated. The globalization of international stock markets as well as the development of information technology has diminished trade- and transaction costs to historical low levels[155]. Danish pension funds are large institutional investors that are likely to achieve low trading prices as a result of their high trading volume. It must therefore be assumed that the pension funds are well positioned to overcome barriers related to trading costs. Transaction costs for Danish pension funds are estimated to account for 0.1 percent of total assets. It should also be remembered that Danish pension funds operate within a small and fairly illiquid market. The high liquidity in international stock markets should therefore induce Danish pension funds to increase their foreign investments.

In section 5.2.2.3 it was shown that foreign equity had a higher turnover rate than domestic equity in the years leading up to 1995, and we have no reason to believe that the cost of trading has increased after this. Additionally, many pension funds have large asset allocations to un-listed foreign equities, meaning that they are traded on a less-liquid market than the large stock exchanges. We therefore conclude that it is not reasonable that trading costs represent an explanation for the observed home equity bias in today's modern capital markets.

7.1.6 Formal barriers

Another similar explanation is based on formal barriers. If governments have imposed restrictions on how much foreigners are allowed to invest in a country, or alternatively how much capital that is allowed to flow in and out, it could be a contributing factor in explaining the home equity bias in Danish pension

[154] See section 5.2.2.2
[155] OECD (2007)

funds. This explanation had empirical support in earlier years, but the consensus today is that formal barriers are no longer relevant[156].

We have already shown in section 2.4 that Danish pension funds are under extensive legal regulation; however this only applies to the overall investment strategy, not the specific equity holdings. Formal trade barriers in international markets have been liberalized and the markets are today open to free trade. Consequently, equity markets are more integrated than ever before. Danish pension funds should in theory be able to invest in other international markets on an equal footing with the Danish market. Considering that the formal barrier explanations were labeled "outdated" as early as in the 1990's, we find no rationale to investigate whether it can explain the decline in Danish pension funds home equity bias during the last decade. The argument for formal barriers therefore seems irrelevant and is not a plausible explanation for the home equity bias.

7.1.7 Information Asymmetries

One of the most acclaimed explanations for the home bias is information asymmetry. The rationale behind this argument is that investors possess different levels of information, which affects portfolio allocations. If Danish pension funds have more knowledge about the Danish market than the foreign markets, this may explain the overweighting of domestic equity. The empirical evidence has shown that there is compelling evidence to support this hypothesis[157].

In perfect capital markets, all investors have complete information and have homogeneous expectations. However, we know that in the real world capital markets are not fully perfect and investors do have different levels of information. If Danish pension funds feel that foreigners have an information advantage regarding foreign equity markets, it is possible that Danish pension funds react to this information asymmetry by overweighting domestic equity. However, Danish pension funds are large institutional investors that are well-positioned to have the necessary knowledge and resources to follow global investment strategies. This includes knowledge about foreign markets and resources needed to monitor foreign equity markets on a real-time basis and produce thorough analyzes of foreign stocks before investing. Additionally, if the pension funds do not possess the required knowledge and skills internally they also have the opportunity to bring in external expertise due to the size of their available resources. On the other hand, Danish pension funds are an integral part of both the Danish capital markets and the

[156] See section 5.2.2.3
[157] See section 5.2.3

overall economy, and it is not unlikely that the pension funds have an information advantage about domestic stocks and that this causes the overweighting of domestic equity. It is clear that information represents an important factor that directly affects the investment decision. We will therefore investigate information asymmetry for Danish pension funds to see if this explanation is able to explain some of the observed home equity bias.

In order to investigate information asymmetry, we start by examining the historical portfolio allocations of Danish pension funds. The hypothesis for information asymmetry will be that the majority of foreign investments were made in listed companies. In addition, we should also find that the investments made in unlisted companies were mainly domestic, as information asymmetry would make it both hard and costly to obtain precise information on unlisted foreign equities. Once we have concluded our preliminary analysis of the portfolio allocations, we examine the actual returns that the Danish pension funds obtained on their investments. Here, the hypothesis will be that Danish pension funds have outperformed the benchmark (OMX Copenhagen) on the domestic market, and also that investments made in domestic unlisted equities outperformed those in foreign unlisted equities.

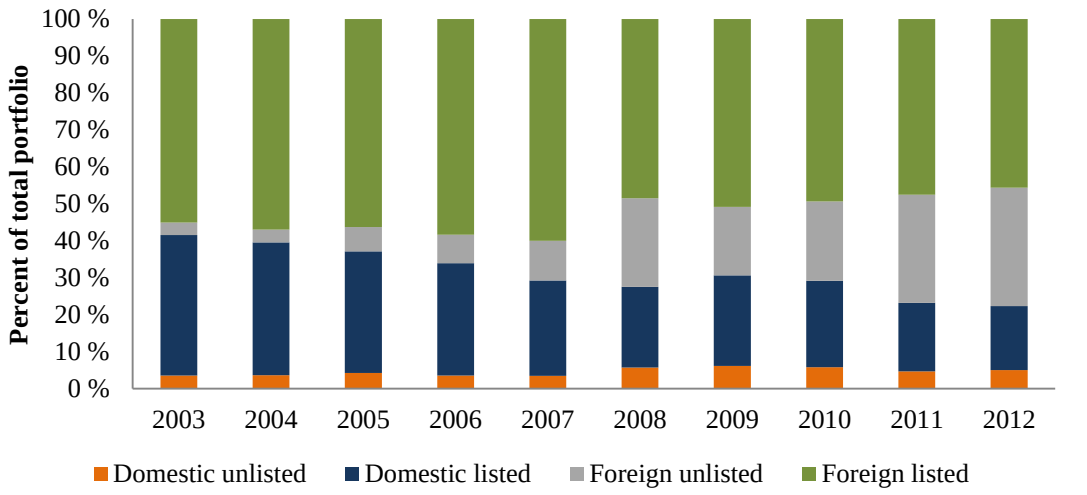

Figure 18: Figure showing the portfolio allocations for individual pension covering the period 2003-2012. Source: Annual reports and own contribution.

Regarding our first hypothesis, we observe that the majority of foreign investments were allocated to listed equities from 2003-2007. Thereafter, foreign unlisted equities have become a larger part of the total portfolio, representing a share of 32 percent in 2012. Thus, Danish pension funds do not appear to divert from unlisted foreign equities due to information asymmetry in the latter part of the previous decade. The

investments in foreign unlisted equities have grown at the expense of domestic listed equities, which also contradict our initial hypothesis. Domestic listed equities accounted for approximately 38 percent in 2003, but only 17 percent, respectively, in 2012. From the figure it is also clear that the investments in domestic unlisted equities were surpassed by unlisted foreign equities in 2005, a trend that continued throughout the decade. In fact, unlisted domestic equities only represent a minor percentage of the total portfolio, thus indicating that Danish pension funds are not in the possession of superior knowledge about smaller domestic firms.

Both these observations indicate that information asymmetry might have been a driver for the home equity bias in 2003-2004, but after that the portfolio allocations contradict our initial hypothesis. It is also possible that they are in possession of superior information about the domestic firms, but if their predictions are negative it would result in low or negative portfolio weights. Unfortunately we have no benchmark to compare the unlisted domestic equities against, which prevents us from exploring this theory.

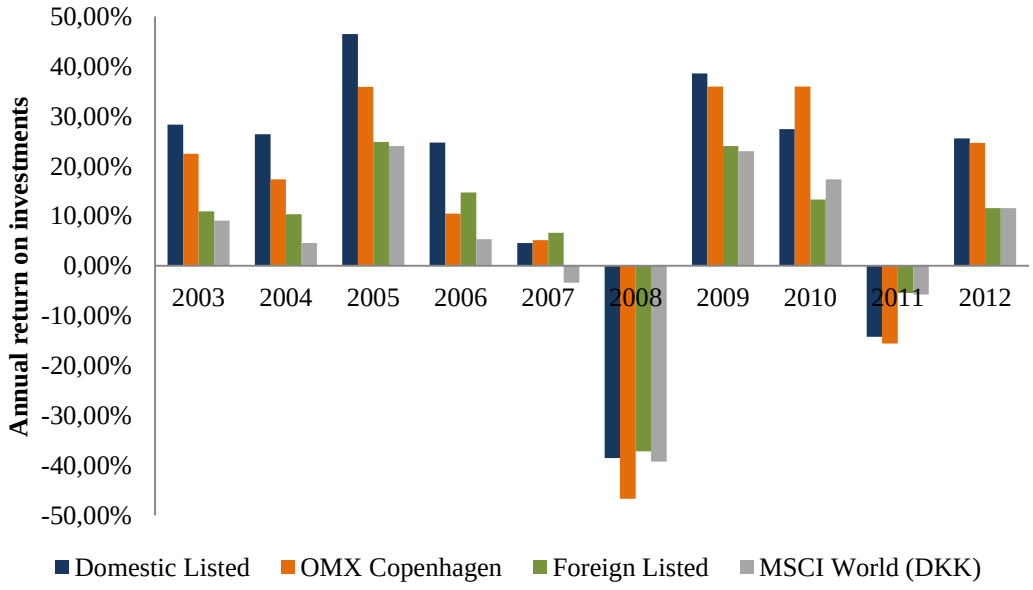

Figure 19: Figure showing the average pre-tax return on investments in listed equities covering the period 2003-2012. Source: Annual reports, DataStream and own contribution.

The average return on domestic listed equities for Danish pension funds was 17 percent, with the OMX Copenhagen delivering an average annual return of 12.5 percent in the same period. The first intuition from this is that the Danish pension funds have good knowledge about the Danish equity market.

According to figure 19 they outperformed the domestic benchmark in eight out of ten years, and are able to translate this knowledge into profitable investments. However, in the same period, the Danish pension funds achieved an annual return on the listed foreign equities of 7.4 percent, while the MSCI world benchmark had an average annual return of 4.7 percent. Thus, they also outperformed the benchmark on their foreign investments, which does not coincide with them having an information disadvantage when investing abroad. We do however have one indication that they possess an information advantage on the domestic market, specifically that Danish pension funds had an average excess return compared to their benchmark on the domestic market of 4.4 percent, while the same number for foreign investments was 2.7 percent. Consequently, Danish pension funds have obtained both an absolute higher return and excess return on their domestic investments compared to the foreign investments, which indicates that they have an information advantage when investing at home. As a result, their competence of judging domestic equities could be one of the drivers behind the home equity bias, even though the allocation to domestic equities has decreased throughout 2003-2012.

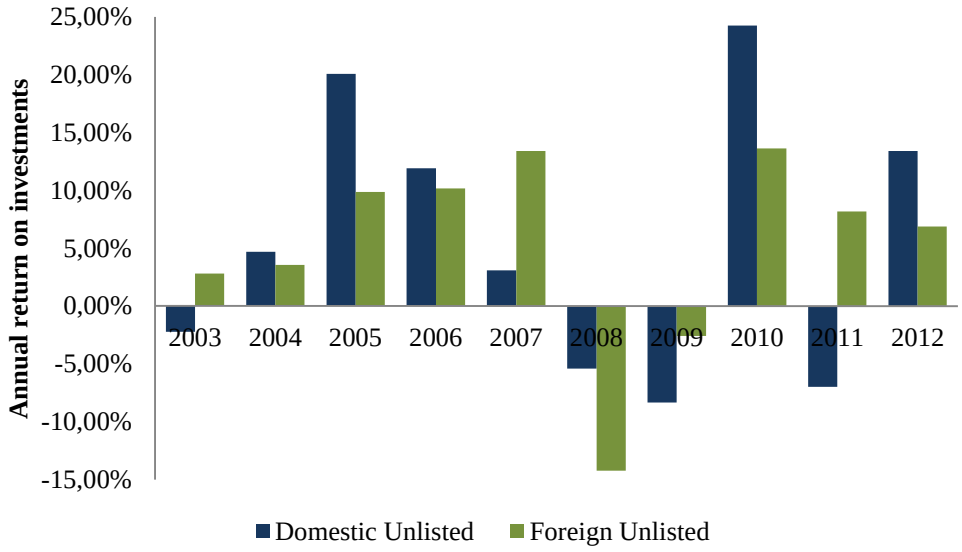

Figure 20: Figure showing the average pre-tax return on investments in unlisted equities covering the period 2003-2012. Source: Annual reports, DataStream and own contribution.

Our final hypothesis regarding information asymmetry was that the returns on domestic unlisted equities should outperform the return on foreign unlisted equities. As we can see from the figure, six out of ten years have yielded a higher return on the domestic market. The average annual return on domestic unlisted equities was 5.4 percent, while the same figure for foreign unlisted equities was 5.2 percent. This difference is much lower than the theory behind information asymmetry predicted. However, it is

important to remember that we cannot draw any conclusions from this graph due to the absence of a benchmark portfolio. It could be the case that foreigners who have invested in Danish unlisted equities have performed worse than the Danish pension funds, which would coincide with the theory of information asymmetry. What we can say is that foreign unlisted equities have either performed better in general than Danish unlisted equities, or alternatively the Danish pension funds are better at analyzing these companies than the advocates of information asymmetry suggests.

To conclude, the findings from our analysis of information asymmetry does not coincide with our initial expectations. This was surprising given the amount of proponents that have supported information asymmetry as a key explanation in earlier studies. Danish pension funds invested on average approximately twice as much in foreign unlisted equities as domestic listed equities in 2012. Furthermore, they were able to outperform the benchmark for foreign equities in nine out of ten years, which is more than they were able to on the Danish equity market. The average return on unlisted domestic and foreign equities was very similar, which contradicted the theory of information advantage when investing in smaller foreign equities. Supporting information asymmetry was the finding of a higher excess return from the domestic equities, which could be due to an information advantage. In short, although the interpretation of the numbers is not straightforward, it appears as though information asymmetry is not one of the main drivers behind the home equity bias in Danish pension funds. One probable explanation for this finding is that the size and research team of the pension funds helps alleviating the information asymmetry that is present when an individual investor decides to invest abroad.

7.1.8 Familiarity stemming from trade

Another factor that is closely related to information asymmetry is familiarity stemming from trade. The logic behind this argument is that trade in goods will correlate with trade in financial assets. When countries are closely linked through trade, it becomes more natural for citizens to invest in the other country as they become familiar with the foreign economy. The empirical evidence for this explanation is mixed and does not give a clear cut answer[158].

We saw in section 4.1 that international trade and foreign portfolio investments have increased sharply over the last decades in Denmark. This could, according to theory, result in increased information about foreign markets and mitigate the home equity bias. Denmark is today a highly globalized country and

[158] See section 5.2.4

dependent on international trade[159]. It is therefore possible that this increase has contributed to the downward trend in home equity bias for Danish pension funds observed in chapter 6. The argument is appealing if we consider a closed economy that has suddenly experienced an increase in trade, but due to Denmark's global economy it is hard to imagine that it drives the investment decision of Danish pension funds. As we know from section 5.2.4, looking at the numbers, Cooper, Sercu, & Vanpée (2012) showed that increased trade does not coincide with increased foreign investments. As the explanation also lacks a foundation in the numbers, we therefore do not perceive it to be a contributing factor to the home equity bias in Danish pension funds.

7.1.9 Governance and transparency issues

Another factor that is closely related to information asymmetry is governance and transparency, which in turn affects the home equity bias. Investors tend to avoid markets with poor investor protection. As a result, foreign investments become less attractive which in turn increases the home bias in the country. Empirical evidence suggests that governance and transparency represent important factors in explaining the home bias[160].

It might be that Danish pension funds find foreign markets less attractive as a result of poor investor protection and low transparency. The importance of a good quality institutional framework for the efficiency of equity markets is already highly recognized. Poor investor protection can lead to management expropriating wealth from the company, leaving the investors to bear the cost.
It is reasonable to assume that Danish pension funds avoid investing in countries where this could become a reality. It is therefore plausible that an improvement in the institutional framework in foreign markets has reduced the home equity bias over the last 10 years. Another factor of relevance for Danish pension funds is the size of their investment portfolios. If they become block holders in companies, then they have more incentives to monitor the management and diminish any agency problems. On the other hand, this is costly and may yet again result in investments being made in countries with better investor protection. Danish pension funds tend to have a low-risk profile and an increasing social responsibility. It is therefore of high importance that their investments are in line with the overall investment policy. As a result, it is critical that they are able to process information from foreign investment opportunities to ensure that they are in line with the investment policy. If a company withholds information about the way it conducts its business, or alternatively, the Danish pension funds have to spend large amounts on processing the

[159] See section 4.1
[160] See section 5.2.5

information, it makes the investment less attractive. Consequently, transparency will also play an important part in determining the investment allocations. We therefore believe that it is of interest to investigate whether this explanation can explain some of the observed home equity bias.

In order to analyze if Danish pension funds underweight foreign markets with poor governance and transparency issues we will start by looking at how these variables differ between Denmark and foreign markets. After we have identified countries with severe governance and transparency problems we can relate this to the asset allocation of Danish pension funds. We expect to find lower foreign equity investments in the countries associated with the greatest governance and transparency problems.

Denmark is ranked the least corrupt country in the world (2012), according to Corruption Perceptions Index (CPI) by International Transparency[161]. Denmark scores 91 of 100 points, where a score below 50 indicates a serious corruption problem. The index measures corruption by their perceived levels of corruption, as determined by expert assessments and opinion surveys of public sector corruption in 177 countries around the world. Further, The Worldwide Governance Indicators (TWGI) developed by Kaufman et al (2009) shows aggregate and individual governance indicators for 215 economies over the period 1996–2012, for six dimensions of governance[162]. The indicators used include voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. According to Cooper, Sercu and Vanpée (2012, p.379), "these indicators captures the effect of the quality of government institutions in general, aggregating separate ratings on the quality of public services, the quality of the civil service and the degree of its independence from political pressure, the quality of policy formation and implementation, and the credibility of the government's commitment to such policies".

These rankings suggest that the Danish market has good investor protection and a high degree of transparency. Consequently, Danish pension funds have a low degree of risk related to investor protection when investing in domestic equity. If foreign equity is perceived as riskier because of governance and transparency issues this might explain some of the overweight in domestic equity. It will therefore be interesting to look at the ranking results for other foreign markets and how this has changed over time.

[161] Transparency International Corruption Perceptions Index 2013

[162] Details on the underlying data sources, the aggregation method, and the interpretation of the indicators, can be found in the WGI methodology paper: The Worldwide Governance Indicators. Daniel Kaufmann, Aart Kraay and Massimo Mastruzzi (2010). "The Worldwide Governance Indicators : A Summary of Methodology, Data and Analytical Issues". World Bank Policy Research Working Paper No. 5430

Table 12 shows the average score in TWGI and CPI as well as the average asset allocation in each international market. TWGI and CPI will serve as a proxy for the investor protection in each international market by indicating governance and transparency issues. A lower score represents a lower degree of investor protection. The score for TWGI are calculated as the average score of the six individual indicators. The scores of 36 individual countries are included in the data. The range of countries included is based on the country list of each index[163]. The data used contains 2160 individual scores for TWGI and 360 for CPI for the period 2003-2012. Asset allocation is based on a sample of six pension funds (Danica Pension, Sampension KP, Jurister og Økonomer, Nordea Liv & Pension, Industriens Pension and SEB Pension) and will serve as a proxy for the Danish pension fund sector.

Historical scores and asset allocation	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Min	Max	Average
Asset allocation Danmark	28,05 %	28,05 %	19,48 %	21,85 %	21,38 %	18,02 %	23,08 %	21,63 %	20,12 %	18,02 %	18,02 %	28,05 %	21,97 %
The Worldwide Governance Indicators	98	96	97	97	97	97	97	97	97	95	95	98	97
Corruption Perceptions Index	95	95	95	95	94	93	93	93	94	90	90	95	94
Asset allocation Europe Ex Denmark	30,32 %	30,88 %	27,50 %	28,90 %	31,25 %	30,72 %	25,92 %	28,63 %	24,83 %	27,73 %	24,83 %	31,25 %	28,67 %
The Worldwide Governance Indicators	88	88	88	88	88	88	87	87	87	87	87	88	88
Corruption Perceptions Index	78	78	79	78	78	75	76	75	76	73	73	79	77
Asset allocation North-America	28,68 %	26,27 %	28,05 %	28,52 %	29,17 %	36,78 %	36,15 %	31,20 %	37,12 %	35,03 %	26,27 %	37,12 %	31,70 %
The Worldwide Governance Indicators	89	87	87	89	89	90	89	89	89	90	87	90	89
Corruption Perceptions Index	81	80	80	79	80	80	81	80	79	79	79	81	80
Asset allocation EM Latin America	0,68 %	0,57 %	0,88 %	0,95 %	1,43 %	0,92 %	1,73 %	1,67 %	1,40 %	1,62 %	0,57 %	1,73 %	1,19 %
The Worldwide Governance Indicators	54	54	53	53	52	52	53	55	55	54	52	55	53
Corruption Perceptions Index	45	44	44	42	43	43	42	42	42	45	42	45	43
Asset allocation Japan	3,97 %	6,17 %	11,67 %	8,18 %	6,87 %	6,17 %	3,60 %	4,40 %	3,97 %	4,70 %	3,60 %	11,67 %	5,97 %
The Worldwide Governance Indicators	83	85	85	87	84	83	85	85	86	85	83	87	85
Corruption Perceptions Index	70	69	73	76	75	73	77	78	80	74	69	80	75
Asset allocation AC Asia Pacific Ex Japan	3,43 %	3,55 %	4,55 %	4,55 %	4,85 %	2,92 %	4,63 %	4,82 %	4,20 %	5,37 %	2,92 %	5,37 %	4,29 %
The Worldwide Governance Indicators	63	63	64	62	61	61	61	61	61	62	61	64	62
Corruption Perceptions Index	54	54	56	56	56	56	56	56	56	53	53	56	55

Table 12: Shows the average yearly score of each international market in The Worldwide Governance Indicators (TWGI) and Corruption Perceptions Index (CPI) as well as the average asset allocation in each international market. Green indicates high score, red indicates low score. Source: Transparency international, Daniel Kaufmann, Aart Kraay and Massimo Mastruzzi.

Looking at the average score in TWGI and CPI for foreign markets we see that they are significantly lower than for Denmark. The individual scores for each country are given in appendix 12. Denmark has the highest score in all consequent years and represents the highest level of investor protection. However, Denmark has experienced a downward trend since 2003. Europe and North-America receive fairly stable scores in the top layer. Even though Japan receives lower scores in both TWGI and CPI, it still ranks in the upper layer. It has also exhibited an upward trend in the scores, which suggests increasingly better investor protection. The rest of Asia Pacific scores below Japan and shows a low stable trend. It is clear that the investor protection in Asia has not improved since 2003. The absolute worst performer is Latin America, where there has not been any improvement over the period. The average score indicates severe governance and transparency issues. It is not unlikely that problems related to governance and

[163] See last part of section 1.4

transparency makes the market less attractive to Danish pension funds. A graph of each individual market is given in appendix 13. Having documented the investor protection in each country, we are now able to compare these scores to the asset allocation of Danish pension funds.

From table 12 it is clear that Danish pension funds have invested the largest proportion of the equity portfolio in international markets with scores in the upper layer, with the highest percentage invested in North America, Europe and Denmark, respectively. A possible hypothesis is that the high investor protection in Denmark causes Danish pension funds to overweight domestic assets compared to what is optimal from an international diversification perspective. The asset allocation in Japan is also significant, coinciding with Japans high investor protection. The equity investments in the rest of Asia are as expected as the rest of Asia shows considerably lower scores. The higher score of Japan might explain why Danish pension funds seem to invest considerable more in Japan than the other Asian countries. The lowest proportion of the equity portfolio is invested in Latin America which also performs worst according to both TWGI and CPI. It is therefore not unlikely that Danish pension funds perceive this market as more risky as a result of governance and transparency issues and therefore limit their exposure to this market.

From our analysis, we have found supporting evidence for governance and transparency as explanatory factors for the home equity bias. The asset allocation appears to correspond with the level of investor protection. However, to be able to conclude anything a more thorough analysis would have been more appropriate. This includes more sophisticated data on foreign investments of Danish pension funds in each individual country. Due to the lack of data on foreign investments on a country level we were unable to do this. To conclude, both governance and transparency appear to influence the investment decision of Danish pension funds.

7.1.10 Overconfidence

It is also possible that the observed home equity bias is a result of behavior biases. A possible psychological factor is overconfidence. Overconfidence is overestimating or exaggerating one's information advantage, skills or knowledge. This could in turn affect the investment decision and result in an overweight of domestic equity.

Danish pension funds are large institutional investors that in theory should be less exposed to overconfidence than individual investors. Due to their corporate structure and evaluation of investment strategies, a continuing bias of overconfidence appears unlikely. On the other hand, if we imagine a setting

where portfolio analysts get their predictions correct over a longer period, they could become overconfident in their stock-predicting abilities. It has been shown that this overconfidence is usually related to investments the investor is familiar with, thus resulting in a home bias. However, we find this theory less likely as Danish pension funds are long-term investors who are risk averse. Thus, as long as the investment horizon has a sufficient long-term view, the pension funds would be able to continuously evaluate the investment. If some factors change that alters the investment decision, they could close their position. If certain portfolio managers exhibited a repetitive pattern of being overconfident in their predictions on the domestic market, the pension fund would likely alter the way they decide portfolio allocations. We therefore discard the explanation as relevant for the observed home equity bias.

7.1.11 Over-optimism

Closely related to the overconfidence bias, there is a widespread agreement that investors are over-optimistic towards their local market. If investors believe that their domestic market will outperform the foreign markets, it leads to a home bias. Strong & Xu (2003) and French & Poterba (1991) have found support for this theory[164].

If Danish pension funds have a bullish outlook on the Danish stock market and are more bearish towards foreign markets, the natural decision would be to assign higher weights to the domestic market. Similar to the overconfidence explanation, this bias affects both the risk and the return perception of equities. What separates them is that over-optimism has been found through survey data on fund managers' beliefs, thus making it more applicable to the Danish pension funds. A similar argument as in the previous section could be applied, relating the alleviation of this bias to the corporate structure and performance evaluation of pension funds. It would however be hard to remove such a bias if it is present with the majority of the fund managers. Due to its relevance for fund managers we have decided to investigate whether this bias can be helpful in explaining the home equity bias.

In order to investigate the relevance of over-optimism we follow the framework of French & Poterba (1991), which is also the same approach as Skov and Meyer's (2006) thesis. This method calculates the implied market returns from both the world portfolio and the actual Danish pension fund weights, based on the covariance matrix of the indices that are included in the market portfolio. The relative optimism towards a market will thus be depicted as the difference between the implied returns from actual portfolio

[164] See section 5.2.6.2

weights and the world portfolio. Instead of using the MSCI World Index as market portfolio, we have relied on the same benchmark indices as we used to determine the market capitalization portfolio in part 6.1.1, except for South Africa and Russia. The covariance matrix (appendix 14) will therefore not be the same as under the mean-variance approach and in part 1.4 the differences in the data are specified. In addition, we also had to make some assumptions in order to relate the asset allocations to indices. With regards to figure 17 in section 7.1.2, "other countries" were classified as FM Africa, "other far east" was classified as AC Asia Pacific ex Japan and "South-America" was classified as EM Emerging markets. Finally, we excluded TopDanmark, Lærernes Pension and Sampension KP due to their high weights in "unallocated" in order to conduct the analysis.

The equation to calculate the implied returns is given by:

$$Implied\ returns\ (\mu) = \lambda \omega^{*\prime} \Sigma \quad (25)$$

Where the level of risk aversion equals λ, $\omega^{*\prime}$ is the actual portfolio weights and Σ is the covariance matrix of the market portfolio. According to Tesar and Werner (1995), a risk aversion of 10 will impose no-short constraints on the portfolio optimization, which coincides with our previous constraints on Danish pension funds (see section 6.1.3.1). Many studies assume that the correct risk-aversion is 3[165], and in order to determine what risk aversion that will be representative of the Danish pension funds, we examine the portfolio holdings of equity relative to the total financial portfolio.

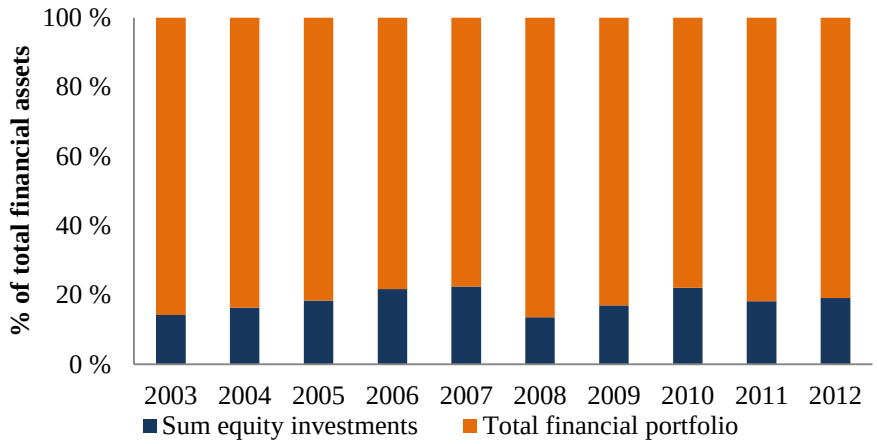

Figure 21: Figure showing the share of equity investments of the total financial portfolio of Danish pension funds. Source: The Danish FSA livsforsikringsstatistikk and own contribution.

[165] See for instance French & Poterba (1991) or Glassman & Riddick (2001)

From the figure it is clear that equities have amounted to approximately 20 percent of the portfolio for Danish pension funds, thus representing a relatively low and stable share. The risk aversion in Danish pension funds is likely to be higher than for individual investors due to their importance for the overall economy, as well as the interest rate guarantees. We decided to set the level at 7, which should be sufficiently high to avoid any short-sales and still be representative of the Danish pension fund sector. This level is however set arbitrarily, similar to other articles, something the reader should keep in mind when presented with the results.

Risk aversion	7						
Implied Market returns	**Denmark**	**Europe Ex Denmark**	**North-America**	**EM Latin America**	**FM Africa**	**AC Asia Pacific Ex Japan**	**Japan**
Danish pension funds	26,58 %	27,90 %	20,37 %	30,70 %	2,22 %	17,14 %	9,23 %
Market capitalization model	22,71 %	25,81 %	21,02 %	31,12 %	1,17 %	19,40 %	10,99 %
Difference in implied returns	**3,87 %**	**2,09 %**	-0,65 %	-0,42 %	**1,05 %**	-2,26 %	-1,76 %

Table 13: Figure showing the implied market returns from the actual holdings of Danish pension funds and the world portfolio in 2012. Source: Annual reports, DataStream and own contribution.

According to table 13, the needed return to justify Danish pension funds' holdings of domestic equities had to be 387 basis points higher than what is implied by the market portfolio. This is a clear indication that Danish pension funds are over-optimistic towards their domestic market. Apart from Africa, they were also over-optimistic towards the return of European equities, which can also be viewed as supportive of this explanation. Europe lies closer to Denmark than any of the other indices above, which indicates that the closer you get to "home", the more optimistic are Danish pension funds towards the market. Furthermore, we also observe negative differences for North-America, Latin America, Asia excluding Japan and Japan. For instance, Danish pension funds' holdings indicated that the implied return in Japan is 176 basis points below what is implied by the market portfolio. This finding is also supportive of the theory, as domestic investors would perceive foreign investments as risky and thus be more bearish.

In an optimal setting, this analysis would have compared the implied returns across pension funds that are separated geographically, thus allowing us to determine whether Danish investors are more optimistic towards the Danish equity market than investors located in another country. This is however not within the scope of our analysis, but this section has found clear indications that Danish pension funds are over-optimistic towards the Danish equity market than a fully diversified investor (the market portfolio). Consequently, the home equity bias can partially be explained by the bullish outlook of Danish pension funds' on the domestic equity market.

7.1.12 Familiarity bias

Another psychological factor that has been brought forward is the familiarity bias. Familiarity bias claims that people are more likely to invest in firms that are more familiar to them and perceive foreign stocks as more risky. Huberman (2001) suggests that this factor is able to explain some of the home equity bias[166].

It must be assumed that Danish pension funds have the needed resources and knowledge to monitor their investments on a real time basis and produce thorough forecasts of future investments. Similar to the discussion on overconfidence, an evaluation of stock predictions versus actual returns would help with alleviating the familiarity bias, and the evaluation is likely to be part of the corporate structure at pension funds. In our opinion, familiarity bias is more likely to occur at the individual level where investors are unaware of the benefits of international diversification. It would therefore be strange if Danish pension attribute a lower risk to these familiar companies if this was not the case. However, there is a problem related to applying a rational thought process when we are evaluating a behavioral bias. Familiarity bias has an intuitive appeal, in that investors believing that the foreign equities are more risky will lead them to believing they are unable to properly evaluate the foreign equities. This argument is closely related to information asymmetry and over-optimism, but it does not necessarily imply that there is information asymmetries present between domestic and foreign investors. As information asymmetry is the most renowned explanation for the home equity bias, we will also investigate whether there are indications of familiarity bias in Danish pension funds.

In order to investigate the familiarity bias within Danish pension funds, we apply the stock market correlation between home and host country as a proxy for familiarity, which is the same approach as Cooper, Sercu and Vanpée (2012). Similar to our previous section on over-optimism, we have to calculate the correlation matrix based on the new indices that represent our world-market portfolio, thus making it different from our analysis in chapter 4. The correlation matrix can be found in appendix 15. The hypothesis for familiarity bias will be that Danish pension funds will be more heavily weighted in countries that correlate with the Danish equity market, or put another way, they invest less abroad in countries that are dissimilar to Denmark. The first figure presents the results for Europe, North America and Asia, while the second figure presents the results for Africa, Japan and Latin America.

[166] See section 5.2.6.3

Alternatively we could also draw some conclusions on this explanation from our previous sections. In chapter 4 we showed that the correlations between Denmark and international markets have been increasing, and in section 7.1.9 we presented the portfolio allocations over time. We already know that Denmark and Europe have the highest correlations and that Europe is also one of the markets where Danish pension funds have allocated a large share of their foreign equity investments, which supports the familiarity bias explanation. Consequently, this section will emphasize the development in correlation compared to the development in foreign investments.

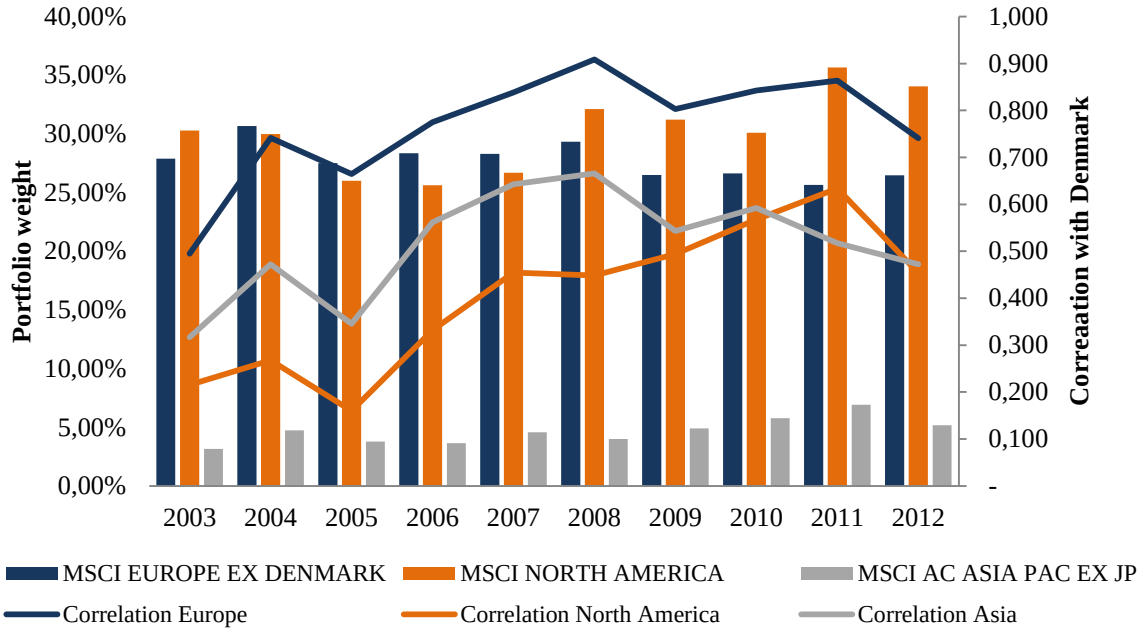

Figure 22: Figure showing the average portfolio weights of Danish pension funds and its correlation with Denmark in Europe, North America and Asia. Source: DataStream, annual reports and own contribution.

The first observation from the figure is that the correlation between Denmark and Europe has increased over time, but the investments in European equities have had a slight decrease. The correlation between Denmark and North America also increased over the period, simultaneously with increasing investments. This observation also holds for the Asian market. It is however not easy to draw any conclusions from the figure in relation to the development in home equity bias. North America had a lower correlation with Denmark than Asia for all years except 2011, but had a much higher portfolio weight every year. The reason for our lack of concluding evidence from this graph could very well be that stock market correlation is not a proper proxy for familiarity. The U.S. stock market is the largest in the world, which would make it familiar to Danish pension funds. If we had relied on another proxy, such as the news coverage of the foreign market in Danish papers, we might see a different result.

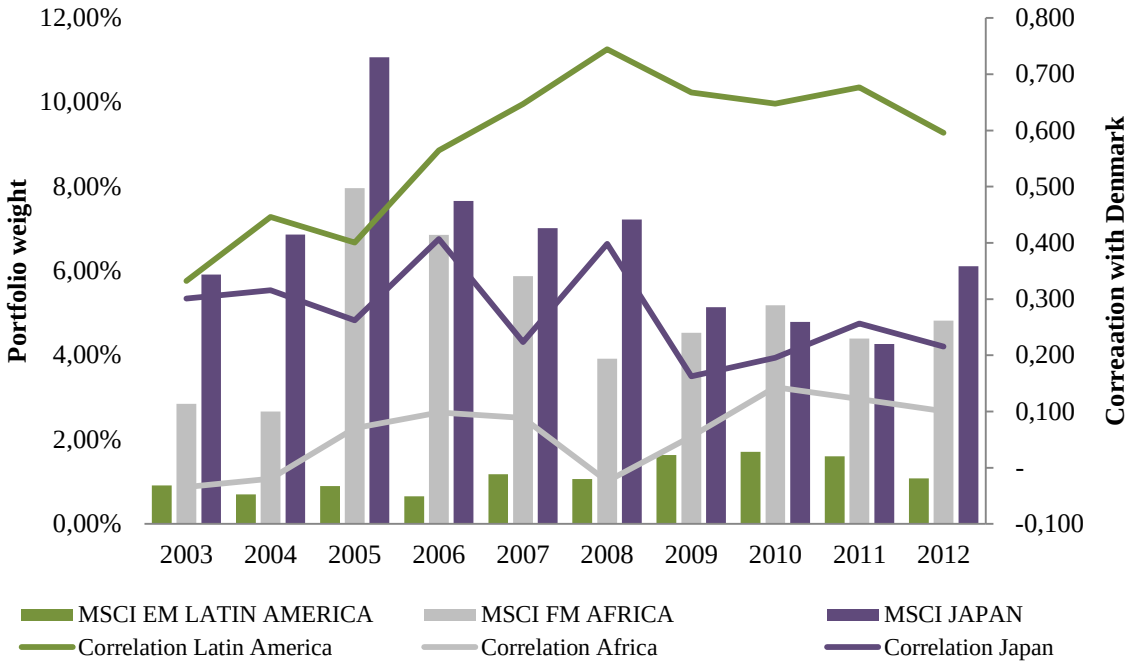

Figure 23: Figure showing the average portfolio weights of Danish pension funds and its correlation with Denmark in Latin America, Africa and Japan. Source: DataStream, annual reports and own contribution.

Figure 23 also shows ambiguous results, with the correlation between Denmark and Latin America experiencing a large increase simultaneously with approximately no growth in equity investments over the period. The correlation between Denmark and Japan decreased while investments were again approximately the same in 2012 as they were in 2003. For the African market, we observe both an increase in correlation and the equity investments.

If we alter our focus towards the absolute correlation, rather than the development in correlation, we again observe ambiguous results. The correlation between Denmark and Latin America was the second highest in 2012, but the equity investments in Latin America were the lowest in 2012. This does not support our initial hypothesis, which may be due to our choice of proxy. Similarly, North America had the highest share of equity investments in most of our observations, but its correlation with Denmark was surpassed by Europe, Latin America and Asia (all but one) in every year. An alternative explanation for the mixed results is that the proxies we apply when trying to explain the home equity bias provide overlapping evidence. Thus, although Latin America had a high correlation with Denmark, the explanation for the low portfolio weight could be down to their poor corporate governance and transparency scores.

To conclude, we have found no evidence of a familiarity bias within Danish pension funds.
This could be explained by our initial discussion that they are able to alleviate the risk perception of foreign markets through corporate mechanisms such as evaluation, or alternatively that our choice of proxy for familiarity is inappropriate. Another explanation is that when stock market correlation is high, it also represents reduced diversification benefits. An alternative approach to this analysis would have been to study the proximity of where the investments of Danish pension funds are located with regards to their headquarters. This approach was applied by Huberman (2001), but is not within the scope of our analysis.

7.1.13 Patriotism

Out of the behavioral bias explanations brought forward, patriotism is the one that is hardest to understand in the setting of portfolio allocation. The argument is that investors prefer domestic equities in order to support their home nation, and that it is unrelated to a belief that domestic equities will outperform foreign equities. Morse and Shive (2011) found support for this explanation[167].

In regards to the Danish pension fund sector, patriotism is highly unlikely to contribute to explaining the persisting home equity bias. Danish pension funds are professional investors and are competing with other pension funds to increase their market share. Thus, investment strategies that are not based on maximizing the future pension payout would not be a sustainable business strategy. Furthermore, it is much easier to accept that individual investors suffer from behavioral biases such as patriotism, but not when the investment strategy is developed and executed by teams of professional investors. On the other hand, it might be that some segments of the Danish population consist of people with high patriotism and that it therefore will be favorable for Danish pension funds to invest in Denmark as a way of attracting these customers. However, this seems very unlikely, as the costs of holding a home equity biased portfolio must be assumed to highly exceed the additional pension savings from these customers. Consequently, we will not pursue this explanation any further.

[167] See section 5.2.6.4

7.1.14 Herding

The last behavioral bias explanation deals with herding amongst portfolio managers. The rationale behind this argument is that portfolio managers replicate the investment strategies of other institutions, and if these peers are heavily weighted in the domestic market, it results in home bias. However, the empirical evidence for this explanation is mixed.[168]

From section 6.3.2 we saw that the pension funds exhibited varying portfolio allocations to foreign and domestic equities, indicating that any herding effect might be absent in the Danish pension fund sector. This finding was however only stationary and an investigation of investment strategy over time might show a convergence in investment patterns. In essence, herding offers a probable explanation why Danish pension funds are overly invested in the Danish market. For instance, the fact that three out of the six largest pension funds exhibit a significant home bias could signal to smaller pension funds that this is a valid investment strategy. One major limitation with this explanation however is that the home bias has declined steadily over the last decade, while the largest pension funds still exhibit a strong home bias. In order to draw any conclusions on this matter, we examine the investment data over time to see if there are any indications of herding amongst the Danish pension funds.

In order to analyze if herding affects the investment decision in Danish pension funds we need to compare the historical asset allocation between individual Danish pension funds. In this section we rely on the sample of six Danish pension funds in the period from 2003-2012. These include Danica Pension, Sampension KP, Jurister og Økonomer, Nordea Liv & Pension, Industriens Pension and SEB Pension. These six pension funds will serve as a proxy for the Danish pension fund sector. An investigation of the historical asset allocating allows us to look for investment patterns that might show signs of herding effect in Danish pension funds.

Our initial hypothesis is that we expect to see a common investment pattern that holds for all the pension funds, whether in the form of a stationary pattern or in the form of a convergence pattern from 2003 until 2012. If we find evidence of a common pattern, then this can represent a herding effect in Danish pension funds. It is important to remember that there are individual differences between the pension funds and that we therefore would not expect to see an exact investment pattern for every pension fund.

[168] See section 5.2.6.5

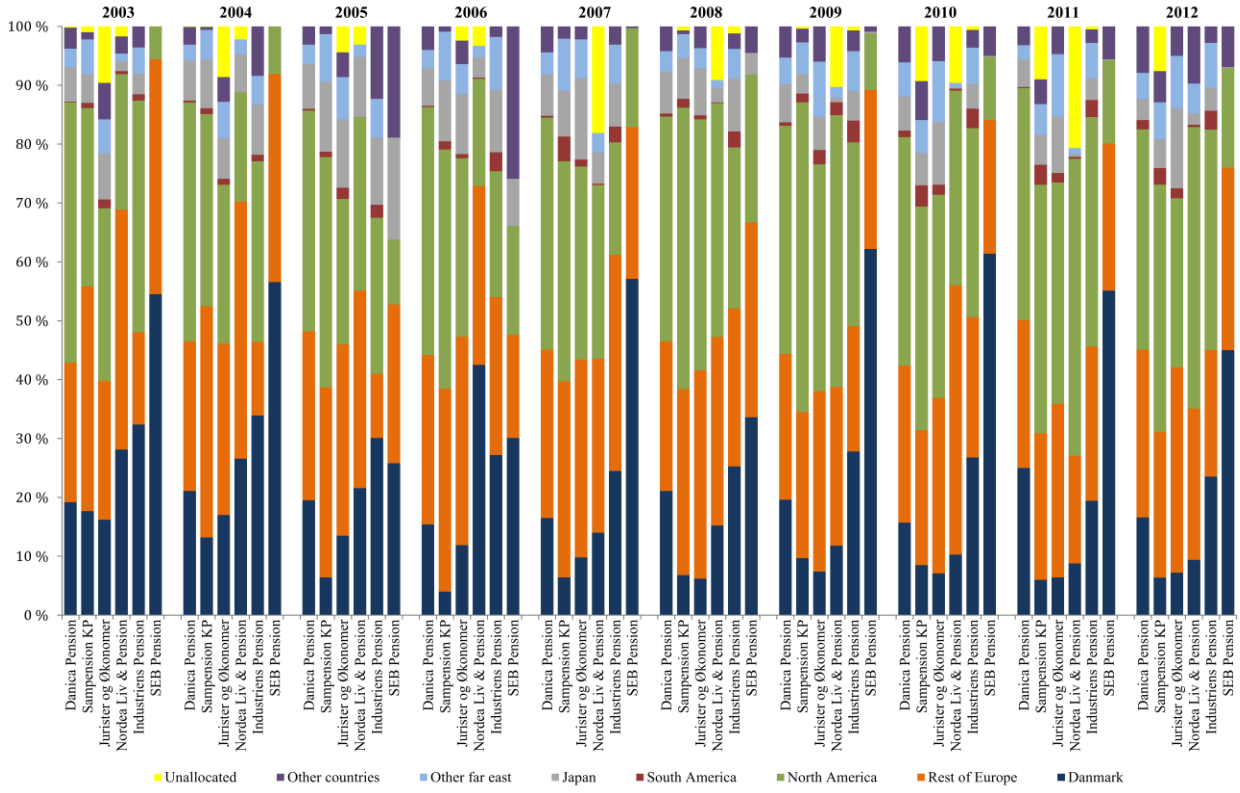

Figure 24: Shows the historical asset allocation (2003-2012) for six Danish pension funds. Source: Annual reports and own contribution.

Figure 24 shows the historical asset allocation for the six Danish pension funds in scope. First of all, we note that the asset allocation has significantly changed from 2003 until 2012. The majority of the pension funds have steadily reduced their domestic equity investments. This is in accordance with the general downward trend in home equity bias we documented in section 6.2. We also note that the investments in North America, other far east and other countries have increased significantly. What is interesting to note is that this development seems to apply to several of the pension funds. Especially the smallest pension funds (Sampension KP, Jurister og Økonomer and Nordea Liv og Pension) seem to have converged to a similar level of domestic equity. SEB Pension has had a larger allocation of equity in domestic assets than the other pension funds, but they have also reduced the proportion in domestic assets over the period. We also note that the asset allocation in Europe and other Far East countries has converged over the last 10 years. However, we still observe significant individual differences in the asset allocation in Japan and other countries. This makes it challenging to draw any conclusions based on this graph alone.

To conclude, it appears as though the asset allocations have had a common investment pattern over time, at least for Denmark, Europe and North-America. With regards to herding, this finding supports the initial

hypothesis as none of the pension funds stand out with high portfolio weights in countries that the other peers are not heavily engaged in, like Japan or South America. There are also some indications of converging investment allocations amongst the smaller pension funds, but this only holds for the domestic and European investments. Refuting the herding effect is SEB pension, who appear to follow an individual investment strategy with higher allocations to Denmark and lower in Northern America. It is also possible that the similarities between portfolio allocations are due to other factors that influence the investment strategy, such as over-optimism or corporate governance. We cannot draw any clear cut conclusions from the analysis above, but the numbers indicate that Danish pension funds follow investment strategies that are not too far off the strategy of their peers.

7.2 Sub-Conclusion

In order to determine which of the most acclaimed explanations for home equity bias that was relevant for our thesis, this chapter investigated each of them in regards to Danish pension funds. Based on previous work and a discussion on its relevance, the explanations we investigated were exchange rate risk, information asymmetries, governance and transparency issues and a number of behavioral biases.
In the analysis of exchange rate risk on home equity bias we showed that currency volatility is significant for Danish pension funds. However, hedging derivatives are able to alleviate its influence on the investment decision and is therefore not one of the drivers behind the observed home equity bias.

Information asymmetry was the most acclaimed explanation in previous articles on home equity bias, but we did not find any convincing evidence of its impact on the home equity bias in Danish pension funds. Foreign investments in unlisted companies exceeded the investments on the domestic market, while generating approximately the same return on investments. Additionally, investments in foreign listed equities generated an excess return compared to its benchmark, although lower than the excess return on listed domestic equities. The findings on foreign investments contradicted our initial hypothesis, and we were therefore unable to obtain convincing evidence of information asymmetries between Danish pension funds and foreign markets.

More compelling evidence was found when we investigated the explanation regarding governance and transparency issues. Denmark obtained the highest ranking in investor protection throughout the analysis period, which coincides with a high portfolio weight on the domestic market. Furthermore, North America and Europe ranked second and third while simultaneously being the regions where Danish pension funds have invested the highest percentage of equity. Oppositely, Latin America had the lowest rank and also

the lowest equity investments. Danish pension funds appear to allocate investments to regions where investor protection is not an issue.

The behavioral biases that provided probable explanations for the home equity bias in Danish pension funds were over-optimism, familiarity and herding. In the analysis of over-optimism, we found support for Danish pension funds expecting higher returns from the domestic market than is implied by the market portfolio. With regards to familiarity bias, we found no evidence that Danish pension funds invest more in countries that have a higher correlation with the Danish market. Lastly, we found indications that Danish pension funds were subject to a herding effect when deciding on investment strategies, although with mixed results.

To conclude, the explanatory factors with most support for the home equity bias in Danish pension funds were corporate governance and transparency, over-optimism and to a lesser extent herding. This is interesting, as previous articles have been highly supportive of information asymmetry yet we found no convincing evidence in our study on the Danish pension funds. The implication of our analysis is that several of the proposed explanations for home equity bias do not apply to the Danish pension funds. The reason that Danish pension funds neglect the benefits of international diversification appears to be driven by investor protection, over-optimism towards Danish equities and to a lesser extent the investment strategy of their peers.

8.0 Conclusion

The objective of this thesis was to investigate the home equity bias within Danish pension funds. In order to investigate the chosen research subject we formulated the following problem statement;

Portfolios tend to be heavily invested in domestic equities, which is difficult to explain given the benefits of international diversification. As global financial markets have become more integrated it has also become easier to diversify internationally. However, integration may also have increased correlations between markets and hence reduce the benefits of diversification. The idea for this thesis is first to investigate the change in correlation between Denmark and international markets and how this has developed over time, then second to document the extent of international diversification by Danish pension funds and evaluate this in light of modern portfolio theory. Lastly, the empirical explanations on home bias from earlier studies will be investigated in regards to the Danish pension funds.

Three main research questions were identified in order to address the problem statement. These were all answered in turn, and include whether international diversification still provides portfolio benefits, if Danish pension funds are home equity biased and what explanations are relevant for explaining the home equity bias in Danish pension funds.

In order to investigate whether international diversification is beneficial for Danish pension portfolios, we conducted a correlation analysis between international equity markets. The analysis showed that, while correlations have increased over time, Danish pension funds could still significantly reduce their portfolio risk through international diversification without compromising return. Consequently, if Danish pension funds are over-invested in their domestic market it represents an inefficient portfolio allocation. We also investigated whether correlation increases during times of financial crisis, but this hypothesis did not yield any statistically significant results.

Due to the vast amount of prior studies related to home equity bias in individuals' portfolios, we conducted a presentation and a review of these results. The explanations with most support were information asymmetry, corporate governance and transparency and behavioral biases. As a result, these explanations constituted the main focus for the remainder of the following analyses.

After the benefits of international diversification were established, we measured the home equity bias within Danish pension funds through three benchmark models. These benchmarks were the market capitalization-model, the GDP-model and the mean-variance model. The analysis showed that the Danish pension funds have been home equity biased in every year from 2003-2012. Although the home equity bias has improved over the period, Danish citizens' pension portfolios are not optimized from a risk-return perspective or a diversification perspective.

In order to determine whether the home equity bias was present in all the pension funds included in our analysis, we also compared the asset allocation of each individual pension fund with the benchmark portfolios. The analysis showed that the level of home equity bias was varying across the sector, where several of the pension funds do not appear to have incorporated international diversification as an integral part of their investment strategy.

The last section investigated which explanations were attributable to the observed home equity bias in Danish pension funds. Both the arguments for exchange rate risk and familiarity bias were refuted, and we obtained no convincing evidence for information asymmetry. Our analysis found support for corporate governance and transparency and over-optimism, and weak support for a herding effect. Thus, similarly to previous studies on this subject we conclude that the home equity bias can be explained by a combination of factors. Furthermore, our analysis indicates that several of the most acclaimed explanations for home equity bias in individuals' equity portfolios are not applicable in the setting of Danish pension funds.

There has been a positive development of home equity bias within Danish pension portfolios during the previous decade. However, this thesis has shown that Danish pension funds still forego the benefits of international diversification. The implication of our findings is that Danish citizens bear unnecessary risk which could be eliminated through international investments. This represents a cost for both present and future pensioners. Looking forward it is essential that the positive development continues as Denmark will experience an increasingly elderly population. The increasing importance of pension funds highlights the significance of efficiency within Danish pension funds. The risk-adjusted performance of Danish pension funds directly affects the economic wealth of the majority of Danish citizens. Taking full advantage of international diversification will be an important step in order to improve the risk-return relationship. This will increase the income levels of pensioners, ensure a sustainable development of pension plans and lay a foundation for economic growth. If Danish pension funds increase their international investments, future

purchasing power of pensioners can be improved which will benefit the Danish society through increased welfare level and higher tax incomes.

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10. Appendix

1. Market Capitalization of individual countries (in USD):

MSCI AC Asia Pacific	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Thailand	121,232,839,927	116,694,914,543	124,864,089,756	141,093,067,500	196,046,200,000	102,594,119,609	138,189,183,810	277,731,739,449	268,488,819,977	382,999,084,668
Singapore	229,328,244,126	277,004,443,151	316,657,881,886	276,329,356,710	353,488,589,000	180,021,481,867	310,765,910,824	370,090,941,025	308,320,307,578	414,125,808,743
Philippines	23,565,070,000	28,947,810,000	40,153,450,000	68,382,050,000	103,224,300,000	52,100,690,473	80,132,276,289	157,320,500,566	165,379,618,220	264,142,879,756
New Zealand	33,051,871,307	43,731,332,611	43,409,099,578	44,939,528,980	47,454,010,000	24,165,565,308	67,061,169,518	71,832,863,368	71,657,479,810	79,802,075,790
Malaysia	168,376,220,000	190,010,530,000	181,235,719,000	235,355,840,000	325,663,010,000	187,065,751,445	255,952,052,510	410,534,133,290	395,082,649,842	476,340,035,965
Korea, Rep.	329,615,950,000	428,648,800,000	718,180,080,000	835,188,110,000	1,123,632,540,000	494,630,742,170	836,461,520,428	1,089,216,501,207	994,301,734,995	1,180,473,422,310
Japan	3,040,664,775,590	3,678,261,910,803	4,736,512,818,775	4,726,268,901,851	4,453,474,908,957	3,220,485,162,543	3,377,892,255,200	4,099,591,000,000	3,540,684,600,000	3,680,982,116,116
India	279,092,830,000	387,851,160,000	553,074,005,800	818,878,670,000	1,819,100,600,000	645,477,832,512	1,179,235,081,612	1,615,860,000,000	1,015,370,000,000	1,263,335,497,354
Indonesia	54,659,060,000	73,250,640,000	81,428,120,000	138,886,360,000	211,692,970,000	98,760,599,266	178,190,945,564	360,388,099,886	390,106,865,178	396,772,107,424
Hong Kong SAR, China	551,236,592,531	665,248,282,197	693,486,417,682	895,249,094,881	1,162,565,801,093	1,328,837,053,060	915,825,000,000	1,079,640,000,000	889,596,618,438	1,108,127,258,370
China	681,203,680,000	639,764,550,000	780,762,720,000	2,426,325,822,800	6,226,305,290,000	2,793,612,600,029	5,007,646,096,891	4,762,836,764,951	3,389,098,223,398	3,697,376,039,677
Australia	585,475,096,074	776,402,759,269	804,073,802,362	1,095,857,964,846	1,298,429,048,000	675,618,871,200	1,258,455,637,300	1,454,546,975,050	1,198,163,542,400	1,286,437,788,906
Taiwan	376,800,633,371	418,509,543,469	485,840,392,803	595,591,535,010	655,460,767,896	371,235,079,597	636,283,994,313	752,406,736,815	652,081,271,845	720,967,078,606
Sum	6,474,302,862,926	7,724,326,676,044	9,559,678,597,642	12,298,346,302,578	17,976,538,034,945	10,174,605,549,080	14,242,091,124,260	16,501,996,255,609	13,278,331,731,683	14,951,881,193,687

MSCI Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Denmark	121,616,265,267	151,342,345,711	178,038,272,937	231,014,611,266	277,746,365,084	131,525,683,285	186,852,391,334	231,746,131,759	179,528,762,434	224,856,393,164

MSCI Europe Ex Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	55,085,771,948	86,343,618,323	124,389,524,596	191,300,276,935	228,707,413,000	72,299,836,620	53,578,044,956	67,682,829,563	82,373,779,948	106,036,783,125
Belgium	173,552,623,613	273,247,424,222	288,515,086,705	396,220,182,862	386,361,615,000	167,446,797,446	261,428,769,307	269,341,845,093	229,895,942,123	300,058,176,062
Finland	170,283,211,500	183,765,377,209	209,504,459,125	265,476,506,833	369,168,145,680	154,367,339,529	91,021,301,492	118,159,660,790	143,080,705,278	158,686,739,381
France	1,355,925,327,952	1,559,109,677,858	1,758,720,655,892	2,428,571,995,791	2,771,216,780,227	1,492,327,413,490	1,972,040,199,973	1,926,488,295,470	1,568,729,793,722	1,823,339,266,082
Germany	1,079,026,236,125	1,194,517,105,828	1,221,250,098,842	1,637,825,722,041	2,105,505,641,000	1,107,957,423,150	1,297,567,916,506	1,429,706,705,313	1,184,458,631,443	1,486,314,805,537
Ireland	85,070,383,451	114,085,428,843	114,134,252,866	163,357,747,593	144,026,157,000	49,401,126,711	61,291,100,000	60,449,267,726	108,054,566,148	109,013,968,937
Israel	75,718,890,000	95,504,760,000	120,113,500,000	173,305,791,400	236,360,550,000	134,463,330,686	182,095,366,680	218,054,779,048	144,969,571,755	148,436,163,943
Italy	614,841,069,627	789,562,620,173	798,167,021,787	1,026,639,570,471	1,072,691,504,606	520,855,088,990	317,316,553,442	318,140,148,672	431,470,759,629	480,452,646,400
Netherlands	488,647,361,251	538,663,694,441	592,905,544,414	779,645,438,538	956,468,740,421	387,906,089,744	542,532,520,239	661,203,716,196	594,731,638,916	651,004,474,344
Norway	94,678,931,751	141,429,856,357	190,952,402,050	281,081,415,264	357,419,915,000	125,919,582,292	227,233,231,201	250,921,559,484	219,245,420,789	252,949,910,233
Portugal	58,284,737,260	70,241,742,558	66,981,305,002	104,201,059,079	132,257,873,000	68,713,401,781	98,649,863,772	81,995,991,553	61,687,724,387	65,529,643,852
Spain	726,243,365,288	940,672,882,969	960,023,632,225	1,323,089,753,396	1,800,097,149,000	946,113,123,222	1,297,226,915,352	1,171,614,868,753	1,030,951,409,037	995,094,819,456
Sweden	289,877,118,397	376,781,095,402	403,947,974,453	573,250,309,549	612,496,954,662	252,542,315,012	432,296,228,760	581,173,906,900	470,122,095,313	560,525,968,445
Switzerland	726,949,345,084	825,849,212,910	938,623,538,841	1,212,508,314,901	1,274,515,506,205	862,662,643,439	1,070,693,526,385	1,229,356,532,561	932,207,250,561	1,079,021,978,022
United Kingdom	2,460,063,963,480	2,815,928,019,428	3,058,182,414,470	3,794,310,288,456	3,858,505,426,696	1,851,953,510,993	2,796,444,322,693	3,107,037,940,785	2,903,178,225,658	3,019,467,050,240
Sum	8,454,248,336,725	10,005,702,516,521	10,846,411,411,268	14,350,784,373,110	16,305,799,371,497	8,194,929,023,102	10,701,415,860,757	11,491,328,047,907	10,105,157,514,708	11,235,932,394,060

MSCI South Africa	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
South Africa	267,745,320,000	455,536,230,000	565,407,960,000	715,025,250,000	833,547,930,000	491,281,773,932	704,821,878,325	635,349,230,978	522,974,990,085	612,308,406,964

MSCI North America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
United States	14,266,265,700,000	16,323,726,300,000	16,970,864,548,060	19,425,854,794,360	19,947,283,820,000	11,737,645,610,000	15,077,285,740,000	17,138,978,000,000	15,640,707,100,000	18,668,333,210,000
Canada	893,950,321,133	1,177,517,943,582	1,480,891,114,535	1,700,708,086,277	2,186,550,151,976	1,002,215,228,838	1,680,958,122,675	2,160,228,651,940	1,906,589,246,256	2,016,116,973,169
Sum	15,160,216,021,133	17,501,244,243,582	18,451,755,662,595	21,126,562,880,637	22,133,833,971,976	12,739,860,838,838	16,758,243,862,675	19,299,206,651,940	17,547,296,346,256	20,684,450,183,169

MSCI EM Latin America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Brazil	234,560,040,000	330,346,580,000	474,646,880,000	711,099,910,000	1,370,376,600,000	589,384,021,012	1,167,334,984,012	1,545,565,661,434	1,228,969,170,883	1,229,849,669,684
Chile	86,291,370,000	117,064,840,000	136,445,770,000	174,555,730,000	212,910,230,000	132,428,480,314	209,475,269,305	341,584,307,362	270,289,100,000	313,325,267,335
Colombia	14,258,480,000	25,222,880,000	46,016,190,000	56,204,320,000	101,955,950,000	87,032,363,670	133,301,343,553	208,501,741,146	201,295,500,000	262,101,261,149
Mexico	122,531,870,000	171,940,260,000	239,127,950,000	348,345,130,000	397,724,640,000	232,581,145,972	340,564,590,896	454,345,259,111	408,691,313,159	525,056,676,421
Peru	16,054,690,000	20,114,850,000	35,994,710,000	59,657,500,000	105,960,110,000	55,625,279,631	69,752,580,097	99,831,340,331	79,329,267,428	96,850,058,685
Sum	473,696,450,000	664,689,410,000	932,231,500,000	1,349,862,590,000	2,188,927,530,000	1,097,051,290,598	1,920,428,767,863	2,649,828,309,384	2,188,574,351,470	2,427,182,933,274

MSCI FM Africa	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Kenya	4,178,210,000	3,890,970,000	6,383,990,000	11,378,040,000	13,386,590,000	10,916,560,841	10,755,988,305	14,460,867,410	10,202,603,924	14,790,720,930
Mauritius	1,955,340,000	2,378,780,000	2,617,350,000	3,598,320,000	5,665,510,000	3,442,532,576	4,739,684,085	7,441,532,534	7,666,703,680	7,092,931,403
Nigeria	9,493,640,000	14,464,420,000	19,355,650,000	32,819,360,000	86,346,840,000	49,802,816,757	33,324,902,304	50,882,966,531	39,269,936,739	56,389,263,863
Tunisia	2,464,210,000	2,641,070,000	2,876,140,000	4,446,380,000	5,355,080,000	6,373,758,287	9,120,142,054	10,681,708,314	9,661,719,481	8,886,882,497
Sum	18,091,400,000	23,375,240,000	31,233,130,000	52,242,100,000	110,754,020,000	70,535,668,462	57,940,716,747	83,467,074,789	66,800,963,824	87,159,798,693

MSCI Russia	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Russian Federation	230,785,730,000	267,957,350,000	548,579,050,000	1,057,188,806,606	1,503,010,900,000	397,183,000,000	861,424,359,114	1,004,524,776,255	796,375,801,262	874,659,493,123

2. GDP of individual countries (in USD):

MSCI AC Asia Pacific	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Thailand	142,640,079,033	161,339,790,595	176,351,948,404	207,088,828,467	246,976,870,173	272,577,799,257	263,711,244,889	318,907,930,076	345,672,232,116	365,965,815,820
Singapore	93,362,870,573	109,336,483,914	123,506,892,268	139,020,876,513	168,705,756,482	178,924,164,930	194,131,267,855	217,200,123,752	245,024,318,394	274,701,299,734
Philippines	83,908,205,720	91,371,236,939	103,065,972,408	122,210,719,246	149,359,920,006	173,602,533,346	168,333,540,385	199,589,447,424	224,095,219,329	250,182,019,476
New Zealand	87,418,267,497	102,983,802,756	113,834,420,634	110,304,429,416	135,291,901,176	130,672,262,113	118,573,727,125	143,246,762,590	162,634,645,669	167,347,054,534
Malaysia	110,202,368,421	124,749,736,842	143,533,152,129	162,692,467,586	193,552,802,792	230,987,618,904	202,251,384,992	247,533,525,518	289,258,937,259	305,032,745,225
Korea, Rep.	643,762,388,701	721,975,255,824	844,863,004,335	951,773,478,985	1,049,235,951,187	931,402,204,982	834,060,441,841	1,014,890,141,871	1,114,471,962,886	1,129,598,273,324
Japan	4,302,939,184,964	4,655,803,055,651	4,571,875,737,175	4,356,761,451,087	4,356,329,296,669	4,849,208,099,924	5,035,141,567,659	5,495,379,357,485	5,896,794,887,859	5,959,718,262,199
India	618,356,467,439	721,585,608,172	834,215,013,543	949,116,769,688	1,238,700,195,725	1,224,095,295,077	1,365,372,433,272	1,710,908,768,960	1,872,840,195,945	1,841,709,755,679
Indonesia	234,772,458,818	256,836,883,305	285,868,610,017	364,570,525,997	432,216,737,775	510,244,548,960	539,579,959,053	709,190,822,691	846,341,443,778	878,043,027,882
Hong Kong SAR, China	161,384,522,525	169,099,768,875	181,570,082,162	193,536,265,094	211,597,405,594	219,279,678,430	214,046,415,026	228,695,747,310	248,725,976,362	263,259,372,905
China	1,640,958,732,775	1,931,644,331,142	2,256,902,590,825	2,712,950,886,698	3,494,055,944,791	4,521,827,288,304	4,991,256,406,735	5,930,529,470,799	7,321,935,025,070	8,227,102,629,831
Australia	466,663,366,337	613,161,189,358	693,662,607,127	747,463,312,369	853,854,910,890	1,055,506,156,997	926,710,311,519	1,141,793,593,834	1,386,889,147,177	1,532,407,884,934
Taiwan	310,538,000,000	340,014,000,000	364,849,000,000	376,334,000,000	393,111,000,000	402,690,000,000	378,969,000,000	430,580,000,000	466,832,000,000	473,970,000,000
Sum	8,896,906,912,803	9,999,901,143,373	10,694,099,031,027	11,393,824,011,147	12,922,988,693,260	14,701,017,651,222	15,232,137,700,350	17,788,445,692,310	20,421,515,991,844	21,669,038,141,543

MSCI Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Denmark	212,621,855,883	244,727,978,021	257,675,536,234	274,376,889,678	311,417,601,999	343,881,383,958	310,544,743,670	313,365,836,299	333,616,014,898	314,887,354,338

MSCI Europe Ex Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	253,945,776,524	291,430,382,497	304,983,601,950	324,954,402,044	375,041,784,030	414,171,069,689	383,733,743,330	375,217,439,474	415,611,711,111	394,707,863,204
Belgium	311,689,616,253	361,683,211,960	377,350,395,463	399,965,627,160	459,618,853,659	507,379,060,314	473,254,584,680	468,078,947,368	512,859,722,222	483,261,763,950
Finland	164,256,207,675	189,064,585,623	195,777,993,334	207,949,409,201	246,127,357,186	271,974,219,065	239,382,754,295	235,163,157,895	262,054,166,667	247,545,641,553
France	1,792,214,221,219	2,055,678,853,687	2,136,555,489,230	2,255,705,477,450	2,582,389,733,356	2,831,794,045,483	2,619,685,000,757	2,548,315,434,211	2,779,719,500,000	2,612,878,387,760
Germany	2,423,814,898,420	2,726,341,472,500	2,766,253,792,966	2,902,748,698,160	3,323,807,412,152	3,623,686,234,299	3,298,219,195,019	3,282,894,736,842	3,624,861,111,111	3,428,130,624,839
Ireland	158,730,360,073	186,281,307,557	202,577,741,641	222,762,911,716	259,574,153,792	264,034,092,036	225,442,965,634	208,022,028,243	225,832,965,850	210,771,406,836
Israel	118,673,283,415	126,571,173,583	133,959,001,783	145,479,599,623	167,111,803,510	201,661,649,944	194,866,363,197	231,674,511,902	258,216,880,939	270,764,000,000
Italy	1,514,503,536,381	1,735,521,503,772	1,786,275,014,007	1,872,982,702,430	2,127,180,496,503	2,307,311,493,055	2,111,148,008,712	2,041,954,747,600	2,195,014,082,353	2,014,669,579,720
Netherlands	538,312,641,084	609,889,925,686	638,470,626,275	677,691,901,433	782,566,743,038	870,811,147,325	796,333,367,137	772,090,789,474	832,009,722,222	770,555,412,702
Norway	224,880,794,328	260,029,106,208	304,060,069,849	340,041,912,704	393,479,162,082	453,885,460,993	378,849,392,446	421,236,092,715	491,064,821,429	499,667,211,001
Portugal	161,931,941,309	185,397,304,328	191,847,858,529	201,790,398,436	231,741,573,803	251,925,293,881	234,119,384,366	227,446,710,526	237,675,277,778	212,273,977,886
Spain	883,839,729,120	1,044,612,070,304	1,130,798,885,738	1,236,352,163,544	1,441,426,534,070	1,593,420,002,197	1,454,336,570,613	1,375,815,789,474	1,453,231,944,444	1,322,964,772,435
Sweden	314,713,404,153	362,089,648,913	370,579,639,747	399,075,661,573	462,512,853,670	486,158,607,820	405,782,994,635	462,903,051,318	536,293,220,339	523,805,608,856
Switzerland	334,574,926,429	374,224,186,244	384,753,967,479	405,183,914,853	450,528,109,859	524,289,203,562	509,467,163,037	550,638,974,462	657,417,830,724	631,173,029,582
United Kingdom	1,875,141,224,490	2,220,820,974,770	2,321,359,350,398	2,483,008,793,219	2,857,080,828,858	2,687,796,663,762	2,208,002,878,868	2,285,561,538,462	2,478,930,645,161	2,471,783,570,300
Sum	11,071,222,560,872	12,729,635,707,632	13,245,603,428,388	14,075,693,573,546	16,160,187,399,569	17,290,298,243,424	15,532,624,366,727	15,487,013,949,964	16,960,793,602,350	16,094,952,850,625

MSCI South Africa	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
South Africa	168,219,325,184	219,092,936,699	247,051,562,311	261,007,039,379	286,171,830,700	273,141,750,193	283,985,548,070	363,240,728,680	401,802,218,556	384,312,674,446

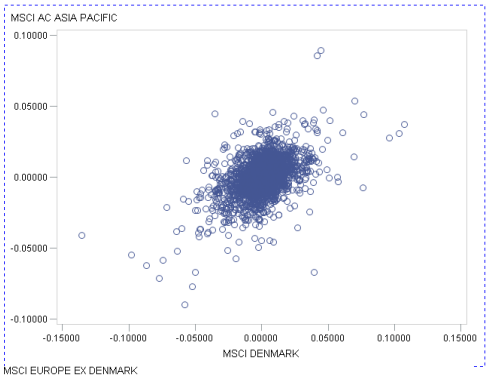
MSCI North America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
United States	11,512,200,000,000	12,277,000,000,000	13,095,400,000,000	13,857,900,000,000	14,480,300,000,000	14,720,300,000,000	14,417,900,000,000	14,958,300,000,000	15,533,800,000,000	16,244,600,000,000
Canada	865,873,242,452	992,226,099,522	1,133,759,985,476	1,278,610,846,645	1,424,065,729,448	1,502,678,437,547	1,337,577,639,752	1,577,040,082,218	1,777,788,888,889	1,821,424,139,311
Sum	12,378,073,242,452	13,269,226,099,522	14,229,159,985,476	15,136,510,846,645	15,904,365,729,448	16,222,978,437,547	15,755,477,639,752	16,535,340,082,218	17,311,588,888,889	18,066,024,139,311

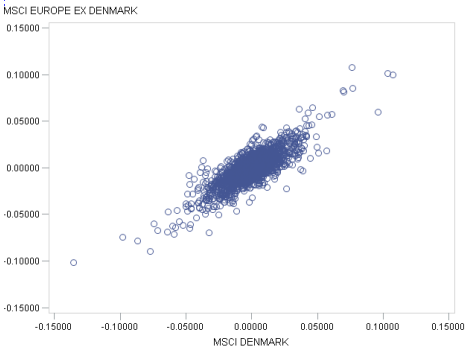
MSCI EM Latin America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Brazil	552,469,288,268	663,760,341,880	882,185,702,547	1,088,916,819,853	1,366,853,244,424	1,653,538,618,145	1,620,165,226,994	2,143,035,333,258	2,476,652,189,880	2,252,664,120,777
Chile	77,840,186,385	100,630,707,852	124,404,150,138	154,671,012,211	173,081,288,190	179,626,662,207	171,956,957,320	217,556,229,881	251,190,792,425	269,869,337,788
Colombia	94,684,582,573	117,074,865,515	146,520,136,085	162,773,603,930	207,520,149,156	244,056,736,297	234,360,070,287	287,000,940,839	336,559,866,921	369,606,330,702
Mexico	722,164,975,397	774,800,766,586	870,215,085,181	966,249,852,838	1,043,459,078,120	1,099,070,673,263	895,354,565,567	1,047,368,841,686	1,159,889,566,239	1,178,126,184,343
Peru	61,346,725,170	69,725,009,965	79,385,073,422	92,432,757,798	107,492,226,613	129,537,265,753	130,064,300,617	157,609,814,184	181,011,064,727	203,790,266,510
Sum	1,508,505,757,793	1,725,991,691,799	2,102,710,147,374	2,465,044,046,630	2,898,405,986,504	3,305,829,955,666	3,051,901,120,785	3,852,571,159,849	4,405,303,480,193	4,274,056,240,121

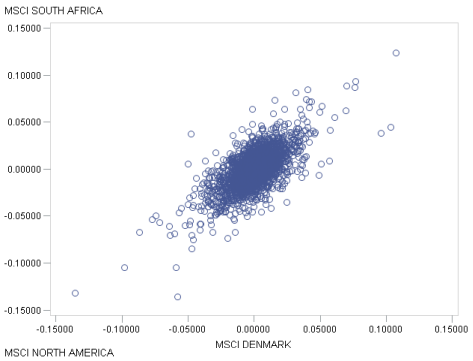
MSCI FM Africa	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Kenya	14,904,504,019	16,095,321,631	18,737,895,401	22,504,136,042	27,236,739,896	30,465,489,796	30,580,367,979	32,198,151,217	33,620,684,016	40,697,163,224
Mauritius	5,609,836,354	6,385,691,315	6,283,796,155	6,731,536,244	7,792,063,567	9,641,077,098	8,834,661,043	9,718,331,363	11,250,559,553	10,486,037,634
Nigeria	67,655,840,108	87,845,403,978	112,248,324,603	145,429,802,542	166,451,202,370	208,064,724,514	169,481,270,115	229,507,890,739	245,682,418,219	262,597,405,488
Tunisia	27,453,084,983	31,183,059,012	32,282,960,678	34,377,235,162	38,848,711,944	44,736,953,169	43,607,568,688	44,377,742,071	46,434,616,144	45,662,043,358
Sum	115,623,265,464	141,509,475,937	169,552,976,837	209,042,709,990	240,328,717,776	292,908,244,578	252,503,867,826	315,802,115,390	336,988,277,932	359,442,649,704

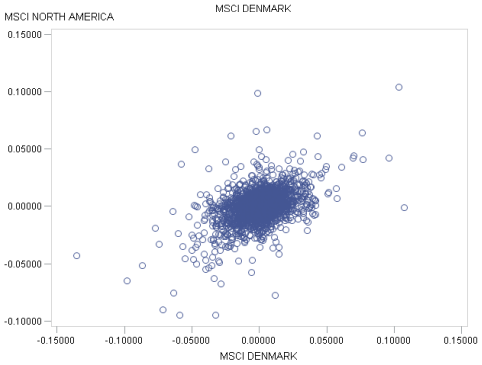
MSCI Russia	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Russian Federation	430,347,770,733	591,016,690,743	764,000,901,161	989,930,542,279	1,299,705,764,824	1,660,846,387,626	1,222,648,134,225	1,524,916,698,233	1,899,085,300,762	2,014,774,938,342

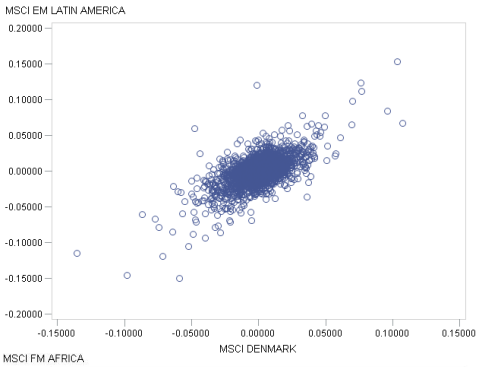
3. Scatter Plots










MSCI EM LATIN AMERICA
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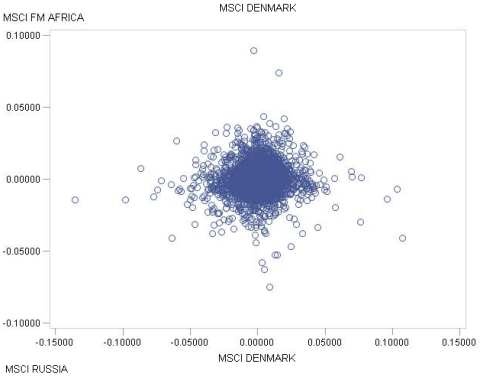
0.15000
0.10000
0.05000
0.00000
-0.05000
-0.10000
-0.15000
-0.20000
-0.15000
-0.10000
-0.05000
0.00000
0.05000
0.10000
0.15000
MSCI DENMARK


MSCI FM AFRICA
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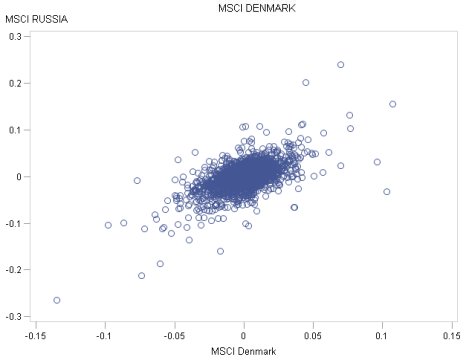
0.05000
0.00000
-0.05000
-0.10000
-0.15000
-0.10000
-0.05000
0.00000
0.05000
0.10000
0.15000
MSCI DENMARK


MSCI RUSSIA
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0.2
0.1
0
-0.1
-0.2
-0.3
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
MSCI Denmark

4. Jarque-Bera statistics excluding financial crisis

	Jarque-Bera Statistics															
	MSCI DENMARK		MSCI AC ASIA PACIFIC		MSCI EUROPE EX DENMARK		MSCI SOUTH AFRICA		MSCI NORTH AMERICA		MSCI EM LATIN AMERICA		MSCI FM AFRICA		MSCI RUSSIA	
Period	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012	2003-2006	2010-2012
Skewness	-0.47	0.03	-0.33	-0.33	-0.26	-0.09	-0.54	-0.04	0.07	-0.44	-0.57	-0.46	0.41	-0.12	-0.60	-0.41
Kurtosis	2.32	1.44	2.15	1.40	1.91	2.15	3.17	1.82	1.66	3.77	2.06	3.16	7.21	2.10	4.60	2.39
Jarque-Bera	58.12	79.19	50.01	97.38	63.11	24.46	51.99	45.25	78.77	43.94	93.54	28.13	797.53	28.22	174.20	33.55
Critical Value	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99	5.99
H0 rejected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

5. Spearman correlation

Spearman correlation estimates - results obtained from SAS								
Correlation Between Denmark and	Average correlation 2003-2012	Average correlation 2003-2006	Average correlation 2007-2009	Increase from 2003 to 2009	Change	Average correlation 2010-2012	Increase from 2007 to 2012	Change
MSCI AC Asia Pacific	0,418	0,365	0,474	0,109	29,9 %	0,424	-0,050	-10,5 %
MSCI Europe ex Denmark	0,753	0,644	0,816	0,172	26,6 %	0,791	-0,025	-3,0 %
MSCI South Africa	0,589	0,429	0,685	0,257	59,9 %	0,639	-0,046	-6,8 %
MSCI North America	0,356	0,209	0,377	0,168	80,6 %	0,489	0,112	29,7 %
MSCI EM Latin America	0,530	0,404	0,620	0,216	53,5 %	0,569	-0,051	-8,2 %
MSCI FM Africa	0,070	0,027	0,060	0,033	120,6 %	0,133	0,073	123,0 %
MSCI Russia	0,506	0,254	0,614	0,360	141,6 %	0,655	0,040	6,6 %

Pearson Product Moment Correlation estimates								
Correlation Between Denmark and	Average correlation 2003-2012	Average correlation 2003-2006	Average correlation 2007-2009	Increase from 2003 to 2009	Change	Average correlation 2010-2012	Increase from 2007 to 2012	Change
MSCI AC Asia Pacific	0,463	0,394	0,529	0,135	34,3 %	0,466	-0,063	-11,8 %
MSCI Europe ex Denmark	0,784	0,656	0,869	0,213	32,5 %	0,828	-0,041	-4,7 %
MSCI South Africa	0,652	0,515	0,746	0,231	44,8 %	0,695	-0,051	-6,8 %
MSCI North America	0,425	0,238	0,464	0,226	94,9 %	0,573	0,109	23,4 %
MSCI EM Latin America	0,605	0,454	0,712	0,257	56,7 %	0,649	-0,063	-8,8 %
MSCI FM Africa	0,060	0,019	0,031	0,012	61,4 %	0,129	0,098	319,7 %
MSCI Russia	0,559	0,316	0,672	0,356	112,9 %	0,689	0,017	2,5 %

PPMC - Spearm				
Correlation Between Denmark and	Average correlation 2003-2012 (diff)	Average correlation 2003-2006 (diff)	Average correlation 2007-2009 (diff)	Average correlation 2010-2012 (diff)
MSCI AC Asia Pacific	0,045	0,029	0,055	0,042
MSCI Europe ex Denmark	0,032	0,012	0,053	0,037
MSCI South Africa	0,063	0,086	0,060	0,056
MSCI North America	0,069	0,030	0,088	0,084
MSCI EM Latin America	0,075	0,050	0,092	0,080
MSCI FM Africa	-0,010	-0,008	-0,029	-0,004
MSCI Russia	0,052	0,061	0,057	0,034

6. Correlation breakdown for each year

	MSCI Denmark	MSCI AC Asia Pacific	MSCI Europe ex Denmark	MSCI South Africa	MSCI North America	MSCI EM Latin America	MSCI FM Africa	MSCI Russia	Average
2003									
MSCI DENMARK		**0.3369**	0.4949	0.3123	0.2150	0.3320	-0.0343	0.0935	
MSCI AC ASIA PACIFIC			**0.2424**	0.3728	0.0505	0.2075	-0.1096	0.0897	
MSCI EUROPE EX DENMA				**0.3937**	0.5618	0.5472	0.0653	0.2042	
MSCI SOUTH AFRICA					**0.1695**	0.2237	-0.0952	0.1302	
MSCI NORTH AMERICA						**0.5315**	0.0311	0.1775	
MSCI EM LATIN AMERICA							**0.0973**	0.1546	
MSCI FM AFRICA								**0.0175**	
MSCI RUSSIA	0.0935	0.0897	0.2042	0.1302	0.1775	0.1546	0.0175	1.0000	
Average	**0.2500**	**0.1700**	**0.3585**	**0.2153**	**0.2481**	**0.2991**	**-0.0040**	**0.1239**	**0.2076**
2004									
MSCI DENMARK		**0.3932**	0.7416	0.5077	0.2679	0.4463	-0.0198	0.1453	
MSCI AC ASIA PACIFIC			**0.4724**	0.4596	0.2349	0.4819	-0.0617	0.2247	
MSCI EUROPE EX DENMA				**0.5897**	0.4162	0.5763	-0.0465	0.2005	
MSCI SOUTH AFRICA					**0.2108**	0.5011	-0.0449	0.2509	
MSCI NORTH AMERICA						**0.6016**	-0.0548	0.0646	
MSCI EM LATIN AMERICA							**-0.0870**	0.2064	
MSCI FM AFRICA								**-0.0232**	
MSCI RUSSIA	0.1453	0.2247	0.2005	0.2509	0.0646	0.2064	-0.0232	1.0000	
Average	**0.3546**	**0.3150**	**0.4215**	**0.3536**	**0.2487**	**0.3895**	**-0.0483**	**0.1527**	**0.2734**
2005									
MSCI DENMARK		**0.3169**	0.6646	0.5312	0.1603	0.4003	0.0706	0.2887	
MSCI AC ASIA PACIFIC			**0.5095**	0.4977	0.0437	0.3469	0.0143	0.2435	
MSCI EUROPE EX DENMA				**0.6131**	0.2986	0.4723	0.0484	0.2963	
MSCI SOUTH AFRICA					**0.1680**	0.4802	0.1402	0.3586	
MSCI NORTH AMERICA						**0.5040**	0.0437	0.1251	
MSCI EM LATIN AMERICA							**0.0575**	0.4172	
MSCI FM AFRICA								**0.0625**	
MSCI RUSSIA	0.2887	0.2435	0.2963	0.3586	0.1251	0.4172	0.0625	1.0000	
Average	**0.3475**	**0.2818**	**0.4147**	**0.3984**	**0.1919**	**0.3826**	**0.0625**	**0.2560**	**0.2919**
2006									
MSCI DENMARK		**0.4869**	0.7752	0.6190	0.3321	0.5644	0.0981	0.6230	
MSCI AC ASIA PACIFIC			**0.4386**	0.4787	0.1607	0.4065	0.0580	0.4106	
MSCI EUROPE EX DENMA				**0.6793**	0.4952	0.6488	0.0473	0.6115	
MSCI SOUTH AFRICA					**0.2627**	0.5782	0.0338	0.6582	
MSCI NORTH AMERICA						**0.7176**	0.0280	0.2462	
MSCI EM LATIN AMERICA							**0.0448**	0.5718	
MSCI FM AFRICA								**-0.0267**	
MSCI RUSSIA	0.6230	0.4106	0.6115	0.6582	0.2462	0.5718	-0.0267	1.0000	
Average	**0.4998**	**0.3486**	**0.5280**	**0.4728**	**0.3204**	**0.5046**	**0.0405**	**0.4421**	**0.3946**
2007									
MSCI DENMARK		**0.5086**	0.8383	0.7460	0.4544	0.6471	0.0887	0.5851	
MSCI AC ASIA PACIFIC			**0.4328**	0.5487	0.0331	0.3251	0.0557	0.3961	
MSCI EUROPE EX DENMA				**0.8056**	0.5514	0.7243	0.0931	0.6734	
MSCI SOUTH AFRICA					**0.3790**	0.6467	0.0104	0.6225	
MSCI NORTH AMERICA						**0.7656**	-0.0300	0.3673	
MSCI EM LATIN AMERICA							**0.0243**	0.5956	
MSCI FM AFRICA								**0.0978**	
MSCI RUSSIA	0.5851	0.3961	0.6734	0.6225	0.3673	0.5956	0.0978	1.0000	
Average	**0.5526**	**0.3286**	**0.5884**	**0.5370**	**0.3601**	**0.5327**	**0.0486**	**0.4768**	**0.4281**
2008									
MSCI DENMARK		**0.5789**	0.9084	0.7770	0.4485	0.7446	-0.0242	0.6905	
MSCI AC ASIA PACIFIC			**0.5170**	0.6025	0.1660	0.3867	-0.0115	0.5901	
MSCI EUROPE EX DENMA				**0.7939**	0.5387	0.7797	-0.0511	0.6740	
MSCI SOUTH AFRICA					**0.3658**	0.6761	0.0178	0.7325	
MSCI NORTH AMERICA						**0.7240**	-0.0250	0.3619	
MSCI EM LATIN AMERICA							**-0.0158**	0.6222	
MSCI FM AFRICA								**-0.0815**	
MSCI RUSSIA	0.6905	0.5901	0.6740	0.7325	0.3619	0.6222	-0.0815	1.0000	
Average	**0.5891**	**0.4043**	**0.5944**	**0.5665**	**0.3685**	**0.5596**	**-0.0273**	**0.5128**	**0.4460**
2009									
MSCI DENMARK		**0.4135**	0.8027	0.6819	0.4941	0.6674	0.0554	0.6601	
MSCI AC ASIA PACIFIC			**0.4297**	0.4823	0.2037	0.3324	0.1244	0.3792	
MSCI EUROPE EX DENMA				**0.7894**	0.6684	0.7864	0.0581	0.7804	
MSCI SOUTH AFRICA					**0.5137**	0.7079	0.0855	0.7078	
MSCI NORTH AMERICA						**0.8033**	-0.0003	0.5705	
MSCI EM LATIN AMERICA							**0.0174**	0.7048	
MSCI FM AFRICA								**0.0788**	
MSCI RUSSIA	0.6601	0.3792	0.7804	0.7078	0.5705	0.7048	0.0788	1.0000	
Average	**0.5393**	**0.3379**	**0.6164**	**0.5669**	**0.4648**	**0.5742**	**0.0599**	**0.5545**	**0.4642**
2010									
MSCI DENMARK		**0.4955**	0.8427	0.7077	0.5679	0.6474	0.1432	0.7002	
MSCI AC ASIA PACIFIC			**0.5112**	0.4981	0.2939	0.4310	0.2131	0.5010	
MSCI EUROPE EX DENMA				**0.7777**	0.6955	0.7699	0.1580	0.7465	
MSCI SOUTH AFRICA					**0.5252**	0.6979	0.0877	0.7720	
MSCI NORTH AMERICA						**0.7855**	0.0846	0.5872	
MSCI EM LATIN AMERICA							**0.1320**	0.6832	
MSCI FM AFRICA								**0.1890**	
MSCI RUSSIA	0.7002	0.5010	0.7465	0.7720	0.5872	0.6832	0.1890	1.0000	
Average	**0.5864**	**0.4205**	**0.6431**	**0.5809**	**0.5057**	**0.5924**	**0.1439**	**0.5970**	**0.5087**
2011									
MSCI DENMARK		**0.4695**	0.8639	0.7223	0.6335	0.6763	0.1219	0.7226	
MSCI AC ASIA PACIFIC			**0.4768**	0.5210	0.2854	0.4670	0.2403	0.5017	
MSCI EUROPE EX DENMA				**0.8019**	0.7641	0.7865	0.1372	0.7933	
MSCI SOUTH AFRICA					**0.5920**	0.7548	0.1932	0.7723	
MSCI NORTH AMERICA						**0.8033**	0.0398	0.6348	
MSCI EM LATIN AMERICA							**0.1179**	0.7192	
MSCI FM AFRICA								**0.1346**	
MSCI RUSSIA	0.7226	0.5017	0.7933	0.7723	0.6348	0.7192	0.1346	1.0000	
Average	**0.6015**	**0.4231**	**0.6605**	**0.6225**	**0.5361**	**0.6179**	**0.1407**	**0.6112**	**0.5267**
2012									
MSCI DENMARK		**0.4161**	0.7406	0.6298	0.4538	0.5957	0.1002	0.6178	
MSCI AC ASIA PACIFIC			**0.4416**	0.4446	0.2794	0.4075	0.1511	0.5068	
MSCI EUROPE EX DENMA				**0.7692**	0.6957	0.7852	0.0343	0.7757	
MSCI SOUTH AFRICA					**0.4927**	0.6611	0.0465	0.6881	
MSCI NORTH AMERICA						**0.7512**	0.0492	0.5763	
MSCI EM LATIN AMERICA							**0.0651**	0.6817	
MSCI FM AFRICA								**0.0881**	
MSCI RUSSIA	0.6178	0.5068	0.7757	0.6881	0.5763	0.6817	0.0881	1.0000	
Average	**0.5077**	**0.3781**	**0.6060**	**0.5331**	**0.4712**	**0.5639**	**0.0764**	**0.5620**	**0.4623**

7. Summary statistics

Tangency		Tangency with rf 0.01		Tangency with rf 0.02		Minimum-Var		Denmark	
Expected Return	13,06 %	**Expected Return**	13,29 %	**Expected Return**	13,46 %	**Expected Return**	8,60 %	**Expected Return**	13,50 %
Variance	2,23 %	**Variance**	2,31 %	**Variance**	2,38 %	**Variance**	1,49 %	**Variance**	6,25 %
Standard Deviation	14,93 %	**Standard Deviation**	15,21 %	**Standard Deviation**	15,43 %	**Standard Deviation**	12,21 %	**Standard Deviation**	25,01 %
Sharpe	0,87	**Sharpe**	0,81	**Sharpe**	0,74	**Sharpe**	0,70	**Sharpe**	0,54
Shrinkage constant	0,0141	**Shrinkage constant**	0,0141	**Shrinkage constant**	0,0141	**Shrinkage constant**	0,0141		

8. VBA Codes

Correlation matrix

```
Function CorCor(rng As Range) As Variant
    Dim i As Integer
    Dim j As Integer
    Dim numCols As Integer
    numCols = rng.Columns.Count
    Dim matrix() As Double
    ReDim matrix(numCols, numCols)

    For i = 1 To numCols
        For j = 1 To numCols
        matrix(i, j) = _
            Application.WorksheetFunction.Covar(rng.Columns(i), rng.Columns(j)) _
            / (Application.WorksheetFunction.StDevP(rng.Columns(i)) _
            * Application.WorksheetFunction.StDevP(rng.Columns(j)))
        Next j
    Next i
    CorCor = matrix
End Function
```

Covariance matrix

```
Function VarCovar(rng As Range) As Variant
    Dim i As Integer
    Dim j As Integer
    Dim numCols As Integer
    Dim numRows As Integer
    numCols = rng.Columns.Count
    numRows = rng.Rows.Count
    Dim matrix() As Double
    ReDim matrix(numCols, numCols)

    For i = 1 To numCols
        For j = 1 To numCols
            matrix(i, j) = Application.WorksheetFunction.Covar(rng.Columns(i), rng.Columns(j)) * numRows
/ (numRows - 1)
        Next j
    Next i
    VarCovar = matrix
End Function
```

Shrinkage Covariance matrix (Matlab)

```
function [sigma,shrinkage]=covMarket(x,shrink)

% function sigma=covmarket(x)
% x (t*n): t iid observations on n random variables
% sigma (n*n): invertible covariance matrix estimator
%
```

```
% This estimator is a weighted average of the sample
% covariance matrix and a "prior" or "shrinkage target".
  % Here, the prior is given by a one-factor model.
   % The factor is equal to the cross-sectional average
% of all the random variables.

  % The notation follows Ledoit and Wolf (2003)
% This version: 06/2009

% de-mean returns
t=size(x,1);
n=size(x,2);
meanx=mean(x);
x=x-meanx(ones(t,1),:);
xmkt=mean (x')';

sample=cov([x xmkt])*(t-1)/t;
covmkt=sample(1:n,n+1);
varmkt=sample(n+1,n+1);
sample(:,n+1)=[];
sample(n+1,:)=[];
prior=covmkt*covmkt'./varmkt;
prior(logical(eye(n)))=diag(sample);

if (nargin < 2 | shrink == -1) % compute shrinkage parameters
  c=norm (sample-prior,'fro')^2;
  y=x.^2;
  p=1/t*sum(sum(y'*y))-sum(sum(sample.^2));
  % r is divided into diagonal
  % and off-diagonal terms, and the off-diagonal term
  % is itself divided into smaller terms
  rdiag=1/t*sum(sum(y.^2))-sum(diag (sample).^2);
  z=x.*xmkt(:,ones(1,n));
  v1=1/t*y'*z-covmkt (:,ones(1,n)).*sample;
  roff1=sum (sum(v1.*covmkt (:,ones(1,n))'))/varmkt...
            -sum(diag (v1).*covmkt)/varmkt;
  v3=1/t*z'*z-varmkt*sample;
  roff3=sum (sum(v3.*(covmkt*covmkt')))/varmkt^2 ...
            -sum(diag (v3).*covmkt.^2)/varmkt^2;
  roff=2*roff1-roff3;
  r=rdiag+roff;
  % compute shrinkage constant
  k=(p-r)/c;
  shrinkage=max(0,min(1,k/t))
else % use specified number
  shrinkage = shrink;
end

% compute the estimator
```

sigma=shrinkage*prior+(1-shrinkage)*sample;

9. Historical home equity bias in individual Danish pension funds

See attached excel spreadsheet

10. Data characteristics and covariance matrix with/without shrinkage estimator

Data characteristics								
	MSCI DENMARK	MSCI AC ASIA PACIFIC	MSCI EUROPE EX DENMARK	MSCI SOUTH AFRICA	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI RUSSIA
Avg Return	0.000517644	0.00027499	0.000191582	0.000506795	0.000204163	0.000671605	0.000450103	0.000416405
Avg Yearly Return	0.13500161	0.071717328	0.049964485	0.132172228	0.05324579	0.175154455	0.117386816	0.108598471
Std.dev	0.015485453	0.012746757	0.015050347	0.019118676	0.012781436	0.01882702	0.011233228	0.02602779
Std.dev Yearly	0.250175145	0.205930157	0.243145803	0.308871665	0.206490414	0.304159816	0.181478353	0.420491818
Sharpe Ratio	0.539628388	0.348260443	0.205491867	0.427919563	0.257860832	0.575863231	0.646836464	0.25826536

Yearly Variance Covariance Matrix (Sample)								
	MSCI DENMARK	MSCI AC ASIA PACIFIC	MSCI EUROPE EX DENMARK	MSCI SOUTH AFRICA	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI RUSSIA
MSCI DENMARK	0.062515663	0.02481886	0.050154101	0.052677015	0.023743078	0.049127503	0.002357346	0.062855961
MSCI AC ASIA PACIFIC	0.02481886	0.042358485	0.022954033	0.033039642	0.007727964	0.023916237	0.002140461	0.038426907
MSCI EUROPE EX DENMARK	0.050154101	0.022954033	0.059051928	0.055260591	0.030255213	0.05363876	0.002186005	0.065456956
MSCI SOUTH AFRICA	0.052677015	0.033039642	0.055260591	0.095292049	0.025277158	0.060197148	0.002719596	0.082725955
MSCI NORTH AMERICA	0.023743078	0.007727964	0.030255213	0.025277158	0.042589281	0.045150306	0.000482728	0.035438513
MSCI EM LATIN AMERICA	0.049127503	0.023916237	0.05363876	0.060197148	0.045150306	0.092406857	0.00197178	0.074842239
MSCI FM AFRICA	0.002357346	0.002140461	0.002186005	0.002719596	0.000482728	0.00197178	0.032896537	0.002682573
MSCI RUSSIA	0.062855961	0.038426907	0.065456956	0.082725955	0.035438513	0.074842239	0.002682573	0.176610136

Yearly Variance Covariance Matrix (with Shrinkage)								
	MSCI DENMARK	MSCI AC ASIA PACIFIC	MSCI EUROPE EX DENMARK	MSCI SOUTH AFRICA	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI RUSSIA
MSCI DENMARK	0.062515663	0.024835265	0.050082678	0.052697791	0.023803224	0.049187118	0.002412956	0.062980263
MSCI AC ASIA PACIFIC	0.024835265	0.042358485	0.023008612	0.033028297	0.007853897	0.024026672	0.002163185	0.038486633
MSCI EUROPE EX DENMARK	0.050082678	0.023008612	0.059051928	0.05526987	0.030236575	0.053659386	0.002246923	0.065577566
MSCI SOUTH AFRICA	0.052697791	0.033028297	0.05526987	0.095292049	0.025410537	0.060281583	0.002791459	0.082813247
MSCI NORTH AMERICA	0.023803224	0.007853897	0.030236575	0.025410537	0.042589281	0.044996871	0.000532915	0.035587264
MSCI EM LATIN AMERICA	0.049187118	0.024026672	0.053659386	0.060281583	0.044996871	0.092406857	0.002052561	0.075022229
MSCI FM AFRICA	0.002412956	0.002163185	0.002246923	0.002791459	0.000532915	0.002052561	0.032896537	0.002790621
MSCI RUSSIA	0.062980263	0.038486633	0.065577566	0.082813247	0.035587264	0.075022229	0.002790621	0.176610136

Difference (Sample - Shrinkage)								
MSCI DENMARK	MSCI DENMARK	MSCI AC ASIA PACIFIC	MSCI EUROPE EX DENMARK	MSCI SOUTH AFRICA	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI RUSSIA
MSCI AC ASIA PACIFIC	0.000000000000	-0.000016404811	0.000071423240	-0.000020776685	-0.000060146512	-0.000059615528	-0.000055609891	-0.000124302642
MSCI EUROPE EX DENMARK	-0.000016404811	0.000000000000	-0.000054578422	0.000011345601	-0.000125933546	-0.000110435110	-0.000022724103	-0.000059726030
MSCI SOUTH AFRICA	0.000071423240	-0.000054578422	0.000000000000	-0.000009278774	0.000018638251	-0.000020626244	-0.000060917562	-0.000120609881
MSCI NORTH AMERICA	-0.000020776685	0.000011345601	-0.000009278774	0.000000000000	-0.000133378368	-0.000084434939	-0.000071863577	-0.000087291688
MSCI EM LATIN AMERICA	-0.000060146512	-0.000125933546	0.000018638251	-0.000133378368	0.000000000000	0.000153435261	-0.000050187268	-0.000148751556
MSCI FM AFRICA	-0.000059615528	-0.000110435110	-0.000020626244	-0.000084434939	0.000153435261	0.000000000000	-0.000080781605	-0.000179989747
MSCI RUSSIA	-0.000055609891	-0.000022724103	-0.000060917562	-0.000071863577	-0.000050187268	-0.000080781605	0.000000000000	-0.000108047654

11. Asset allocation for each individual pension fund

See attached excel spreadsheet

12. Individual scores - governance and transparency

The Worldwide Governance Indicators (TWGI)

MSCI AC Asia Pacific ex Japan	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Thailand	55	53	51	44	44	43	44	43	44	44
Singapore	84	87	88	86	86	87	86	87	87	91
Philippines	40	36	41	37	37	37	36	35	37	40
New Zealand	96	97	96	96	96	96	96	97	99	98
Malaysia	68	65	65	61	61	57	56	61	60	61
Korea, Rep.	58	49	54	50	42	39	40	42	39	39
India	44	44	47	46	45	45	44	43	42	40
Indonesia	22	26	28	32	35	36	35	35	36	38
Hong Kong SAR, China	85	89	89	89	88	88	87	87	86	88
China	36	36	35	36	36	38	37	35	36	35
Australia	91	93	92	92	93	93	92	92	92	93
Taiwan	77	79	77	73	73	75	75	79	79	79
Average	63	63	64	62	61	61	61	61	61	62

MSCI Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Denmark	98	96	97	97	97	97	97	97	97	95

MSCI Japan	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Japan	83	85	85	87	84	83	85	85	86	85

MSCI Europe Ex Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	93	93	93	94	97	96	93	94	93	94
Belgium	89	88	87	87	87	86	88	87	88	88
Finland	100	100	100	99	98	98	98	98	98	98
France	82	85	85	86	86	86	85	86	84	84
Germany	88	88	90	92	92	90	90	89	89	89
Ireland	92	92	94	93	94	93	92	91	89	90
Israel	66	67	65	68	67	68	65	67	68	68
Italy	73	72	70	70	69	69	67	68	67	66
Netherlands	95	94	94	93	93	93	94	94	96	96
Norway	94	96	95	95	95	96	96	97	97	97
Portugal	89	86	86	81	81	83	81	79	78	78
Spain	82	81	81	76	76	75	74	75	77	75
Sweden	97	97	95	96	97	96	96	96	98	98
Switzerland	96	97	95	96	97	97	96	96	96	97
United Kingdom	88	87	87	90	89	88	85	87	87	87
Average	88	88	88	88	88	88	87	87	87	87

MSCI North America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
United States	84	83	84	86	85	87	84	85	85	86
Canada	94	91	91	93	93	93	95	93	94	94
Average	89	87	87	89	89	90	89	89	89	90

MSCI EM Latin America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Brazil	54	52	50	49	49	51	54	56	55	54
Chile	84	86	86	84	83	82	83	85	83	83
Colombia	36	39	38	41	42	42	41	42	45	43
Mexico	53	52	50	49	47	45	46	46	46	48
Peru	41	41	39	40	40	42	41	45	46	44
Average	54	54	53	53	52	52	53	55	55	54

Corruption Perception Index (CPI)

MSCI AC Asia Pacific ex Japan	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Thailand	33	36	38	36	33	35	34	35	34	37
Singapore	94	93	94	94	93	92	92	93	92	87
Philippines	25	26	25	25	25	23	24	24	26	34
New Zealand	95	96	96	96	94	93	94	93	95	90
Malaysia	52	50	51	50	51	51	45	44	43	49
Korea, Rep.	43	45	50	51	51	56	55	54	54	8
India	28	28	29	33	35	34	34	33	31	36
Indonesia	19	20	22	24	23	26	28	28	30	32
Hong Kong SAR, China	80	80	83	83	83	81	82	84	84	77
China	34	33	32	33	35	36	36	35	36	39
Australia	88	88	88	87	86	87	87	87	88	85
Taiwan	57	56	59	59	57	57	56	58	61	61
Average	54	54	56	56	56	56	56	56	56	53

MSCI Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Denmark	95	95	95	95	94	93	93	93	94	90

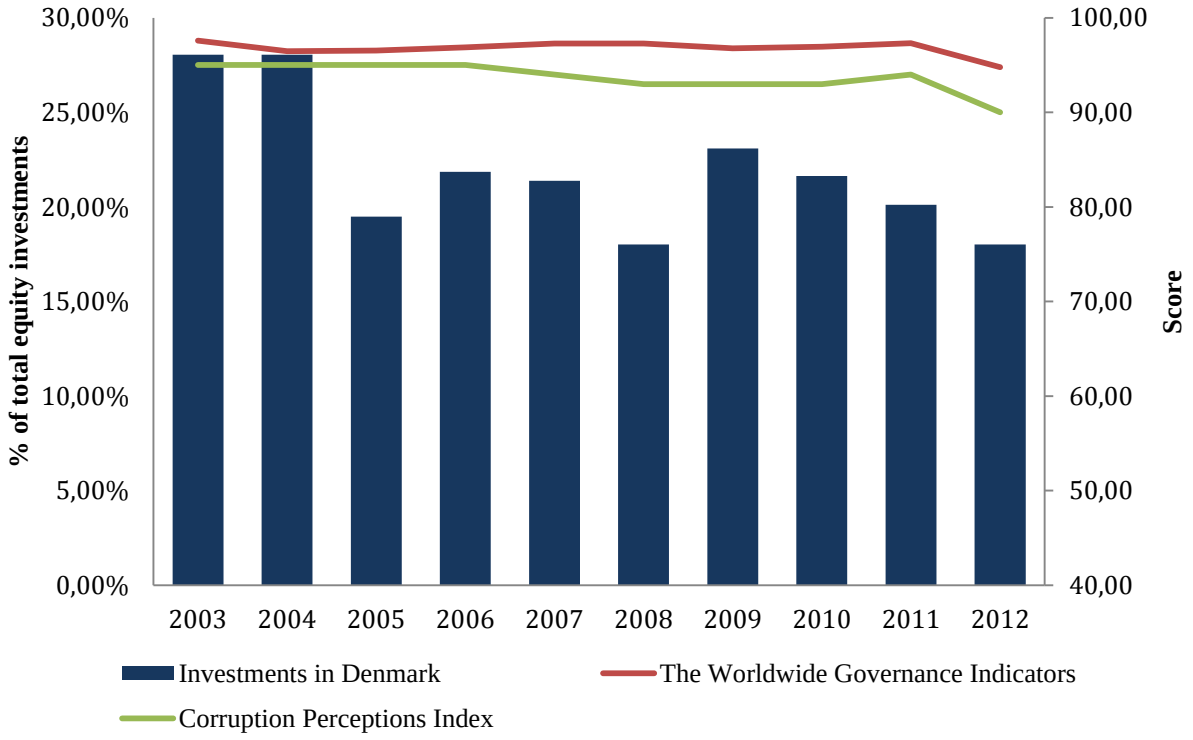
MSCI Japan	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Japan	70	69	73	76	75	73	77	78	80	74

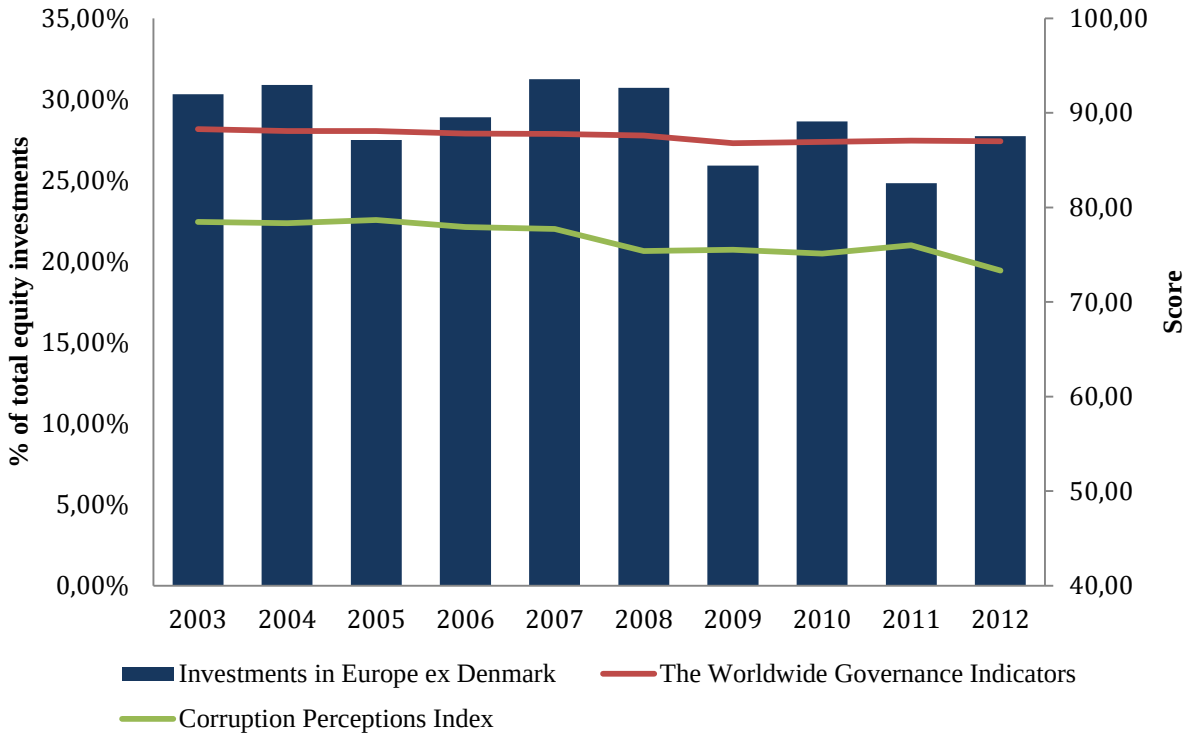
MSCI Europe Ex Denmark	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	80	84	87	86	86	81	87	87	88	69
Belgium	76	75	74	73	71	73	71	71	75	75
Finland	97	97	96	96	94	90	89	92	94	90
France	69	71	75	74	73	69	69	68	70	71
Germany	77	82	82	80	78	79	80	79	80	79
Ireland	75	75	74	74	75	77	80	80	75	69
Israel	70	64	63	59	61	60	61	61	58	60
Italy	53	48	50	49	52	48	43	39	39	42
Netherlands	89	87	86	87	90	89	89	88	89	84
Norway	88	89	89	88	87	79	86	86	90	85
Portugal	66	63	65	66	65	61	58	60	61	63
Spain	69	71	70	68	67	65	61	61	62	65
Sweden	93	92	92	92	93	93	92	92	93	88
Switzerland	88	91	91	91	90	90	90	87	88	86
United Kingdom	87	86	86	86	84	77	77	76	78	74
Average	78	78	79	78	78	75	76	75	76	73

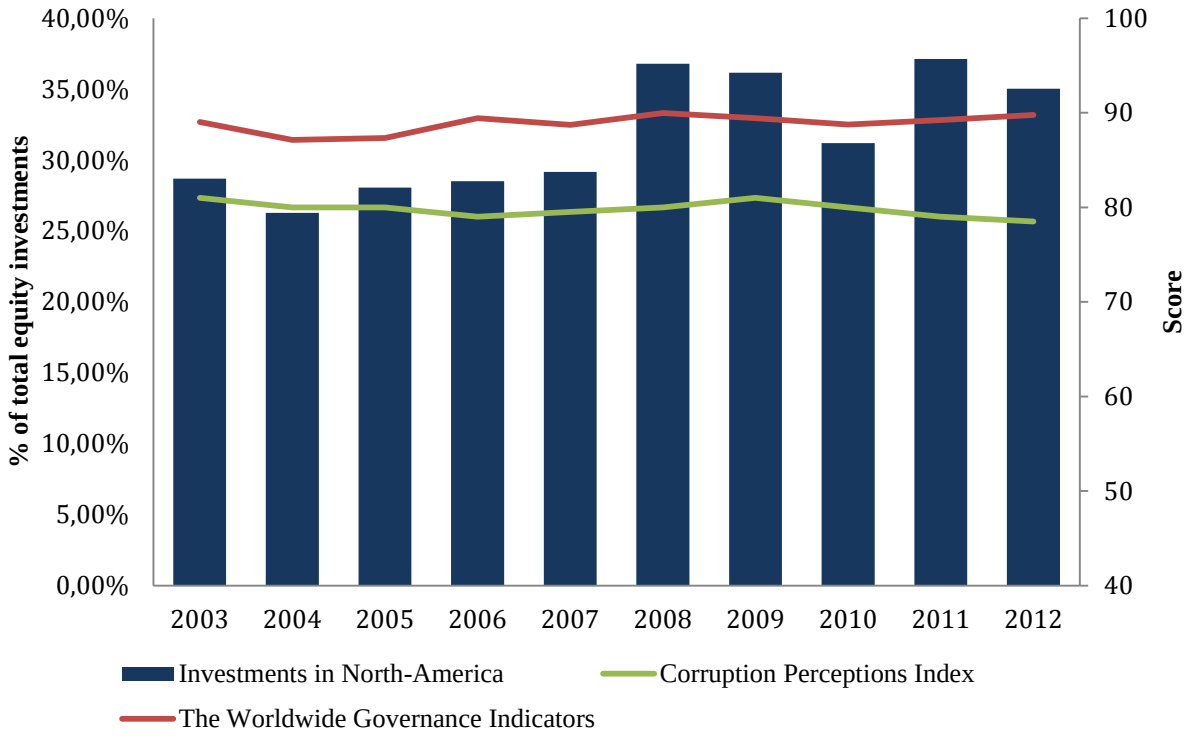
MSCI North America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
United States	75	75	76	73	72	73	75	71	71	73
Canada	87	85	84	85	87	87	87	89	87	84
Average	81	80	80	79	80	80	81	80	79	79

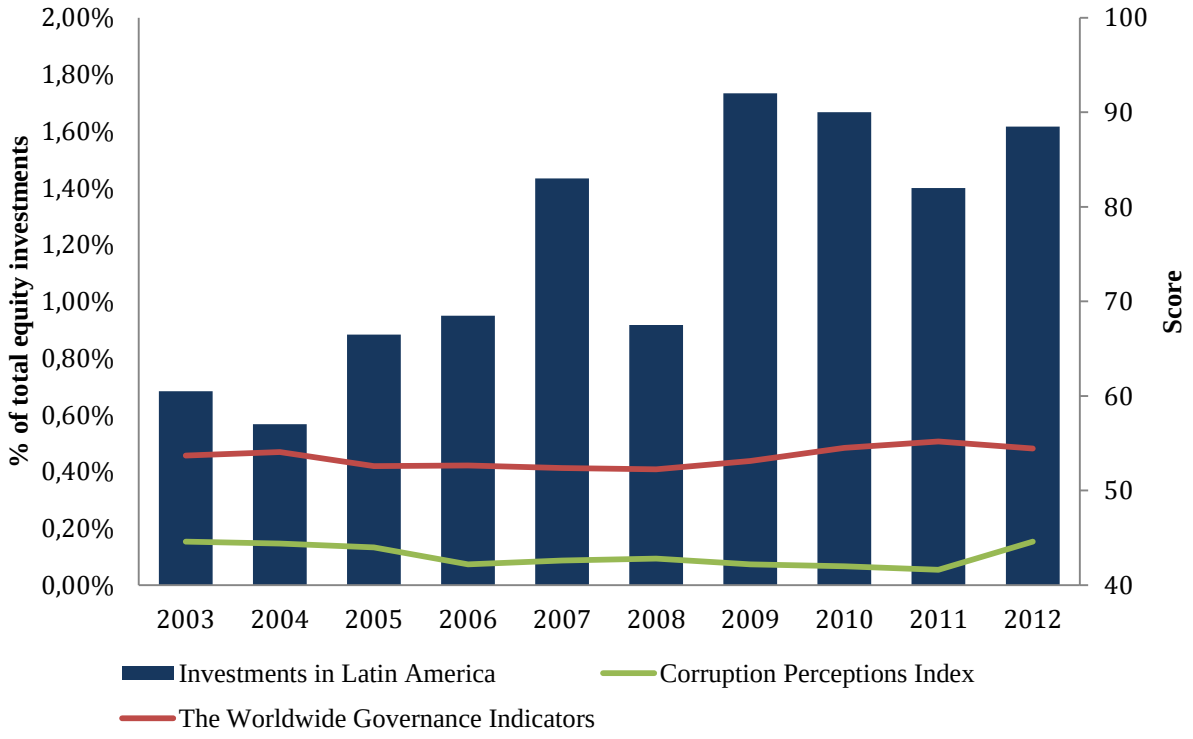
MSCI EM Latin America	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Brazil	39	39	37	33	35	35	37	37	38	43
Chile	74	74	73	73	70	69	67	72	72	72
Colombia	37	38	40	39	38	38	37	35	34	36
Mexico	36	36	35	33	35	36	33	31	30	34
Peru	37	35	35	33	35	36	37	35	34	38
Average	45	44	44	42	43	43	42	42	42	45

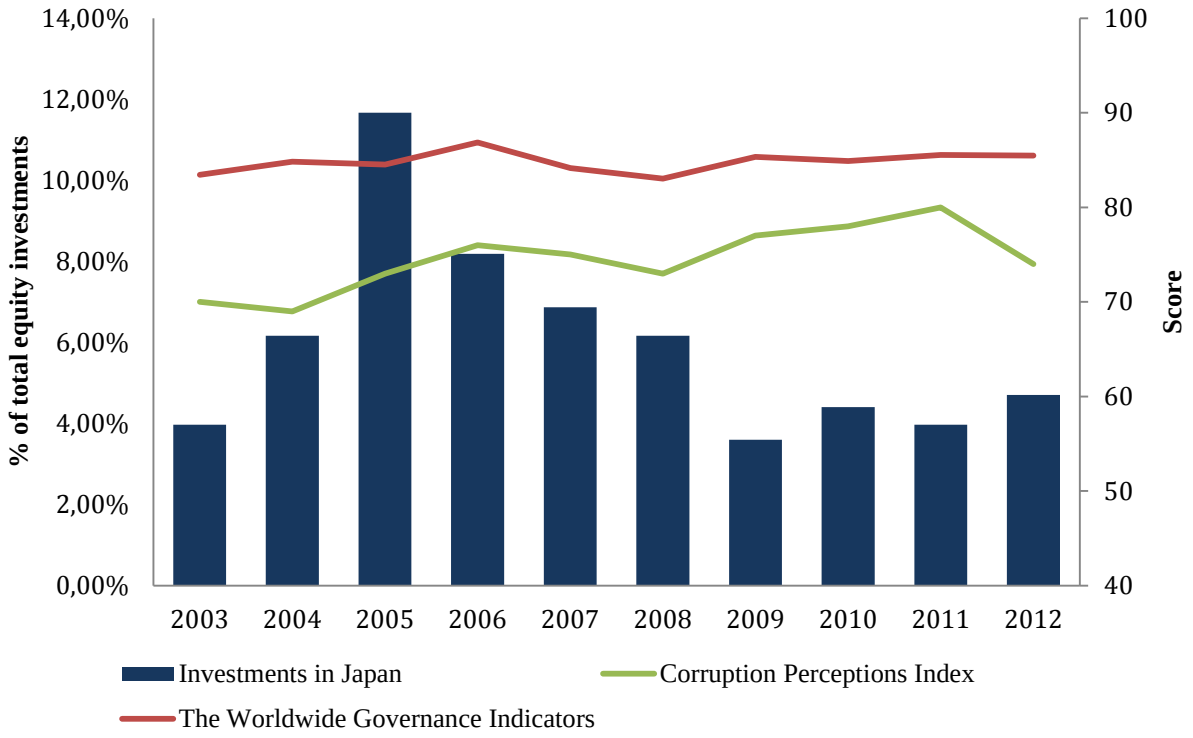
13. Trend between asset allocation and governance and transparency score. Individual markets.

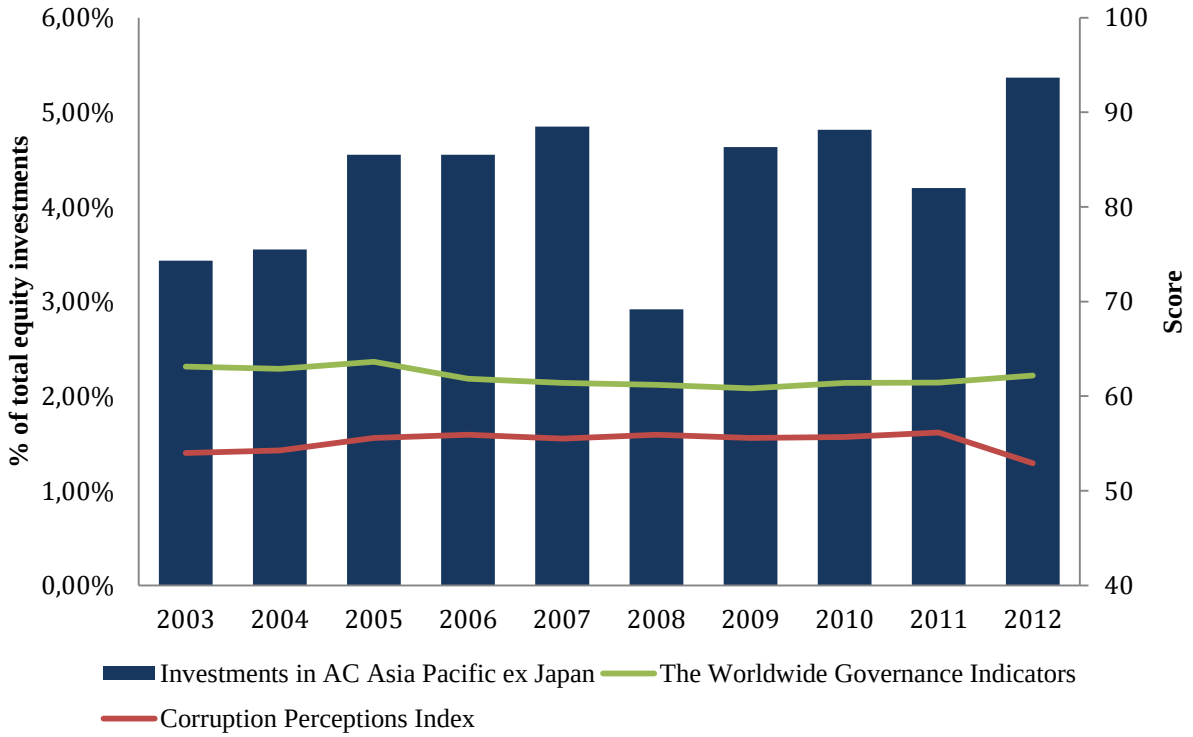





40,00%
35,00%
30,00%
25,00%
20,00%
15,00%
10,00%
5,00%
0,00%
% of total equity investments
100
90
80
70
60
50
40
Score
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Investments in North-America
Corruption Perceptions Index
The Worldwide Governance Indicators


2,00%
1,80%
1,60%
1,40%
1,20%
1,00%
0,80%
0,60%
0,40%
0,20%
0,00%
% of total equity investments
100
90
80
70
60
50
40
Score
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Investments in Latin America
Corruption Perceptions Index
The Worldwide Governance Indicators


14,00%
12,00%
10,00%
8,00%
6,00%
4,00%
2,00%
0,00%
% of total equity investments
100
90
80
70
60
50
40
Score
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Investments in Japan
Corruption Perceptions Index
The Worldwide Governance Indicators


6,00%
5,00%
4,00%
3,00%
2,00%
1,00%
0,00%
% of total equity investments
100
90
80
70
60
50
40
Score
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Investments in AC Asia Pacific ex Japan
The Worldwide Governance Indicators
Corruption Perceptions Index

14. Covariance matrix to section 7.1.11

Yearly Variance Covariance Matrix							
	MSCI DENMARK	MSCI EUROPE EX DENMARK	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI AC ASIA PAC EX JP	MSCI JAPAN
MSCI DENMARK	0.06254	0.05017	0.02375	0.04915	0.00236	0.03191	0.01675
MSCI EUROPE EX DENMARK	0.05017	0.05907	0.03027	0.05366	0.00219	0.03071	0.01406
MSCI NORTH AMERICA	0.02375	0.03027	0.04261	0.04517	0.00048	0.01300	0.00187
MSCI EM LATIN AMERICA	0.04915	0.05366	0.04517	0.09244	0.00197	0.03438	0.01239
MSCI FM AFRICA	0.00236	0.00219	0.00048	0.00197	0.03291	0.00312	0.00131
MSCI AC ASIA PAC EX JP	0.03191	0.03071	0.01300	0.03438	0.00312	0.04926	0.03125
MSCI JAPAN	0.01675	0.01406	0.00187	0.01239	0.00131	0.03125	0.05323

15. Correlations for 7.1.2

Correlations (Denmark with other international markets)	MSCI EUROPE EX DENMARK	MSCI NORTH AMERICA	MSCI EM LATIN AMERICA	MSCI FM AFRICA	MSCI AC ASIA PAC EX JP	MSCI JAPAN
2003	0.495	0.215	0.332	-0.034	0.317	0.301
2004	0.742	0.268	0.446	-0.020	0.472	0.316
2005	0.665	0.160	0.400	0.071	0.346	0.262
2006	0.775	0.332	0.564	0.098	0.562	0.407
2007	0.838	0.454	0.647	0.089	0.643	0.223
2008	0.908	0.449	0.745	-0.024	0.666	0.398
2009	0.803	0.494	0.667	0.055	0.544	0.162
2010	0.843	0.568	0.647	0.143	0.592	0.196
2011	0.864	0.634	0.676	0.122	0.518	0.257
2012	0.741	0.454	0.596	0.100	0.472	0.216