BI Norwegian Business School - campus Oslo

GRA 19502

Master Thesis

Component of continuous assessment: Thesis Master of Science

Using the interest rate term spread as a means to predict stock market returns

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Start: 02.03.2017 09.00

Finish: 01.09.2017 12.00

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Hand-in date:

01.09.2017

Programme:

Master of Science in Business, major in Finance

I Preface

With this master thesis, we conclude our MSc in Business, major in Finance at BI Norwegian Business School, Oslo.

The master thesis investigates the interest rate term spread's ability to create abnormal returns in ten sample economies in Europe, America and Asia. We hope that our master thesis can be beneficial and inspiring for future studies and shed light on less investigated areas within the field of financial literature, with our practical approach on asset allocation between debt and stock.

The investigation has been time consuming and challenging, but also educational and inspiring. As far as we are concerned, there are little to no research performed on the interest rate term spread's predictive ability on the stock market performance before this master thesis was written. As a consequence of this, in lack of relevant and reliable earlier work on the issue, we have had to pave our own path when writing the thesis, and build models and collect data based on economic theory and in the following a tad of intuition.

We would like to thank our supervisor Kjell Jørgensen for all the help provided throughout the process of our work with this master thesis. Further we would like to thank Henry Lai and Zelim Chilaev for valuable insights and proof reading.

Oslo, August 2017

II Abstract

We research an investment strategy; the Asset Allocation Model, incorporating the difference between long-term and short-term interest rate – the interest rate term spread – as a leading indicator for asset class allocation. Intuitively, a positive spread implies higher economic growth in the future, which should eventually propagate to the stock markets. Using the term spread, we create a categorical dummy variable which signals investment in the stock market in positive spread periods and no exposure to stock (risk) in negative spread periods. By the Efficient Market Hypothesis, all available information and expectations about future economic growth should already be reflected in stock prices and exploiting information from the debt markets should not yield any persistent abnormal returns.

The model is tested in ten sample economies; the US, the UK, Japan, Norway, Denmark, Sweden, Germany, Finland, Switzerland and China, using historical data from 10-year government bonds, 3-month Interbank Offered Rates and the major stock market indices from the respective markets.

We find evidence that the Asset Allocation Model has been able to outperform the market index in every sample economy both in absolute cumulative returns and by the risk-adjusted Sharpe ratio, with satisfactory statistical significance in seven out of ten countries (excl. UK, China and Japan). We argue that the interest rate term spread contains information that is not reflected in the stock market, with the implication that the Efficient Market Hypothesis does not truly hold in its semi-strong form. We also emphasize that the good results are largely attributable to the model's ability to predict the heaviest stock market declines. Although the results are very interesting and statistically significant, we advise caution on the consistency of the results out of sample due to relatively short research periods, and the nature of financial markets characterized by structural changes.

Table of contents

List of tables

1 Introduction

1.1 Inspiration

The relationship between interest rate term spread and economic growth has been thoroughly studied in the past. Inspired by the article "Rentekurven som ledende indikator" (the yield curve as leading indicator) by Stein Svalestad (2011), we took interest in this subject that investigates the relationship between the yield curve and real economic growth. As much research has been done on the ability to make excess returns by active stock picking, and the popularity of index investing is rising, we rather wish to investigate the ability to predict asset class performance. In our master thesis, we will examine the relationship between interest rate term spread and real GDP growth further and build an investment strategy using the interest rate term spread to time positions in the stock market and find whether such a strategy can provide abnormal returns relative to passive exposure in stock market indices ("beating the market").

The idea behind our hypothesis is that growth in the real GDP results in positive stock market returns and vice versa, so that if the fixed income markets are useful predictors for economic growth, we can also use the same information to predict future stock market returns. If our working hypothesis is true, we can possibly argue against the Efficient Market Hypothesis, as we are able to use public interest rates to create abnormal returns by timing stock market exposure. Svalestads (2011) empirical model shows that there was a statistically significant relationship between the interest rate term spread and the real GDP growth in the period 1985-2010 in Norway. Then he implements a simple portfolio strategy where you invest in the stock market (using Oslo Børs Benchmark Index) when long-term interest rates are higher than short-term, and invest in the money market if not. This model gave more than six times the accumulated return of being passively invested in the stock market during the period, largely due to not being exposed to the stock market during its heaviest declines (e.g. the dot-com bubble and the financial crisis of 2007-2008).

We wish to see if we can replicate the same findings in Norway, and also apply the same model to some of the largest stock market indices to see if the results are consistent. The indices must be geographically limited because our proxies for interest rates and the stock market must all belong to the same economic market.

1.2 Thesis structure

The thesis is structured into seven chapters with subchapters, followed by two appendixes. The first chapter introduces the thesis with our inspiration for choosing a topic, practical information and the research question with hypotheses. The second chapter reviews relevant literature and previous research performed which we will relate our research to. Chapter three presents financial theory on which we build our research. Chapter four presents our methodological approach to investigate the hypothesis. In Chapter five we present our approach to gather and structure data. Chapter six is the most important chapter and includes the results of our analysis and a discussion regarding our findings whether or not we will reject our null hypothesis. In the final chapter, we conclude our findings.

1.3 Research question

This Master Thesis will investigate whether the interest rate term spread can be used as an indicator to predict stock market returns. We will construct an investment strategy which allocates its funds in the stock market or risk-free rate given the information obtained from the term spread. Our research question is:

Can we outperform the stock market by using the interest rate term spread as a signal for optimal asset allocation?

1.4 Results

The testing is divided into three categories; cumulative return, Sharpe ratio and statistical testing and the results are shortly presented here. The results are more thoroughly discussed in chapter 6.

The cumulative return of the Asset Allocation Model (AAM) has outperformed the cumulative return of the stock market index in all of our sample economies over the entire sample period (see Appendix 1). Splitting up the sample periods into individual allocation periods reviled that the AAM has a success rate of >50% for shorter periods. Intuitively, the model performs under shorter periods as well as longer periods.

The Sharpe ratios are low, however marginally higher for the AAM than for the stock market indices. We find that the average return of the AAM is higher than the average return of the indices, surprisingly as the AAM contains periods of low yielding risk-free return. This is because the AAM correctly predicts periods where the stock market yields lower returns than the risk-free rate, and hence, helps avoid larger losses in the stock market.

The statistical testing consisted of two sample Z-tests performed in each sample economy. The test compares the mean return of the AAM and the stock market index to statistically measure the performance of the AAM. The statistical test results differ too much between the sample economies and the results are not strong enough to provide us with unambiguous proof of the AAM's performance. However, we argue that there is information in the interest rate yield curve which is not embedded in stock prices.

1.5 Definitions

AAM	The Asset Allocation Model is an investment strategy exploiting the interest rate yield curve to allocate its funds
AAM multiple	Performance measure for the AAM, calculated by AAM return divided by stock index return
1-periods	Periods with a positive yield curve in which the AAM signals investment in stocks
0-periods	Periods with an inverted yield curve in which the AAM signals investment in risk-free rate
Correctly predicted periods	Periods where the dummy variable correctly predicted the best performing asset class of period t+1
Incorrectly predicted periods	Periods where the dummy variable incorrectly predicted the best performing asset class of period t+1
Active portfolio	Portfolio mirroring the Asset Allocation Model
Passive portfolio	Portfolio invested in the stock market index

1.6 Acronyms

AAM	Asset Allocation Model
EMH	Efficient Market Hypothesis
GDP	Gross Domestic Product
G7	Group of Seven: the seven largest advanced economic powers, reported by the International Monetary Fund
***IBOR**	Interbank Offered Rate
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development

2 Literature Review and Background

The interest rate yield curve (term spread) as an indicator of economic growth has been widely researched over the past 50 years. Much research has been done using long-term (10-year) Treasury Bonds (government-backed debt obligations) and short-term (3-month) Treasury Bills (T-Bills) in the United States and other OECD countries. The term spread in the interest rate yield curve is the difference between the yield of the 10-year bond and the 3-month bill. The spread has been found to contain information that is helpful to predict macro-economic factors such as output growth, inflation, industrial production, consumption and recessions. The term spread's forecasting ability is considered a stylized fact by many macroeconomists (Wheelock & Wohar, 2009).

Several different researchers have tried to establish a horizon for the forecasting ability of the term spread. Research conducted by Estrella and Hardouvelis (1991) found that the spread could predict the cumulative real outputs for four years into the future and marginal real outputs for one and a half years. Later, Estrella and Mishkin (1998) found that the term spread outperforms other predictive variables in a one-on-one comparison for horizons beyond one quarter. Gerlach and Bernard (1998) found that the term spread could predict recessions for up to two years in several European and North-American countries. Other researchers find the predicting ability to range from one quarter to three years into the future. Most research are empirical studies to find *if* the term spread has forecasting abilities, with little concern for *why* it is able to perform so well.

Researchers has not agreed upon a theory for why the term spread is a good predictor for the economic cycle, the phenomenon is referred to as a *"stylized fact in search of a theorem"* (Benati & Goodhart, 2008). Estrella and Hardouvelis (1991) conclude that historically, the spread has shown predictive ability for the future macro-economic direction and could be beneficial as an economic predicator not only for private investors but also for the Federal Reserve, as it reflects factors that are not controlled by the monetary authorities. However, they noted that it is unclear how well the spread could predict the economic growth in the future, especially if the monetary authorities adopted it as a leading indicator. This is due to the uncertainty in whether the historical correlation is policy invariant. Recent studies find that the predictive ability of the spread has declined since the middle of the 1980's (Wheelock & Wohar, 2009).

Researchers have debated measurements of portfolio performance for a long time. Different theories have been established for investment managers' market timing and selection ability. Academic literature has widely cited and built upon original studies such as Jensen (1968), Sharpe (1966) and Treynor (1965). Their models are used by various empirical researchers for testing abilities to outperform market benchmarks. An implication of this debate is whether or not an actively managed portfolio will yield higher returns than a passively invested portfolio. Different studies have tried to identify mutual funds ability to time the market. Over the period 1977-1987, Brinson et. al. (1995), found that the long-term policy explained over 90% of a funds return, and actively managed timing and selection strategies had negative impact on the performance. Goetzmann, Ingersoll and Ivkovic (2000) used a multifactor regression model to investigate 558 mutual funds' performance. They found no positive significant timing ability for any of the sample funds. Other studies, however, have concluded differently. Low (2012) analysed 67 Malaysian funds where he found on average positive timing ability.

The overall consensus is that it is not possible to time the market and that passively invested portfolios have at least the same risk-adjusted expected returns as actively managed portfolios. Further, studies have found that the yield curve contains information about the future development in the economy, although the reason is not thoroughly understood. Less empirical research has been done on the possibility to exploit these relationships in the stock market. We wish to build upon these macro-economic findings to investigate our hypothesis that the interest rate term spread can as well be a leading indicator for future stock market performance.

3 Theoretical Framework

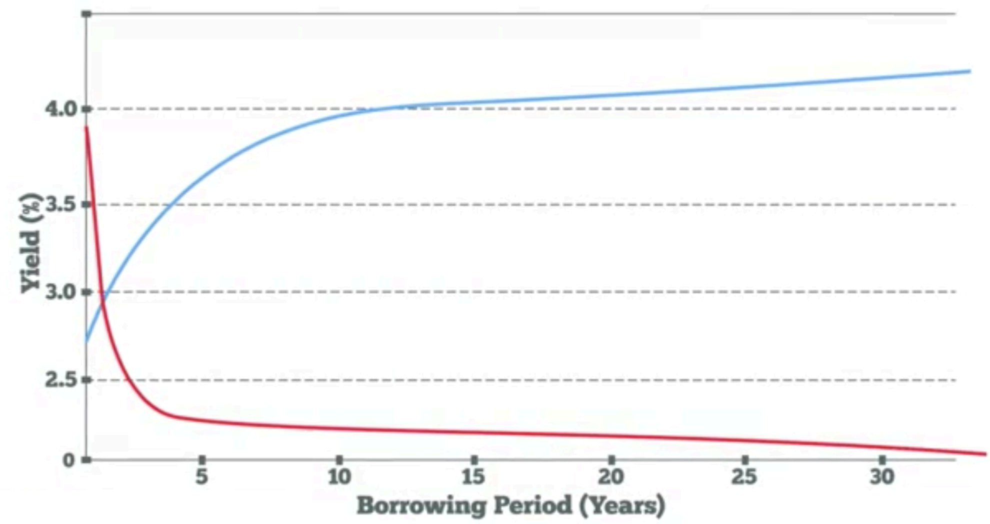
As described in Chapter 2, much research has been conducted on the predictive ability of the term spread on the future macro-economic situation. Less research has been done directly on the term spreads ability to forecast the stock market. This could be valuable information for private and institutional investors, and may help forecast the future market performance.

Stein Svalestad (2011) conducted an analysis of the performance of a portfolio invested in the Oslo Børs Benchmark Index (OSEBX) in periods with positive term spread, and in short-term NIBOR (3-month) minus 100 basis points in periods with negative term spread. He found that the cumulative profit would be over six times the return of a passively managed portfolio during the period 1985-2010. We have not been able to find extensive research beyond Svalestad's article on this field.

3.1 Term structure of interest rates

Important for this thesis is the term structure of interest rates. The term structure of interest rates is the relationship between the yield to maturity for bonds with different time to maturity. The normal term structure of interest rates is an upward sloping yield curve, implying that long-term bonds yield higher interest rates than short-term bonds. The opposite is an inverted yield curve with a downward sloping trend. This occurs when the short-term interest rate is higher than the long-term interest rate and is interpreted as a sign of future recession. Harvey (1989) studied the predictive ability of different leading indicators and found that the interest rate term spread provided the best predictions of the business cycle for the following four quarters.

Plot 1: Term structure of interest rates



Note: Plot 1 shows the term structure of interest rates with years to maturity on the X-axis and interest rate on the Y-axis. The blue graph shows a normal yield curve and the red graph shows an inverted yield curve.

To explain the term structure of interest rates we have the Expectations Hypothesis and the Liquidity Preference Theory, which is described in the following subchapters.

3.2 Expectations Hypothesis

The Expectations Hypothesis is a widely accepted financial theory and states that the forward interest rates equal the market's expectations to the future interest spot rates. Under the assumption of no arbitrage and no liquidity premium, the long-term interest rate equals the short-term interest spot rate and all forward interest rates required to cover the period of the long-term interest rate, as shown in equation [1]:

$$(1 + r_n)^n = (1 + r_{n-k})^{n-k} * (1 + {}_{n-k}r_n)^k, \quad [1]$$

where

r_n = spot rate for period 0 – n (long-term),

r_{n-k} = spot rate for period 0 – n-k (short-term), and

${}_{n-k}r_n$ = forward rate for period n-k – n (short-term)

The theoretical basis of the Expectations Hypothesis is built on a no-arbitrage argument; investing in two similar debt obligations with different time to maturity, will yield the same return if invested over the same time-horizon (i.e. investing in a 6-month bill will yield the same return as a 3-month bill rolled over in a new 3-month bill at expiration). Any given term-structure should, by no-arbitrage, not yield a risk free abnormal return. By the Efficient Market Hypothesis (EMH), any deviation from this argument will shortly be corrected by market forces. Hence, the two investments will yield the same return over an equal time-horizon.

If the forward interest rate is equal to the expected future spot rate and the Expectations Hypothesis holds, we can use the yield curve to make predictions on the market's expectations to future economic states. Under the Expectations Hypothesis, high long-term spot rates and low current short-term spot rates, e.g. positive term-spread, must be compensated by high expedited future spot rates. This indicates market expectations of future economic growth. Similarly, low long-term spot rates and high current short-term spot rates, e.g. negative term-spread, indicates that the market expects a recession in the foreseeable future.

Both nominal and real term structures can be applied in the formula. Applying real interest rates may give indications on the expected inflation in the near future. Much of the research done on this area is using the nominal term structure. Wheelock and Wohar (2009) argue that under fiat monetary regimes (money not being backed by a commodity) inflation tends to be persistent, meaning that shocks to the inflation tends to shift the expected inflation equally over all time-horizons. In research done under these persistent inflations, empirical evidence pertains nominal interest rates rather than real interest rates.

Furthermore, the stock market data are given in nominal terms. Based on these arguments we are using nominal terms in our thesis rather than real terms.

3.3 *Liquidity Preference Theory*

The Liquidity Preference Theory states that long-term investors will not invest in short-term bonds unless the forward rate is higher than the expected future spot rate. Furthermore, short-term investors will not invest in long-term bonds unless the forward rate is higher than the expected future spot rate. Supporters of the Liquidity Preference Theory claims there are more short-term investors than long-term investors and empirical evidence shows that the forward short-term rate typically overestimate the subsequent short-term spot rate (Kessel, 1971). The forward rate minus expected spot rate is the liquidity premium. The same relationship holds as in equation [1], however, now the ${}_{n-k}r_n$ -term consists of expected future spot rate plus the liquidity premium, which increases the long-term spot rate.

Kessel (1971) studied T-Bills price behaviour over the period 1959-1962, which spans one complete economic cycle to conduct his analysis. He concludes that the term structure of interest rates builds upon both the Expectations Hypothesis and the Liquidity Preference Theory. When adjusting the prices for the risk premium he finds that the Expectations Hypothesis does a good job in predicting the short-term interest rates for up to one year ahead.

3.4 *Theories to why the relationship holds*

The predictive ability of the term spread on future economic growth or recessions has been thoroughly investigated and economists widely agree that there exists a relationship between the spread and the future state of the economy. However, there is no consensus to why the relationship exists. There are two major explanations to why the spread is able to predict the growth in the economy (Bjønnes, Isachsen & Stoknes, 1998). Both explanations assume that the Expectation Hypothesis holds.

3.4.1 *Theory 1*

The first theory assumes that the yield curve is primarily driven by the monetary policy. We assume that strict monetary policies work contractive on the real growth in the economy. If the monetary authorities raise the key policy rate, this will impact short-term interest rates, which will increase. However, strict monetary policies are assumed to be temporary and will not affect the long-term interest rate at the same scale. The result is a less steep or even inverted yield curve. Implications of this are that the term spread predicts the real growth in the economy.

3.4.2 Theory 2

The other theory assumes that the term spread reflects the market expectations to growth in GDP (Svalestad, 2011). When the economy is facing times of expansion, there are more growth opportunities and more projects with positive NPV's. In this situation corporations will undertake more investments financed by debt. These investments have a long time-horizon and the corporations will issue long-term debt. With an increase in the supply of long-term debt, the bond price will fall, resulting in a steeper yield curve. Here we can assume that the market also expects the monetary authorities to increase the key policy rate, resulting in an even steeper yield curve.

3.5 Market Efficiency Theory

The Efficient Market Hypothesis (EMH) is a financial theory, first introduced by Eugene Fama in 1965. Fama stated that a market is efficient when the asset's prices at any given time reflect all available information. The theory suggests that in an efficient market, assets will trade at a fair market value and only react to new information and unpredictable, investors should thereby not be able to create risk-adjusted abnormal return by buying under-priced, or sell over-priced stocks. Hence, it should be impossible to consistently outperform the market by expert stock picking or market timing strategies. The theory assumes that profit maximizing, rational investors will price an asset correctly based on all available information, and it will be impossible to create risk-adjusted abnormal return. Under the market efficiency theory stock prices are unpredictable and follow a random walk. With this argument, the optimal choice for a long-term investor is to invest in market indices providing a well-diversified portfolio with low or without exposure to idiosyncratic risk. The Efficient Market Hypothesis is built upon three levels of efficiency:

Weak form efficiency: Asset prices reflect all information about previous price movement and trading volume. In a weak form market these data will not be able to predict further price development, as these data are already reflected in the price. Technical analysis will not be able to create risk-adjusted abnormal return in a weak form market.

Semi-strong form efficiency: In a semi-strong market the price of an asset will, in addition to the historical information from the weak form, reflect all publicly known information, such as expected dividend or key accounting numbers. In a semi-strong form market neither technical nor fundamental analysis will be able to create risk-adjusted abnormal return.

Strong form efficiency: In a strong form market, the price of an asset will reflect all historic, public and private information. In a strong form market the price of an asset will be the fair market price and it will be impossible to consistently outperform the market, as the price even reflects all inside information.

In weaker financial markets information can provide investors with abnormal return. An investor in such a market will be rewarded for his effort to identify mispriced assets. Though this information comes at a price of time and resources spent gathering and analysing such information. This reward will decrease as a higher number of investors identify mispriced assets in the market, and the market move toward a higher efficiency level.

In this thesis, we try to exploit the term spread to create long-term abnormal returns and effectively beating the market. If we succeed in finding a strategy that is able to provide us with such abnormal returns, we have evidence against the Efficient-market hypothesis and we can prove that the stock market does not reflect all publicly available information.

3.6 Time-horizon of long- and short-term interest rates

Most research on the field has been conducted using 3-month bills as short-term interest rates and 10-year bonds as long-term interest rate. We aim to use 10-year government bonds and 3-months Interbank Offered Rates. This keeps the time-horizon of interest rates consistent with standard time-horizons in previous research. The *IBOR is the closest substitute to a 3-month bill we can obtain and is justifiable with theory (Kozicki, 1997). Even for the economies where the government issues 3-month debt we will stick to the *IBOR to keep the research consistent. In addition, we can argue that the *IBOR is a better proxy for the market expectations to real growth as it takes into account more risk factors than government debt, and can provide useful information in our signals. Hence, the Interbank Offered Rates may be more volatile and may give better predictions for the stock market.

4 Methodology

We are researching a market timing model and analysing the performance of the Asset Allocation Model relative to the passive return of the stock market. In other words, the main goal is to find if applying the AAM is able to yield abnormal returns, and thus if the interest rates can help predicting stock market returns. We create dummy variables using the difference between long- and short-term interest rates, and use it for signalling asset allocation between a broad stock index and a risk-free rate in each of our sample countries. The same statistical analyses will be applied to each of our 10 research countries, followed by a summary of our findings.

4.1 The interest rate term spread

In order to perform an analysis on the predictive power of the interest rate term spread on the stock market, we created a dummy variable describing the term spread, using the key parameters r_L (long-term interest rate) and r_S (short-term interest rate). Note that by creating the categorical dummy variable, we only take into account the yield curve being normal or inverted; the size of the spread does not matter. Also, the absolute values are not taken into account.

The interest rate term spread in period t is then given by equation [2]:

$$r_{L,t} - r_{S,t} = SPREAD_t \quad [2]$$

Using a dummy variable d, all periods with a *positive* $SPREAD_t$ ($r_{L,t} > r_{S,t}$) are assigned a value of d = 1, while periods with a *negative* $SPREAD_t$ ($r_{L,t} < r_{S,t}$) are assigned a value of d = 0. The dummy variable lays the foundation of the AAM, where we are positioned in the stock market only when the spread is positive and consequently economic growth is predicted. We investigate further whether fluctuations in the stock market can be predicted by the model, and thus if it may be used as a timing signal for asset allocation.

4.2 The Asset Allocation Model

Using the dummy variable d obtained from the interest rate term spread, we employ the model empirically in 10 countries to test for statistically significant abnormal returns compared to passive stock index investing in each country. Hence, we compare two strategies; (1) a passive stock market index investing strategy, and (2) the asset allocation model (AAM), where all capital is invested in the stock market in positive spread periods and all capital is invested in the risk-free rate in negative spread periods.

We are now able to calculate portfolio returns of every month during the research period for both strategies in all countries, and further to compare the strategies. The performance may now be measured just as any other active investment strategy, for example like the widely studied performance of active mutual funds or other stock-picking strategies.

Model (2) is the model that we are going to study and discuss further, while (1) is simply the return of the market; a passive strategy that we need to include for comparison purposes. Is the asset allocation model able to outperform the returns of the stock market indices?

4.3 Transaction costs

We ignore transaction costs in our study. We do not believe that eventual transaction costs would affect our results significantly, and mutual funds often do not charge transaction costs, but rather ongoing charges such as management fees. It is also hard to quantify the total costs of rebalancing to different investors, and our assessment is therefore that the inclusion of such fees could, rather than being helpful, be a source of error in our results. We also wish to emphasize that the indices studied are not directly tradable financial instruments – but passive index funds are tracking them by replicating their underlying assets, making index investing an inexpensive and readily available opportunity to investors.

4.4 Analysis

There is many possible ways to describe the performance of an investment strategy statistically. We will apply a handful of methods to provide a good overview of strengths and weaknesses of the AAM. In each country, we create one passive stock index portfolio, and one active portfolio where the AAM is applied. The performance of the AAM is analysed using descriptive statistics, statistical tests and widely used performance measures such as the Sharpe ratio.

4.4.1 Descriptive statistics

We use simple measures such as average returns, standard deviation, and numbers/percentages of correctly predicted investment periods in order to provide a broad overview of the results from our analysis. Further, those measures let us calculate the well-known Sharpe ratio; a measure for risk-adjusted returns often applied in comparisons between two (or more) investment strategies in financial performance analyses (Ledoit and Wolf, 2008). We calculate the Sharpe ratio using monthly frequencies, and find annualizing unnecessary in this application as we use monthly frequencies consistently throughout our whole dataset, yielding fair comparisons between the strategies. The Sharpe ratio is given by

$$SR = \frac{\mu - R_f}{\sigma} , \qquad [3]$$

where, in monthly averages, μ = return of investment strategy, R_f = risk-free rate, and σ = standard deviation of investment strategy.

Remember that μ and σ are unknown quantities that must be estimated statistically and are subject to estimation error (Lo, 2002). Consequently, our estimators are based on observable, historical data and given by

$$\hat{\mu} = \frac{1}{T} \sum_{t=1}^{T} Rt , \qquad [4]$$

and

$$\hat{\sigma}^2 = \frac{1}{T} \sum_{t=1}^{T} [Rt - \hat{\mu}]^2 , \qquad [5]$$

where R_t = return in month t.

4.4.2 Cumulative returns

The differences in average returns in positive and negative spread periods is interesting, but does not really tell much about the performance of the model in itself. What would be of greatest importance to investors is the cumulative return of the AAM compared to the cumulative return of passive index investing, and hence, if the difference in cumulative returns between investing in the stock market or in the money market in each period can be explained by the interest rate term spread. Investors would always prefer to invest in the highest yielding asset in any investment period to obtain the highest possible cumulative returns, and the question is if the spread can predict which asset class will yield the highest returns in the future.

Each investment period p is the period from one change in the dummy variable to the next. We obtain investment periods of various lengths, where periods of d = 1 signals investment in the stock market, and periods of d = 0 signals investment in the money market. The cumulative return on the passive portfolio will be calculated using the following formula:

$$Value_p = Value_{p-1} * (1 + r_{stock}) \qquad [6]$$

The cumulative return on the AAM portfolio will be calculated using the same formula when the dummy variable for p-1 is 1, and the following formula when the dummy variable for p-1 is 0:

$$Value_p = Value_{p-1} * (1 + r_{bond}) \qquad [7]$$

We can now calculate the returns of investing in the stock market versus investing in the money market in each period to obtain a difference

$$r_{stock,p} - r_{bond,p} = \alpha_p, \qquad [8]$$

where, in period p, $r_{stock,p}$ = stock market return, $r_{debt,p}$ = money market return, and α_p = difference in return between stock market and money market.

Investors clearly want to invest in the stock market in every period p with a positive α, and rather yield the risk-free rate in every period with a negative α. What we want to investigate is if our dummy variable d can explain the differences in α.

4.4.3 Statistical tests

Looking at descriptive statistics and the cumulative returns of the strategy may give an indication, but no tangible information, about the statistical significance of the results. We have a large number of observations and standard deviations are known. We therefore find it appropriate to perform a Z-test to test our hypothesis that the AAM yields significantly higher returns than the passive strategy. Behind this type of statistical test lies an assumption that the test statistic has a normal distribution and that our observations are independent and identically distributed (IID). A common assumption in finance is that we can obtain stationarity data by differentiating. Returns are per definition the first difference of a time-series of historical prices and since proving stationarity is not a focus in this thesis we will assume all return data from our indices, bond- and interest-rates are stationary. The Z-score is given by

$$z = \frac{\hat{\mu}_1 - \hat{\mu}_2}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}} , \quad [9]$$

using our estimators for average returns and variance from eq. [4] and [5], and with n as the number of observations.

In addition to testing the full sample period of the AAM against the passive portfolio, we will also test the positive and negative spread periods separately against each other and against the passive portfolio in order to see if there are any systematic differences in the predictive power of the two types of signals. Intuitively, and based on our hypothesis, we expect the following hypotheses to hold: 1) AAM outperforms the passive portfolio, 2) positive spread periods outperform the passive portfolio, 3) negative spread periods underperform the passive portfolio, and 4) positive spread periods outperform negative spread periods. Our hypotheses can be derived as

$$H_0 = \hat{\mu}_1 = \hat{\mu}_2 \quad [10]$$

and

$$H_1 = \hat{\mu}_1 > \hat{\mu}_2, \quad [11]$$

where portfolio 1 is the one portfolio that is expected to outperform portfolio 2.

To test for rejection of H_0, the Z-score is compared to critical values of 1.28, 1.64 and 2.33 corresponding to significance levels of respectively 10%, 5% and 1% in our one-sided Z-test. If we are able to reject H_0 and accept H_1, this implies that our predictions on higher average returns on portfolio 1 versus portfolio 2 are correct within a given significance level. According to standards within financial research, the null hypothesis will be rejected at a 5% significance level (Stock and Watson, 2011).

5 Data

5.1 Input data

To check the consistency of the Asset Allocation Model across markets, we have tested the same model in ten different economies. The intuition behind the model is the same in any market economy, and we believe that testing the same model in several economies reduces the likelihood of a type I-error[1], which we fear after doing some preliminary analyses of Norway. We have picked some of the major financial markets of the world, as well as some smaller, autonomous economies with their own currency and monetary policies, in direct contrast to for example the EU member states that share the same currency (the euro).

Table 5.1: Input data

Country	Long-term interest rate	Short-term interest rate	Stock index	Research period
China	China 10Y Govt. Bond	CHIBOR 3M	Hang Seng (HSI)	07/2002 – 02/2017
Denmark	Denmark 10Y Govt. Bond	CIBOR 3M	OMX Copenhagen 20 (OMXC20)	01/1990 – 02/2017
Finland	Finland 10Y Govt. Bond	EURIBOR 3M	OMX Helsinki 25 (OMXH25)	01/1999 – 02/2017
Germany	Germany 10Y Govt. Bond	EURIBOR 3M	DAX 30 (DAX)	01/1999 – 02/2017
Japan	Japan 10Y Govt. Bond	JPY LIBOR 3M	Nikkei 225 (NKY)	07/1986 – 02/2017
Norway	Norway 10Y Govt. Bond	NIBOR 3M	Oslo Børs Benchmark Index (OSEBX)	02/1986 – 02/2017
Sweden	Sweden 10Y Govt. Bond	STIBOR 3M	OMX Stockholm 30 (OMXS30)	01/1987 – 02/2017
Switzerland	Switzerland 10Y Govt. Bond	CHF LIBOR 3M	Swiss Market (SMI)	07/1988 – 02/2017
United Kingdom	UK 10Y Govt. Bond	GBP LIBOR 3M	FTSE 100 (UKX)	02/1986 – 02/2017
Unites States	US 10Y Govt. Bond	USD LIBOR 3M	S&P 500 (SPX)	02/1986 – 02/2017

[1] A type I-error occurs when incorrectly rejecting the true null hypothesis, e.g. finding that the model outperforms the passive portfolio when it truly does not.

As proxies for long-term interest rates, we use 10-year government bonds, which are also the main benchmark for long-term interest rates in literature. Short-term rates offer us a wider universe of choices. One question is whether we should use for example 1) short-term government bonds/treasury bills or 2) Interbank Offered Rates, which is the rate of interest charged on short-term lending between banks. The latter have in common that the rates are set as a weighted average of interbank lending rates based on surveys of banks in their respective economies.

The objective of our research is to examine whether we can use information from debt markets to predict stock market returns, and there is no clear-cut answer on which short-term rates to incorporate in our model. However, short-term interest rates often refer to 3-month Interbank Offered Rates. These are the most easily obtainable and most used short-term rates in literature. Also, in the US, the spread between treasury bills and LIBOR (the TED spread), is argued to be an indicator of trust in the banking sector, as the spread can be interpreted as the risk premium of lending to banks relative to lending to the government, which is normally considered to be the least risky debtor in the economy. Due to these implications, we choose to use 3-month Interbank Offered Rates as they incorporate this presumably significant risk premium in our signals.

5.2 Investment opportunity set

In positive spread periods (d=1), the model predicts positive economic growth in the future, and we invest 100% of our capital in the stock market. As proxies for the stock market, we use major stock indices in each respective country, as seen in Table 5.1.

In negative spread periods (d=0), the model predicts negative economic growth, and we invest 100% of our capital at the risk-free rate. As our hypothesis predicts a decline in stock market prices in these periods, the risk-free rate should yield a higher return than the stock market. We have considered several possible investment opportunities for these periods. Available options for an investor are for example money market funds, bank savings accounts or eventually government debt obligations. Money market funds life spans are rarely long enough to cover the time-horizon for our research and will thus not provide us with sufficient data to cover the research periods. Historical savings account rates are hard to obtain and often differ significantly – both between banks, and also due to differences (e.g. withdrawal limitations) in the financial products offered. Hence, it is not suitable in our research. Government bonds with 3-month maturity are not available in all countries, and can thus not be used consistently through our research. Our solution is to use a realistic proxy for risk-free rates available to investors, although it will be an indication and not absolute.

The 3-month Interbank Offered Rate provides a realistic market proxy of the risk-free interest rate available to investors. These data are publicly available, can be obtained for long periods of time, and for the sake of simplicity - they are the same data as we use for short-term interest rates in our investment signals. To be consistent throughout the study, we stick to the Interbank Offered Rates also in economies where 3-month government bonds are available.

5.3 Data collection

All data in our research is publicly available and obtained from Thomson Reuters Datastream. We have collected data as far back in time as possible, but we have also set a criterion that the rates and indices used in our research should still be in existence today. This implies that for example data for countries that have adopted the euro are only valid from 01/1999, when the euro and the EURIBOR rates were adopted. The former short-term FIBOR (Germany), or HELIBOR (Finland), used up until 1999, are thus not included in our dataset as they are not current. Datastream ticker symbols are listed below (datatype in parenthesis where more than one datatype is available).

Table 5.2: Datastream ticker symbols

Country	Long-term interest rate	Short-term interest rate	Stock index
China	CHGBOND.	CHIB3MO (IO)	HNGKNGI (PI)
Denmark	DKGBOND.	CIBOR3M (IO)	DKKFXIN (PI)
Finland	FNGBOND.	BBEUR3M (IO)	HEX25IN (PI)
Germany	BDGBOND.	BBEUR3M (IO)	DAXINDX (PI)
Japan	BMJP10Y (RY)	BBJPY3M (IO)	JAPDOWA (PI)
Norway	NW10BND (RY)	NWIBK3M (IO)	OSLOBMI (RI)
Sweden	SDGBOND.	SIBOR3M (IR)	SWEDOMX (PI)
Switzerland	SWGBOND.	BBCHF3M (IO)	SWISSMI (PI)
UK	BMUK10Y (RY)	BBGBP3M (IO)	FTSE100 (PI)
US	BMUS10Y (RY)	BBUSD3M (IO)	S&PCOMP (PI)

RY: Redemption yield, IO/IR: Offered rate/Interest rate, PI/RI: Price Index/Total Return Index

6 Analysis

6.1 Description of the Asset Allocation Model

The Asset Allocation Model (AAM) was constructed in Excel. Several measures have been calculated in order for us to conduct the best possible analysis. To start constructing the AAM, the data collected from Datastream were separated by country. All data were collected at a monthly frequency. The Interbank Offered Rates and the 10-year government bonds are given in annual terms and thus they had to be converted to monthly rates to match our monthly data. Further we constructed the dummy variable as described in section 4.1. We compared the AAM portfolio with a passive portfolio invested in the market index. The performances of the two portfolios were measured both by monthly average returns and by the cumulative return of the AAM and the passive portfolio.

We have now performed an empirical analysis on historical stock data over the period 1986-2016 (or as far back as the data are available for some of the economies). The aim of the analysis has been to find out if we can make abnormal returns in the stock market by using the yield curve as a leading indicator for asset allocation. We will in this chapter present the results of our analysis based on the methodology presented in chapter 4, and further discuss what the results tell us about our investment strategy.

6.2 Cumulative return

To begin with we have performed a preliminary analysis of the cumulative return of one dollar invested in the risk-free rate, one dollar passively invested in the stock index and one dollar allocated actively in the stock index or the risk-free rate using the AAM in each sample economy, as shown in Table 6.1.

Table 6.1: Cumulative returns

	Bond	Passive	Active	Multiple
US	*3,335*	*10,738*	*12,929*	*1,204*
UK	*5,770*	*5,044*	*10,480*	*2,078*
Japan	*1,632*	*1,069*	*1,827*	*1,708*
Norway	*6,412*	*15,854*	*78,871*	*4,975*
Denmark	*3,015*	*8,633*	*18,849*	*2,183*
Sweden	*4,600*	*12,202*	*13,873*	*1,137*
Germany	*1,455*	*2,324*	*4,042*	*1,739*
Finland	*1,455*	*2,473*	*5,287*	*2,138*
Switzerland	*1,972*	*5,490*	*8,734*	*1,591*
China	*1,696*	*2,210*	*5,219*	*2,362*

Note: Table 6.1 shows the cumulative return on one dollar invested in the risk-free rate, stock index and AAM respectively in column one through three. The fourth column shows the multiple given by the formula Active return divided by Passive return, giving the actual performance of the AAM. The cumulative returns in column one through three are based on different observation lengths and are not yielding a meaningful comparison across countries.

The results from the cumulative analysis show that the AAM outperforms the market index in every sample economy. The size of the multiple, however, differs to some degree between the different countries with the AAM model performing best in Norway and worst in the United States, with multiples of 4,975 and 1,204 respectively. Plots for each economy can be seen in Appendix 1.

The plots show that the AAM was able to avoid losses for all sample economies during the financial crisis of 2008-2009, though to varying degree, which we will discuss later in this chapter. Further, the model was able to avoid losses during the dot-com bubble, and other financial distress periods for individual sample economies.

The cumulative returns give us a good historical picture of the performance for an investor using the model during our whole research period. However, the information gained from looking at cumulative returns only, is limited. Remember that a model outperforming the benchmark in the beginning of the research period will, measured in absolute returns, perform exponentially better in the following, although percentage returns are equal. This is due to the compound interest effect.

Also, it does not tell us much about the performance for single investment allocation periods, i.e. from one dummy variable change until the next. In order to get a deeper understanding of the performance of the single investment periods we have calculated the holding period return (HPR) for both stocks and the risk-free rate in each single investment period p. Further, we subtract the opposite asset from the one we are invested in given the period dummy:

$$d = 1:\ \ HPR_{stock,p} - HPR_{Rf,p} = Difference_p \qquad [12]$$

and

$$d = 0:\ \ HPR_{Rf,p} - HPR_{stock,p} = Difference_p \qquad [13]$$

A positive difference represents a correct asset allocation, and a negative difference represents an incorrect asset allocation in the given period. Table 6.2 gives the sum and average of all differences in each sample economy in addition to the number of investment allocation changes.

Table 6.2: Single period performance

	Sum	**Average**	**Allocation Change**
US	*100,083 %*	*5,004 %*	*21*
UK	*111,659 %*	*5,317 %*	*22*
Japan	*69,657 %*	*11,610 %*	*7*
Norway	*583,148 %*	*22,429 %*	*27*
Denmark	*152,451 %*	*13,859 %*	*12*
Sweden	*184,038 %*	*13,146 %*	*15*
Germany	*74,806 %*	*12,468 %*	*7*
Finland	*139,235 %*	*69,617 %*	*3*
Switzerland	*295,215 %*	*18,451 %*	*17*
China	*207,300 %*	*5,183 %*	*41*

Note: Table 6.2 shows the sum and average of all differences for each sample period as given by equation [12] and [13], in addition to the number of allocation changes.

The table shows positive average return for single periods in all sample economies, which is in accordance with the total cumulative return in Table 6.1. This gives us an indication that the AAM is able to predict the best performing asset for a period given the dummy variable. The cumulative performance results seem to support the claim that the AAM can outperform the market but will be further interpreted in the discussion part later in this chapter.

To supplement the performance measure of the AAM further, the dummy variable's success ratio in predicting the best performing asset in the coming month is measured by the percentage of correct predictions out of the total number of prediction periods. The results are presented in Table 6.3. The average return in correctly predicted periods and the average return in incorrectly predicted periods follow in Table 6.4.

Table 6.3: Dummy variable success ratio

	Success ratio
US	*59,140 %*
UK	*55,376 %*
Japan	*53,134 %*
Norway	*55,914 %*
Denmark	*58,154 %*
Sweden	*56,233 %*
Germany	*58,986 %*
Finland	*58,525 %*
Switzerland	*60,350 %*
China	*56,571 %*

Note: Table 6.3 shows the dummy variable's success ratio as a percentage of correct one-month-ahead prediction of the best performing asset out of the total number of predictions.

Table 6.4: Average returns in correctly and incorrectly predicted periods

	Correct	**Incorrect**
US	*2,721 %*	*-2,206 %*
UK	*1,716 %*	*-0,863 %*
Japan	*4,180 %*	*-4,053 %*
Norway	*2,885 %*	*-0,543 %*
Denmark	*3,308 %*	*-2,003 %*
Sweden	*3,935 %*	*-2,791 %*
Germany	*4,387 %*	*-4,041 %*
Finland	*4,693 %*	*-4,264 %*
Switzerland	*2,741 %*	*-2,372 %*
China	*1,874 %*	*-0,368 %*

Note: Table 6.4 shows the average return of periods where the dummy correctly predicted the best performing asset in the first column, and the average return of periods where the dummy incorrectly predicted the best performing asset in the second column.

The results vary between ~53-60% success in prediction of the one-month-ahead best performing asset. The average returns show that for all sample economies, the gains are higher in correct periods than the losses are in incorrect periods. The results clearly show that the model over a long time-horizon is able to predict the best performing asset of the next month based on the interest rate term spread. The results are important for the overall validation of the AAM performance and will be interpreted further in the following discussion-part of this chapter.

6.3 Sharpe ratio

The Sharpe ratio, as described in section 4.4.1, is calculated for each sample economy on both the active and passive portfolio. When comparing the Sharpe ratios, we get an indication of which portfolio yields the best risk-return trade off. The results of the Sharpe ratio are given in Table 6.5.

Table 6.5: Sharpe Ratio

Sharpe Rario			
	Passive	**Active**	**Excess Sharpe**
US	*0,092*	*0,093*	*0,3 %*
UK	*0,017*	*0,028*	*62,0 %*
Japan	*0,012*	*0,033*	*181,0 %*
Norway	*0,072*	*0,239*	*233,1 %*
Denmark	*0,089*	*0,178*	*100,2 %*
Sweden	*0,075*	*0,107*	*43,1 %*
Germany	*0,067*	*0,127*	*91,0 %*
Finland	*0,070*	*0,127*	*82,2 %*
Switzerland	*0,086*	*0,118*	*36,8 %*
China	*0,056*	*0,136*	*142,8 %*

Note: Table 6.5 shows the Sharpe ratio for a passive index portfolio and the AAL-model over the entire observation period for each sample economy. The third column shows, in percentage, the excess Sharpe ratio for the active portfolio compared to the passive.

We see that the active portfolio has a steeper slope than the passive portfolio in every sample. This result is an indication that the AAM gives a better return on each unit of risk than what a passive stock portfolio has. Our investment horizon is always one month ahead until the next dummy variable is determined, hence providing us monthly data. Sharpe ratios cannot be annualized correctly by simply scaling up the standard deviation with $\sqrt{12}$ (Lo, 2002). We have therefore calculated the monthly Sharpe ratio and not the more commonly used annual Sharpe ratio. Further, the Sharpe ratio has been shown to be low and yield higher ratios for bonds than stocks over time for investments with long time-horizons, (Hodges et. al., 1997). Our seemingly low Sharpe ratios may come from a combination of these two arguments; firstly, that it is based on monthly data and hence is approximately $1/12^{th}$ of an annual ratio, and secondly, long time-horizons usually yield low Sharpe ratios.

6.4 Two sample Z-test

For a statistical analysis of the portfolio, we have performed a one-sided Z-test for comparison of mean returns. The test is performed in accordance with the description in section 4.4.3. In order to draw any valid conclusion about our hypothesis that the AAM is able to create abnormal return, a significant difference in the mean of the passive and active portfolio is needed. The results are measured in significance at a 10%, 5% and 1% level to find directional significance in the mean returns. The results from the Z-test are presented in Table 6.6.

Table 6.6: Z-score

	1-0	1-passive	Passive-0	A-P
US	1,397*	-0,412	1,817**	-0,122
UK	-0,163	-0,884	0,702	0,047
Japan	0,728	0,146	0,583	0,269
Norway	2,181**	0,112	1,904**	1,019
Denmark	2,346***	0,297	2,014**	0,754
Sweden	1,492*	-0,174	1,626*	0,214
Germany	1,949**	0,503	1,448*	0,573
Finland	1,778**	0,478	1,3312*	0,533
Switzerland	1,608*	-0,045	1,680**	0,265
China	1,135	0,080	1,067	0,429

*Note: Table 6.6 shows the Z-score of a one-sided Z-test for comparison of mean returns. The test is performed on 1-period mean against 0-period mean, 1-period mean against a passive index investment mean, a passive index investment against 0-periods and the AAM against the passive index. ***, **, and * mark significance at the 1%, 5%, and 10% level respectively.*

The different columns in Table 6.6 show the comparison of different portfolios mean return. The different portfolios are tested against each other based on intuitive relationships. In the first column, we have tested whether the mean return of the stock index is significantly higher in 1-periods than in 0-periods. The intuition of this is based on the expectation of economic growth in periods where the interest rate yield curve is positively sloped. Hence, the stock market should yield higher returns in 1-periods than in 0-periods. Column two test the difference in mean of 1-periods against a passive index portfolio over the entire period. The intuition here is the same as for column one, however, here we test if the 1-period mean is significantly higher than the overall performance of the stock market in all periods. In column three we test whether the overall stock market performance, represented again by the passive index portfolio, is higher than the standalone 0-periods. In the fourth column, we test the AAM against a passive index portfolio. This is the most important of the four columns as it represents our hypothesis that the AAM can create abnormal returns by allocating its investments according to the dummy variable.

The results display a high degree of significance for 7 out of ten sample economies. The significant results are found in the comparison of 1-0 periods and passive-0 periods. This seems to support the expectation that the model can create abnormal return by avoiding the heaviest declines in the 0-periods, as claimed earlier. For all sample economies, the percentage of 1-periods make up between 50-90% of the total number of periods. This may explain some of the reason why there are no significant results in the 1-passive, and A-P column.

6.5 Discussion of the results

In this final part of the thesis we will discuss the results we have presented earlier in this chapter. To start with, we will sum up the most important findings of the results. The tests can be divided into three major categories; the cumulative return, the Sharpe ratio and the Z-tests. The cumulative return over the entire period show that the AAM has outperformed the market in all the sample economies (see Table 6.1 and Appendix 1). The cumulative return earned in each individual allocation period show that the model can work over shorter periods and that the point of entry does not matter too much to the performance of the model. The average return for individual allocation periods is positive and the dummy success rate is between ~53-60% for all sample economies. Further, the Sharpe ratio is higher for the AAM than for the market index in all sample economies. The statistical testing of the model shows a varying degree of significance.

6.5.1 Cumulative return results

As stated earlier, the cumulative return for the AAM is higher than the cumulative return for each sample economy. However, the degree of success varies from country to country, as the multiple in Table 6.1 shows, with Sweden being the lowest at 1,137 and Norway being the highest at 4,975. Many different factors may be used to try to explain the different degree of success from country to country. Assuming the AAM has a success rate >50% (Table 6.3), intuitively, more frequent allocation changes, driven by more volatile short term and long term interest rates would be beneficial as the allocation is correct more often than it is incorrect – higher frequency of allocation changes results in higher cumulative return for the AAM.

The AAM cumulative return does not differ much from the passive index portfolio in the beginning for any sample economy. This is due to different factors. For some countries such as the United States, Germany and Finland, the first 0-period does not occur before a few years into the research period, which results in the AAM and the index having the same cumulative return. When a 0-period first occur, it has to last over a longer period and the dummy has to be correct for us to start seeing differences in the cumulative return. However, due to the exponential growth of cumulative returns, we see that after a correctly predicted 0-period, the difference becomes clearer as the AAM has a better base to build future return on. The opposite will happen in cases where the 0-period is incorrectly predicted. However, due to the dummy success rate being >50% the probability of predicting a 0-period correctly is higher than the probability of predicting incorrectly. With the previous point and the fact that the expected return is higher in correctly predicted periods than the expected loss in the incorrectly predicted periods, we can expect higher return from the AAM than from the stock market index.

The high success probability may in some cases remedy an incorrectly predicted allocation as we see in Sweden. The AAM incorrectly predicted a 0-period from 1989-1994. Due to bad asset allocation, the stock market index earned a higher cumulative return over the coming 10-15 years. However, during the financial crisis, the AAM correctly predicted a 0-period where the stock market plummeted and the AAM earned a higher cumulative return.

As for the AAM's behaviour in the United States, we can see from Plot 2 in Appendix 1 that the dummy switches from 0 to 1 earlier than optimal. This will effectively undermine the primary strength of the AAM, which is to create abnormal return by avoiding the heaviest declines in the stock market. In the United States, we see that during the 2001 dot-com bubble and the 2008 financial crisis the dummy changes from 0 to 1 right before the worst decline starts. The model misses out on high stock return right before the peak but reinvests in the stock market when it starts to decline. This behaviour is unique to the United States as the rest of the sample economies are invested in the risk-free rate during these heavy declines. One possible explanation may be overreaction to interest rate changes (Estrella & Hardouvelis, 1994). This research investigates the future changes in long- and short-term interest rates in the G7 countries. The study finds that the US long-term rates overestimate the expectations of future development in the economy. This results in too high long-term interest rates based on biased expectations, and a positive term spread in times where the AAM would benefit from a negative spread. The overreaction does not occur in the rest of the observed markets, where the allocation of funds proves better suited.

6.5.2 Sharpe ratio results

The Sharpe ratios from our portfolios clearly indicate a better risk-adjusted return using the AAM than investing passively in the stock index. The average return is higher and the standard deviation is lower in all countries in our study, except in the US where the average return is slightly lower using the AAM. The fact that standard deviations are lower in the AAM portfolios is no surprise, as they contain periods of risk-free investments. However, you would traditionally expect the passive portfolios that contain 100% stock all the time to yield higher average returns than the portfolios that contain periods of bond investment as well, but the AAM yields at average 0,19 percentage points higher monthly returns. The higher average returns are a clear indication that the AAM portfolios avoids many of the stock market declines during our research period as these periods of expectedly low-return risk-free investments actually increases the average portfolio returns.

6.5.3 Statistical test results

The results from the statistical tests show significant results for the difference in means in *1- vs. 0-periods* and the *passive portfolio vs. 0-periods* for the United States, Norway, Denmark, Sweden, Germany, Finland and Switzerland. The tests, however, do not show significant differences in the means of the *AAM vs. the passive portfolio*, nor in the *1-periods vs. passive portfolio*. As shown in Table 6.3, the dummy variable has a >50% success rate, which implies that the periods suffering declines in stock returns are mostly grouped in 0-periods and periods of high positive returns are mostly grouped in 1-periods. Hence, it is reasonable to assume that there should be a significant difference in these means.

The dummy variable is 1 in >50% of the forecasting periods for nine out of the ten sample economies, with the exception of China having a 48/52 distribution. Seven out of ten have >75% 1-periods. This implies that the entire 1-period observation make up >75% of the observations in the passive portfolio, while 0- periods make up <25% of the observations of the passive portfolio. The same is true for the AAM. They only differ in the 0-periods where the AAM obtains the *IBOR rate and the passive still is invested in stocks. The high amount of equal observations in *1-periods vs. passive portfolio* and *AAM vs. passive portfolio* is the reason why we do not see any significant differences in the tests. However, with the significant differences in *1- vs. 0-periods* we can argue that there is statistically valid proof that the AAM can predict and avoid the heaviest declines in the stock market.

6.5.4 Overall performance of the AAM

The different tests provide us with different results of which sample economy the AAM performs best and worst in. In terms of cumulative return Norway is the absolute best performing sample economy with a multiple of 4,975. Sweden and the United States have the lowest multiples with 1,137 and 1,204 respectively. The Sharpe ratio shows that Norway and Japan has the best risk/return trade-off compared to their respective benchmark index. The United States and Switzerland have the lowest trade-off with the United States' AAM having only 0,3% higher Sharpe ratio than the S&P 500. In the statistical tests, we see that Denmark performs best with a Z-score of 2,346 when comparing the mean of *1- vs 0-periods*. Denmark is the only sample economy where we can reject the null hypothesis at a 1% significance level. Norway, Germany and Finland can reject the null hypothesis at a 5% level and Switzerland, Sweden and the United States at a 10% level. The United Kingdom has the weakest relationship with a negative Z-score.

According to previous research, the interest rate yield curve has predictive powers of the real economic outputs for years into the future (see Chapter 2). Further, by economic intuition, economic growth indicates fertile opportunities for corporations in the years to come, which again leads to higher expected future cash flows and higher stock prices. Over our sample period the term spread has clearly provided us with information with which we could create abnormal returns in all countries compared to the individual stock market indices. The success rate of the dummy variable is good in a financial perspective where one cannot expect to consistently outperform the market. As stated before the AAM has higher expected return than the market index due to its success rate and average return in correctly predicted periods.

With this information, we can argue that the AAM can create abnormal returns compared to the market index. Statistically we argued that even though the *active vs. passive* mean comparison was not statistically significant, the AAM can statistically be proven to outperform the market at a 10% significance level for seven out of ten sample economies, though only four out of ten are significant at a 5% level. Usually, in financial studies the null hypothesis is rejected at a 5%

significance level (Stock & Watson, 2011). We cannot reject the Z-test's null hypothesis at a 5% level, however, the results strongly indicate that there are tendencies of differences in the means.

The evidences are not unambiguous and the performance has varied among the sample economies. However, the interest rate yield curves clearly provide some valuable information that is not fully embedded in the stock market. Based on the results of the tests and the argumentation provided previously in this chapter we can argue that the returns of the AAM has outperformed the stock market, which in turn implies that the EMH does not completely hold. The AAM has performed well in both long and short periods and has a higher risk adjusted expected return then the market in each sample economy, but statistical differences are only partially confirmed by the Z-tests. By exploiting the information given by the yield curve we have consistently performed better than the market in all our sample economies, with the most substantial differences coming from the asset allocation in periods of recession and steep decline in the stock market.

6.6 Limitations to the research

This study is based on historical data and does not focus on predicting the future economic development. The relationship between the term spread and the economic development is not fully understood although accepted as a fact (Benati & Goodhart, 2008). By nature, backtesting can often be exposed to the risk of overfitting. Although this is a relatively simple model we cannot ignore that out-of-sample behaviour might be structurally different. This makes it hard to predict whether the AAM will perform as good in the future as it has in the past. Remember also, that the good results yielded, to a large extent must be attributed to the two periods of larger declines in the stock market. The long-termism of the model might call for an even longer research period than applied in this thesis in order to reduce the probability of making a Type 1-error.

By the EMH, we assume that new information is instantly incorporated into asset prices, and thus cannot be exploited to create abnormal returns. Hence, if the information provided by the term spread is taken more into account by investors or economic policymakers, the AAM may stop performing altogether (Estrella & Hardouvelis, 1991). We will not encourage anyone to blindly follow the AAM, however, it may be used as a supplementary tool in an investment strategy.

The performance of the AAM will be exposed to the current and expected fiscal and monetary policy in each country. Alesina and Summers (1993) found a clear negative relationship between interest rate volatility and central bank independence. This may affect the performance of the AAM as high interest rate volatility will lead to more frequent changes in asset allocation. Furthermore, the performance of the model may be affected by the different fiscal and monetary policies of left- or right-winged governments. We will suggest future research to focus on the different effect of liberal or conservative policies on the performance of the AAM and customize the model to better fit the different policies.

Our model has been made in Excel and the working model has been a good way of testing our hypothesis according to the chosen methodology. However, through the past months of working intensely with this thesis we have been exposed to a few issues which have not been feasible with our Excel-approach. We have found that the interest rate term spread can provide very useful information for predicting stock market returns, however it is highly likely that the model can be even further analysed and optimized using statistical software to build the model. Our suggestions for further research are 1) testing the model with other debt maturities, and 2) adding lags to the signals, using for example the Akaike/ Baysesian Information Criterion (AIC/BIC), or 3) predicting asset allocation changes by using expected future interest rates.

7 Conclusion

We have researched ten different economies empirically in order to investigate the usability of an investment strategy using the difference between long- and short-term interest rates as a means to predict stock market returns. The intuition behind the model is that a rising yield curve implies real economic growth, which eventually should fuel the stock markets if this expectation is not already properly reflected in current stock prices. Our primary goal has been to find whether this strategy – the asset allocation model – has been able to outperform a passive stock index investment by timing when to be exposed to the stock markets.

We found that the AAM has outperformed the stock index in all ten samples by cumulative returns. Note that the research period start dates differ from between 1986-2002 due to data availability. The model's success ratio in predicting the best yielding asset in the following month was between ~53-60%, and also, the correctly predicted periods yielded higher average excess returns than the incorrectly predicted periods caused average losses. The Sharpe ratio, a widely used measure for risk-adjusted returns, was higher for the AAM than the passive portfolio in all countries – both higher average returns and lower variance was found using the model, with the exception of the US, where the average return was slightly lower.

The most interesting results were found in our Z-scores. Firstly, they show that the positive spread periods yielded higher average returns than the negative spread periods with a confidence of at least 90% in seven out of ten countries. What is more eye catching, is that comparing the positive spread periods to the passive portfolio give no significant results, however, comparing the negative spread periods to the passive portfolio give significant results in the same seven countries as above. This is in line with our assumption from our preliminary assessment; the model's strongest feature is its ability to predict larger recessions. We note that it correctly predicted not to be exposed to the stock market both when the dot-com bubble burst and under the financial crisis of 2007-2008 in most countries. However, only two such major events are present during our research period, and we believe this is not enough empiricism to say anything certain about the model's ability to predict the next crash.

The interest rate yield curve provides some interesting information that is not fully embedded into the stock market. By exploiting the information given by the yield curve and allocating our investment accordingly we have persistently outperformed the market in ten out of ten sample economies. The evidence suggests that during our research periods the EMH has not fully held. The markets have been less than semi-efficient and we have created abnormal return with publicly available information. We have strong indications that interest rates can be a helpful means for assessing future stock market development.

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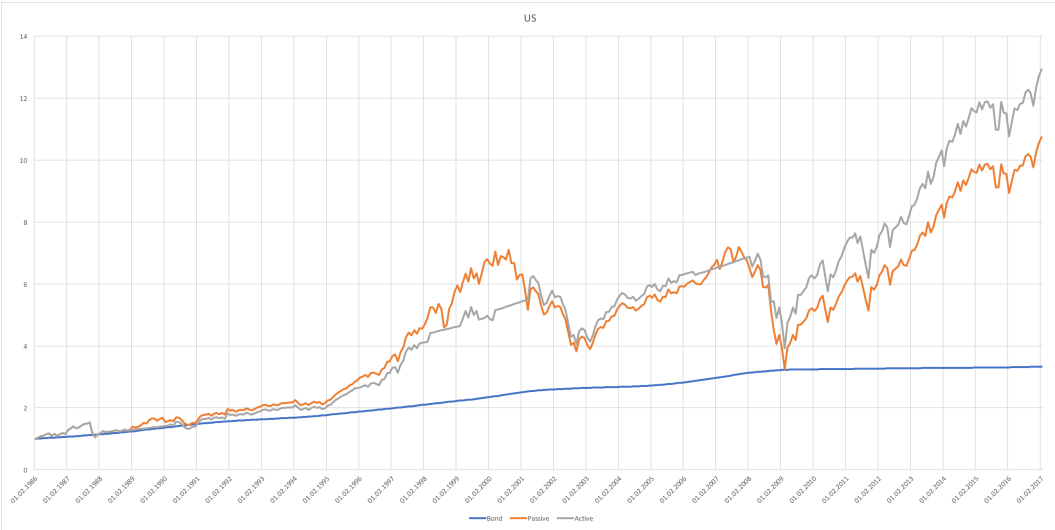
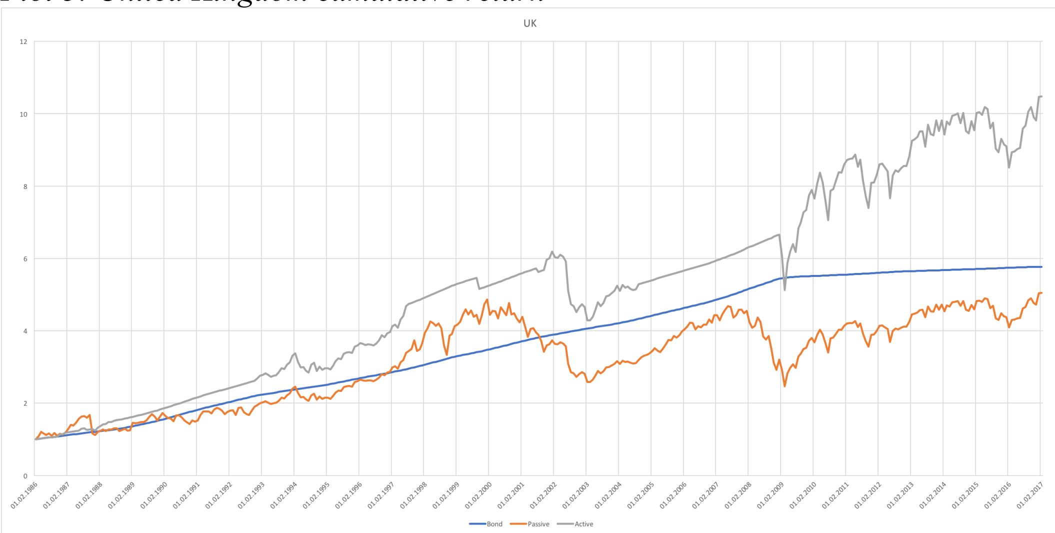
Appendix 1: Cumulative Return

Appendix 1 shows the plot of the cumulative return on one dollar invested in the AAM (grey line), the stock market index (orange line) and the risk-free rate (blue line) for each sample economy.

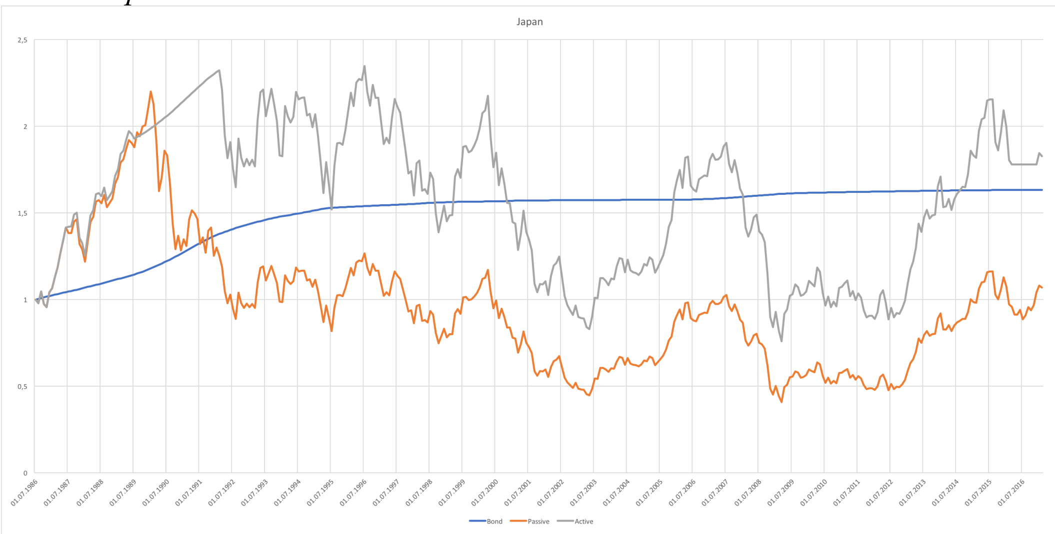
Plot 2: United States cumulative return



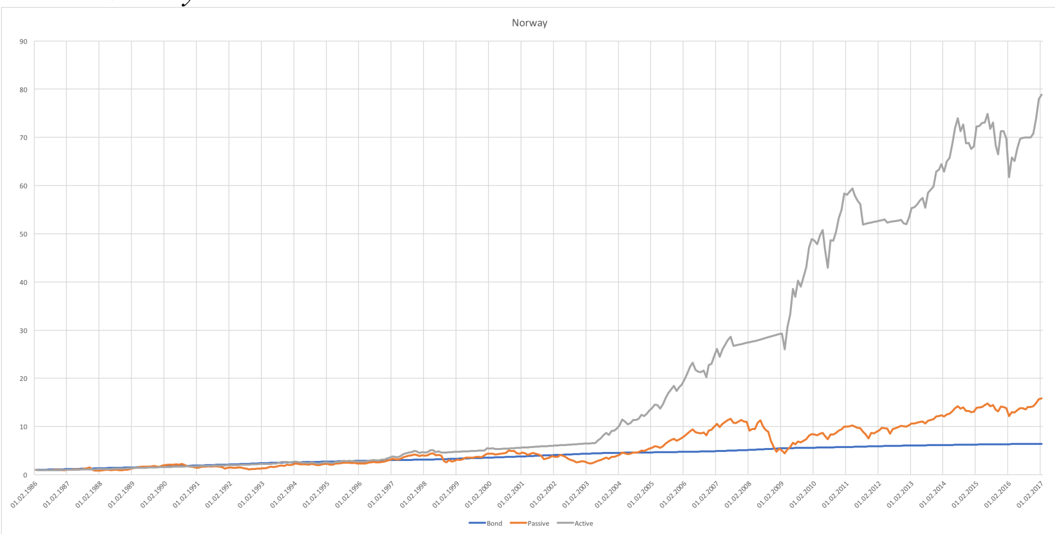
Plot 3: United Kingdom cumulative return



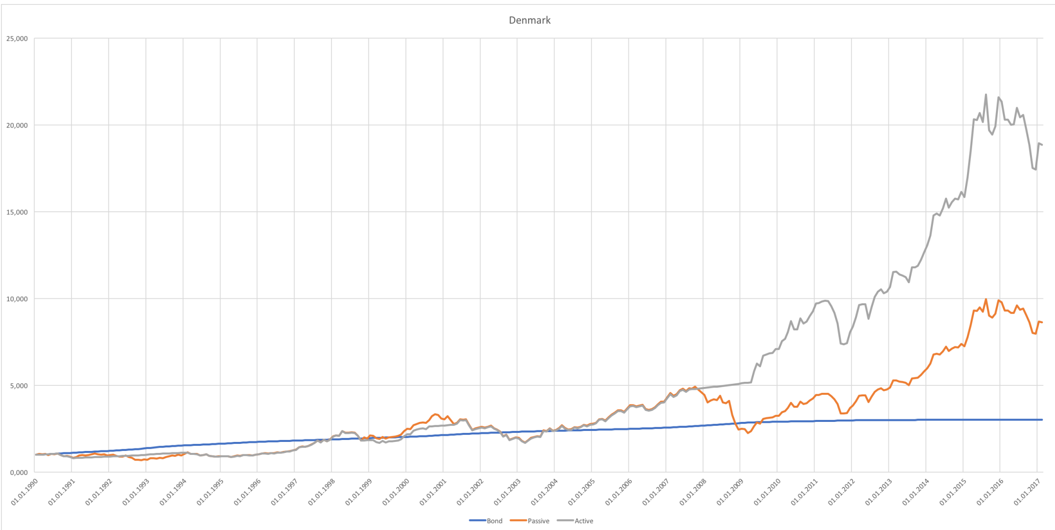
Plot 4: Japan cumulative return



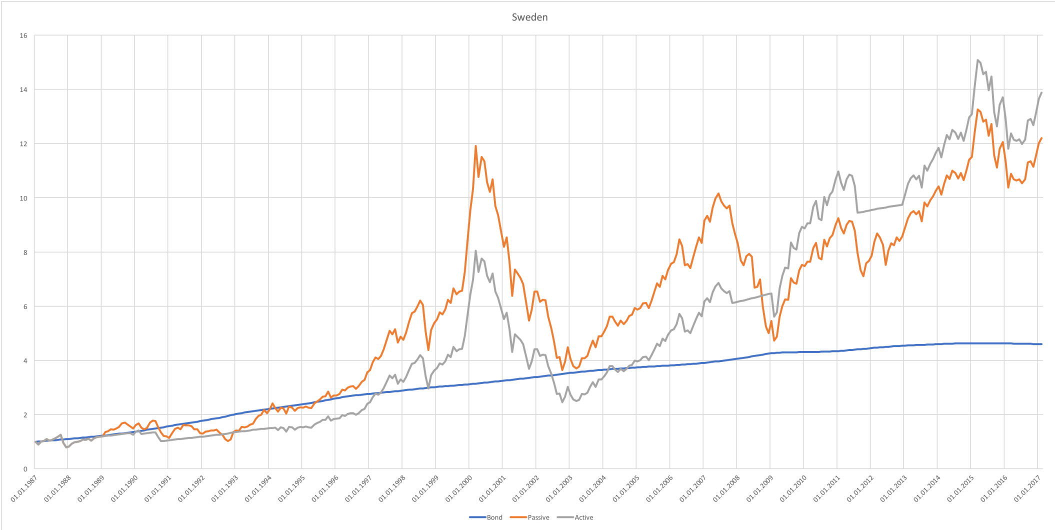
Plot 5: Norway cumulative return



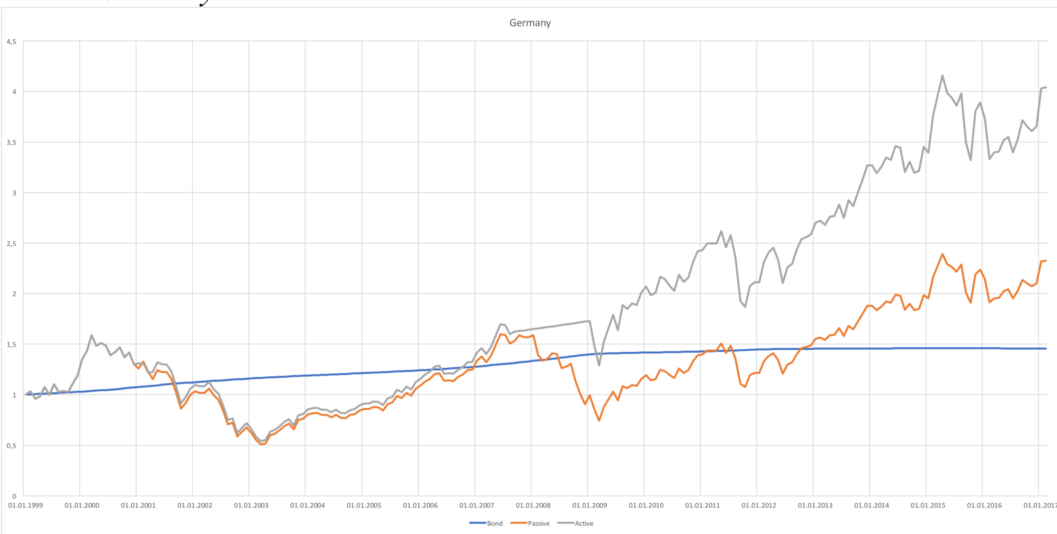
Plot 6: Denmark cumulative return



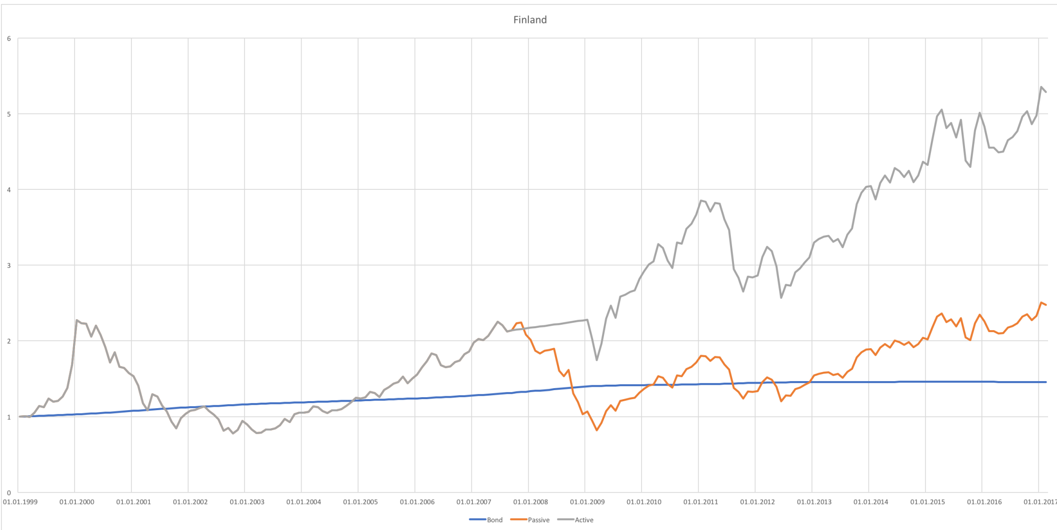
Plot 7: Sweden cumulative return



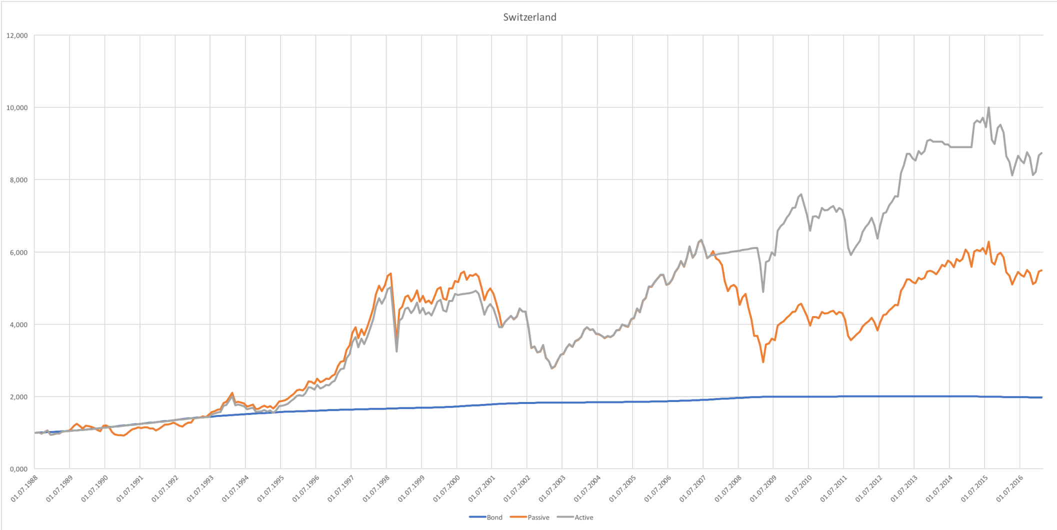
Plot 8: Germany cumulative return



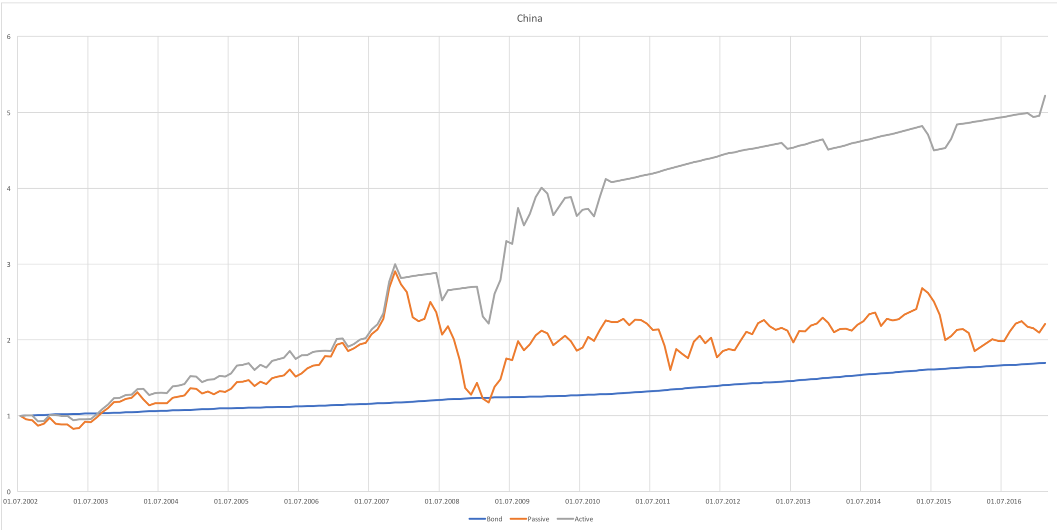
Plot 9: Finland cumulative return



Plot 10: Switzerland cumulative return



Plot 11: China cumulative return



Appendix 2: Single Period Cumulative Return Difference

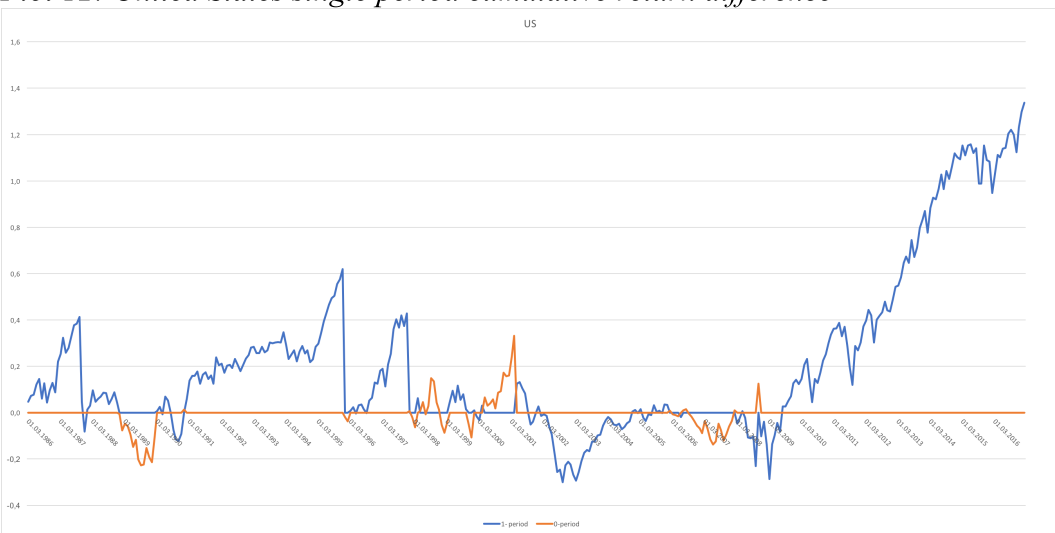
Appendix 2 shows the difference between the cumulative return on one dollar invested in the stock market index and one dollar invested in the risk-free rate for each single allocation period. At the end of each investment period the investment is reset to one dollar and the accumulation starts anew.

In 1-periods (blue line), we expect the stock market to perform better than the risk-free rate. We therefore subtract the cumulative risk-free return from the cumulative stock return.

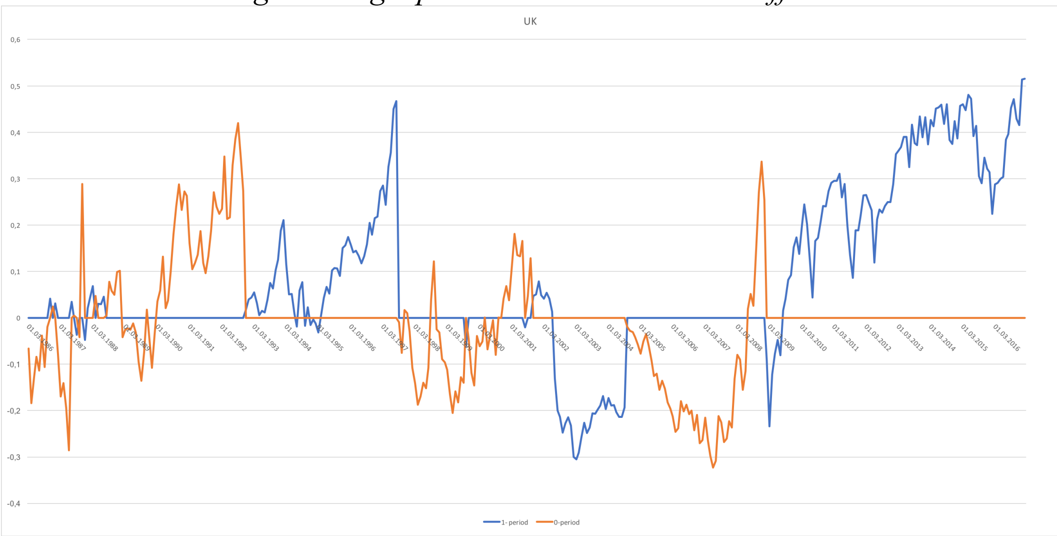
In 0-periods (orange line), we expect the stock market to underperform the risk-free rate. We therefore subtract the cumulative stock return from the cumulative risk-free return.

Only one graph is active at any given time.
The AAM is allocating correctly in periods where the active graph has a positive value and incorrectly in periods where the graph has a negative value.

Plot 12: United States single period cumulative return difference

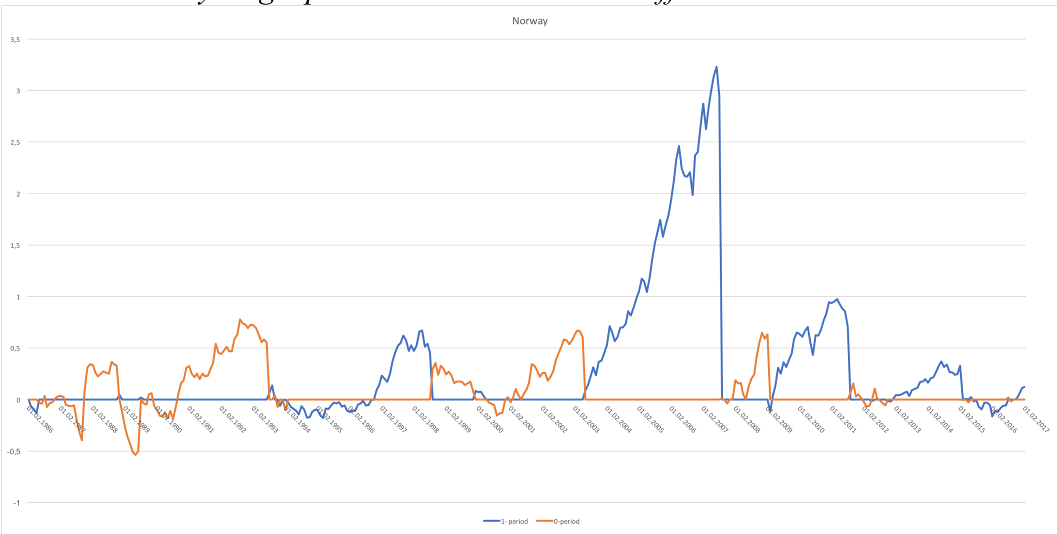


Plot 13: United Kingdom single period cumulative return difference

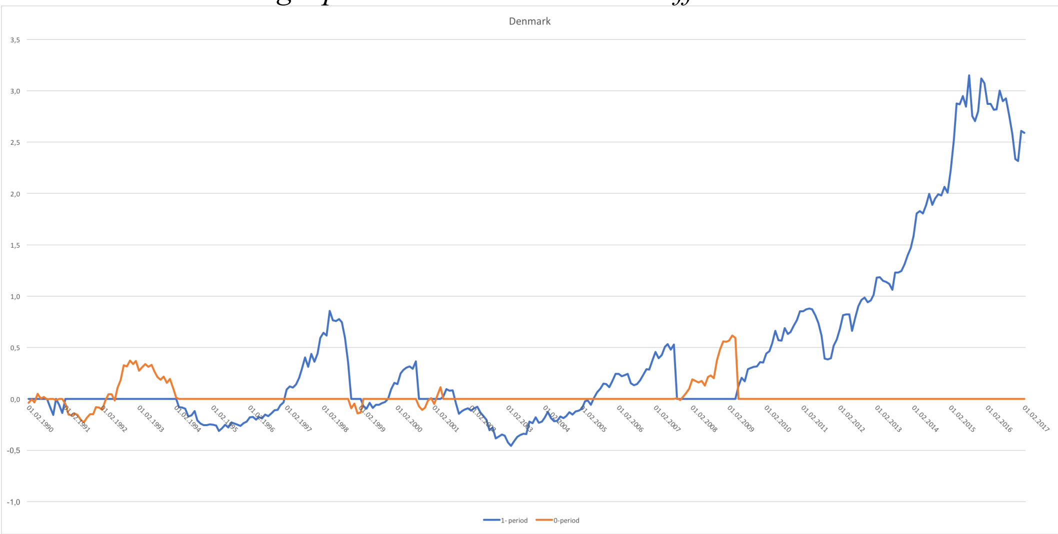


Plot 14: Japan single period cumulative return difference

Plot 15: Norway single period cumulative return difference



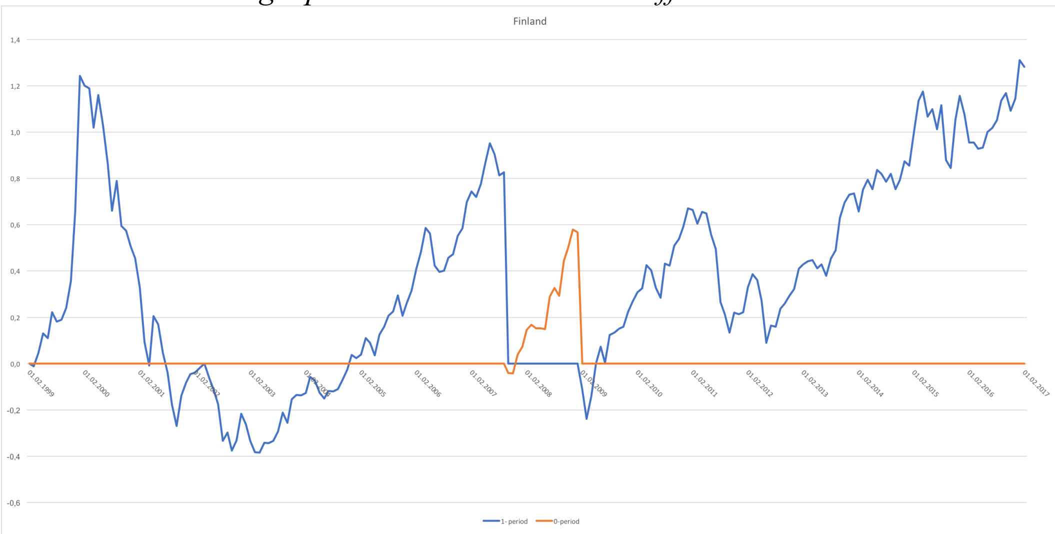
Plot 16: Denmark single period cumulative return difference



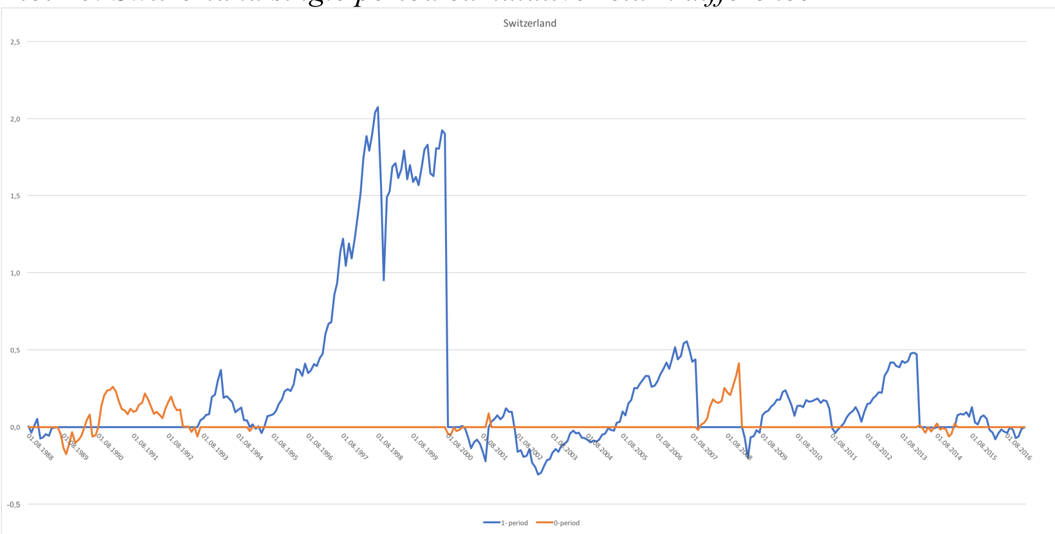
Plot 17: Sweden single period cumulative return difference

Plot 18: Germany single period cumulative return difference

Plot 19: Finland single period cumulative return difference



Plot 20: Switzerland single period cumulative return difference



Plot 21: China single period cumulative return difference