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Stock Returns and Inflation: A Sector Analysis on Nordic Countries

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Abstract

This study investigates the relationship between stock returns and inflation. It examines if stock returns are differently related to inflation depending on sector. Since different industries are differently exposed to inflation, it may be appropriate to investigate the correlation between various sectors and inflation. Sector returns relation to price changes are compared to market index returns and government bond returns. This study is based on Fama's methodology of the Fisher hypothesis and focuses on the Nordic countries, excluding Iceland. The findings suggests that stocks are reversely related to inflation, implying that they do not offer protection against inflation. There doesn't seem to be any difference between sectors and their relation to inflation.

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1. Introduction

There have been numerous studies examining the relationship between stock returns and inflation, and most conclude that nominal stock returns have a negative correlation with inflation, meaning that the hypothesis of stocks being hedge against inflation is rejected (Nelson 1976, Jaffe and Mandelker 1976, Fama and Schwert 1977, Apergis and Eleftheriou 2001, and Durai and Bhaduri 2009). The connection between stocks and inflation is often explained by the study of Alchian and Kessel (1959). They found that companies that are debt holders experience a greater increase in equity value than companies that are creditors, thus having better protection against price increase. Inflation may affect companies in different ways. During periods of high inflation, taxes usually increases thus reducing company earnings (Feldstein and Summers 1979), but also investments reduces as a result of higher inflation (Fama1981, Zion et al 1993). The implication of inflation can also be illustrated by the Gordon growth model. For instance, an increase in inflation may lead to investors demanding compensation for higher risk. That would reduce the value of dividend since the discount rate has become higher, given that the growth rate is constant.

When examining the correlation between stock returns and price increase, a value-weighted stock portfolio (Fama and Schwert 1977) or an existing market index (Branch 1975) is usually applied in the regression against expected and unexpected inflation. However, by using a value-weighted portfolio or a market index, a lot of information is being missing. Certain industries are affected by inflation differently than others, and certain industries are tackling inflation differently than others. For instance, some industries may not be able to immediately increase prices on their products or services as other industries can, to offset increase in inflation. The consumer staple industry may have more flexibility to increase prices on their products than the Real Estate sector, with long rental agreement having less room for price changes. It might therefore be necessary to investigate the relation between sector returns and inflation.

The purpose of this thesis is to determine whether the relationship between stock returns and inflation differ depending on sector. It should answer the question whether there are sector indices that have stronger or weaker relationship to inflation. This also implies an examination of whether stock returns are hedge against inflation. The methodology applied in the thesis is based on the Fisher hypothesis which raises the question if the hypothesis holds

for the Nordic countries. The methodology is developed by Fama (1975) and based on OLS regression which makes it possible to distinguish between expected and unexpected inflation. The implication of the hypothesis is that the current interest rates embodies information about future inflation rate. This study examines sector returns and price changes in Denmark, Finland, Norway and Sweden. The focus of the thesis lies on stocks relation to inflation. It does not include any investigation on the validity of the Fisher hypothesis or Fama's method. It does not include any examinations whether inflation or interest rates contain unit root, or whether there is any seasonal pattern.

The thesis is categorized in six parts. The next section is Theory which includes theory description and review of previous studies. It is followed by Data, Methodology, and Empirical Results. The Empirical Result section consists of tables that illustrate the results for the Fisher hypothesis and the relation between sector returns and inflation. The last two parts are Discussion and Conclusion.

2. Theory and Literature Review

2.1 The Fisher Hypothesis

Fisher came up with the theory that the nominal interest rate is the sum of real rate of interest and expected rate of inflation assuming markets have perfect foresight and are well-functioning. But with imperfect foresight and uncertain markets the nominal interest rate is said to equal the sum of expected rate of interest and expected inflation (Fama 1975). The hypothesis implies that a change in inflation due to money supply will produce a change in the nominal interest rate. The real rate of interest is assumed to be constant and can only be determined by real factors which make it unfazed by price development, and thus makes it independent of inflation. Productivity of capital, investors time and risk preferences are such factors (Fama and Schwert 1977). Expected inflation and nominal interest rates are said to constitute a one-to-one relationship. This means that movements in inflation, ceteris paribus, are followed by a proportional movement in the nominal interest rates. The theory is also known as the fisher effect.

$$i_n = i_r + \pi^e \qquad (1)$$

Where i_n is the nominal interest rate, i_r is the real interest rate and is π^e expected inflation

The Fisher hypothesis can be applied to the stock market. Wong and Wu (2003) state that the nominal rate of return on stocks can be decomposed into markets expectations of the real rate of return and the inflation rate.

$$R_s = r_r + \pi^e \qquad (2)$$

Where R_s is the nominal rate of return, r_r is the real rate of return and π^e is the inflation.

The implication is that an increase in inflation should be reflected with a proportional increase in stock return. That means stocks may function as complete hedge against inflation which gives us the model:

$$R_s = \alpha + \beta\pi^e + \varepsilon \qquad (3)$$

For the Fisher hypothesis to hold, the beta should equal one to offset changes in inflation completely. This is also referred as the one-to-one relationship.

2.1.1 Fisher's empirical research

Fisher (1930) attempted to find evidence for the theory through studying the relation between price levels and nominal interest rates. He estimated correlation between inflation and lags of nominal interest rates for UK and USA with a sample period covering the years 1820-1924 respectively 1900-1927. The interest rates concerned government bonds and were lagged over 28 and 20 years, respectively. Fisher got satisfactory results with highest correlation coefficient estimates for 0.980 UK and 0.857 for USA. Price changes did not affect interest rates during a single year but when accounting for more years, the relationship became significant with price change having a diminishing effect on interest rates. Observing price and interest rates during long period of time, it is clear that changes in interest rates are adjusted for changes in prices. Furthermore, Fisher also examined short-term interest rates relation to prices by looking at short term commercial paper rates and wholesale price index. Similar findings were made for the short term interest rates. The relationship proved to be significant. Fisher summarizes the findings by stating that changes in price levels are followed by changes in interest rates. During periods of high inflation, interest rates tend to be high and during periods of low inflation, interest rates tend to be low.

2.1.2 Efficient Markets

Fama (1975) asserts that Fisher's empirical research does not support the perception that markets are well-functioning, or as Fama prefers to call it, efficient. Fisher's findings implied that past changes in prices are reflected in current interest rates. But Fisher does not find a relationship between current interest rates and future inflation. This is, according to Fama, inconsistent with the argument that markets are well-functioning (efficient). If real return rate is constant and inflation is to some extent predictable with markets using all available information, then there should be relationship between current interest rates and subsequent inflation. The method of distributed lags is rejected by Fama, suggesting that forecasters are rational and can form price expectations by using all available information.

In order to support his argument, Fama attempted to determine the efficiency of one-to-six month U.S Government Treasury Bills by testing for autocorrelation in purchasing power. That tells us to what extent past changes in purchasing power embody information about

future changes in purchasing power. The purchasing power is computed by the rate of monthly Consumer Price Index. Fama does also test for autocorrelation when trying to determine if the real rate of interest is constant which is computed from the nominal interest rate of Treasury bills. The sample for both tests covers the period of January 1953 to July 1971 consisting of 12 lags. The estimated autocorrelation coefficients suggests past changes in purchasing power to contain information about future changes. Also, the coefficients estimated for the real interest rates are insignificant and close to zero which support the hypothesis of the real rate of interest to be constant. The results support the efficient market hypothesis and rational expectations which imply that the market is capable of setting the nominal interest rate by using all relevant information.

2.1.3 Stochastic Trend

Mishkin (1992) challenges the theory of Fisher hypothesis by pointing out the Fama's testing lacks robustness and argues that the theory only holds for certain countries and periods, even though the Fisher hypothesis is accepted for the period of 1951 to October 1979. He finds that interest rates are not able to predict fluctuations in inflation prior to World War II and after October 1979. Earlier studies have shown that macroeconomic time series tend to contain stochastic trends, which is highly relevant for the Fisher hypothesis, and this got Mishkin's attention. Because, if inflation and interest rates exhibit stochastic trend , then they are likely to trend together and display correlation. In order to find out whether the interest rate and inflation has stochastic trend, Mishkin conducted unit root tests by the procedures of Dicky-Fuller and Phillips on monthly data from January 1953 to December 1990. Besides unit root tests, cointegration tests were also made to determine if the Fisher hypothesis holds. It turns out that there is cointegration during the period were inflation and interest rate exhibit strong stochastic trend, from 1953 to October 1979 which illustrates the evidence of the long-run Fisher hypothesis. However, there is no support for the short-run hypothesis

2.1.4 Previous Studies

Koustas and Serletis (1999) find evidence that reject the existence of the long-run fisher effect for several countries, which is in contrast to Mishkin. Also, Payne and Ewing (1997) find evidence rejecting the long-run effect for developing countries in Africa, Asia and South America. Berument, Ceylan and Olgun (2007) attempted to investigate whether the Fisher hypothesis is universal by testing it for the G7 countries and numerous developing countries. The evidence suggests that the weak form of Fisher hypothesis holds consistently for the G7

countries. In a sample of 45 developing countries, the Fisher hypothesis holds for 23 countries. Evan and Lewis (1995) do also find the Fisher hypothesis to hold in its weak form which is in contrast to Berument and Jelassi (2002) who find support for the strong form of Fisher effect. Paul (1983) finds short-term and the long-term nominal interest rates in India to be positive related to change in price levels, implying that the Fisher effect holds. The Fisher effect has been tested several times for Japan (Ito 2003, Berument et al 2007), which like the Nordic countries is a small open economy. Ito (2009) studies the Fisher hypothesis for three different periods of monetary policy regime and finds that the theory holds in periods of tightened monetary policy where the sensitivity of interest rates for inflation expectations were high. In contrary, interest rates were not sensitive at all during periods of loose monetary policy (the other two periods).

Some critics has been raised regarding the method of Fama. Carlson (1977) concludes that Fama's assumptions of the real interest rate being constant, and expected inflation reflecting all relevant information about future inflation, are too theoretical. To demonstrate, Carlson uses Livingston data which is a survey on forecast of CPI (Consumer Price Index). He finds that the real interest rate fluctuates around 2,5 percent. Also, the author uses Fama's equation for the Fisher effect and includes a lagged variable of employment to population ratio which predicts inflation well. As a consequence of including the variable, the coefficient of interest rate dropped significantly, from being close to one, which illustrate that subsequent inflation do not incorporate all relevant information. Joines (1977) goes even futher than Carlson, by question the accuracy of Fama's data. He finds that the autocorrelation of the residuals of CPI and WPI (Wholesale Price Index) reflects a seasonal pattern in the market forecast errors, which is inconsistent with the assumption of market efficiency.

2.2 Stocks and Inflation

Plenty of researches have been made to determine the relationship between stock returns and inflation in various aspects and most of the researches have produced similar results. Surprisingly, most results contradict the intuition and the theory of Fisher which implies a positive relationship between stock returns and inflation. Instead, evidence suggests the relationship to be negative such as early studies of Nelson (1976), Fama and Schwert (1977), Fama (1982). But also later studies of Chatrath et al (1996), Apergis and Eleftheriou (2001), Andrangi and Chatrath (2002), Durai and Bhaduri (2009). There are also studies with results that support the Fisher hypothesis concerning stock returns, such as Boudoukh and

Richardson (1993), Choudhry (1999), Wong and Wu (2003), Alagidede and Panagiotidis (2010).

Few studies have been conducted to determine inflations relation to stock returns for different sectors. Since it is argued and commonly believed that the real estate prices are a hedge against inflation, Fama and Schwert (1977) examined the case. The estimated coefficient for real estate prices is 1.19 which indicates that real estate is a protection against inflation but the coefficient proved to be insignificant. Wei and Wong (1992) constructed 19 portfolios classified by sector. Most portfolios reflected industrial sectors such as mining, petroleum and railroads but also sectors as bank and chemical. All portfolios seem to have an inverted relation to both expected an unexpected inflation, but banks and machinery illustrate a stronger inverted relation to expected inflation. The bank portfolio has also a stronger negative relation to unexpected inflation in comparison to other portfolios. Lajeri and Dermine (1999) studied the effect of unexpected inflation on banks and non-financial firms on the French Market. The results prove that unexpected inflation has less effect on non-financial firms than banks. Another research concerning sectors is the paper by Diaz and Jareño (2009) which involves seven sectors (oil and energy, basic materials, industry and construction, consumer goods, consumer services, financial and real estate services, technology and telecommunication). Diaz and Jareño have chosen two different approaches in comparison to mentioned research. The first approach is within the field of behavioral finance. The attempt is to determine how investors react to inflation news depending on recent development of the market. It is found that positive inflation surprises during difficult economic periods have a significant impact on stock returns. The financial and real estate services is the most affected sector.

It has been argued that the inverse relationship is spurious due to real economy factors. Despite the subject not being part of this thesis it may shade some light over the relationship. Fama (1982) hypothesizes that the inverse relation between inflation and real activity cause the inverse relationship between stock returns and inflation. He finds stock returns and inflation to be related to real activity. Therefore Fama argues that stock return and inflation is a proxy relationship. By including real activity variables such as growth rates of monetary base, industrial production and GNP, the coefficients for expected and unexpected inflation becomes insignificant. The study of Benderly and Zwick (1985) support Fama's (1982) evidence, that the inverse relation between inflation and future output is the reason for the

inverse relationship between stock returns and inflation. Khil and Lee (2000) find the inverse relation to be driven by real output while monetary factors drive a positive stock-inflation relation. Consistent with Fama, the results of Zhao (1998) illustrate the negative relationship between stock returns and inflation to be driven by expectations of real output. Andrangi and Chatrath (2002) got different results, the inverse relation endure after purging the effects of real activity. Their study proves that the inverse relationship is persistent.

3. Data

The data used in this thesis consist of annual inflation rates, interest rates for treasury bills, interbank loans, and government bonds (see 3.2 Interest Rates), and index series for all shares listed at respective market, and for all main sectors with exception for the financial sector (see 3.3 Stock Indices). The length of the different series varies. The market and the sector indices have the same length for all four countries, starting at 29th of December 1995 and ending at 31th of December 2010. However, the length for inflation and interest rates is not the same for all countries. For instance, inflation for Sweden is around ten years shorter in comparison to the others. Nevertheless, the data for inflation and short-term interest rates cover significant more years than the data for stock indices. When testing the Fisher hypothesis, the full length is applied in order to get a more precise estimate, and when testing for the stock-inflation relationship, the length of expected and unexpected inflation are adjusted for the length of stock index data. The observations of the dataset are both monthly and quarterly. Fama (1976b) compute continuously compounded rate for inflation, nominal interest rates, and stocks and compares it to the regularly computed data. There was no noticeable difference in the results. Therefore, no effort has been made to compute the data continuously compounded in this thesis.

Tabel 1: Data Description

Country	Series	Data	Monthly period	Quarterly period	Source
Denmark	Market Index	OMX Copenhagen	1995.12-2010.12	1996.1-2010.4	Nasdaq OMX
	Sector Index	All, BA CD, CS, DF, HC, ID, IT, MA, RE	1995.12-2010.12	1996.1-2010.4	Nasdaq OMX
	Price Index	Inflation	1981.1-2010.12	1981.1-2010.4	Statistics Denmark
	Short-term interest rates	1-month and 3-month CIBOR	1988.6-2010.12	1988.3-2010-4	Denmark's nationalbank
	Long-term interest rates	2-year Government Bond	1987.1-2010.12	1987.1-2010.4	Denmark's nationalbank
		5-year Government Bond	1987.1-2010.12	1987.1-2010.4	Denmark's nationalbank
Finland	Market Index	OMX Helsinki	1991.6-2010.12	1996.2-2010.4	Nasdaq OMX
	Sector Index	All, BA, CD, CS, HC, ID, MA, RE	1995.12-2010.12	1996.1-2010.4	Nasdaq OMX
	Price Indicies	Inflation	1980.1-2010.12	1980.1-2010.4	Statistics Finland
	Short-term interest rates	1-month and 3-month Interbank rate	1991.6-2010.12	1991.2-2010.4	Datastream
	Long-term interest rates	5-year Government Bond Benchmark	1992.1-2010.12	1992.1-2010.4	Bank of Finland
Norway	Market Index	OBX Total Return Index	1995.12-2010.12	1996.1-2010.4	Oslobors
	Sector Index	All, CD, CS, EG, HC, ID, IT, MA	1995.12-2010.12	1996.1-2010.4	Oslobors
	Price Indicies	Inflation	1979.1-2010.12	1979.1-2010.4	Statistics Norway
	Short-term interest rates	1- month and 3-month NIBOR	1979.1-2010.12	1978.8-2010.4	Norges Bank
		3-month Treasury Bill	2003.2-2010.12	2003.2-2010.4	Norges Bank
	Long-term interest rates	3-year Government Bond	1987.4-2010.12	1987.3-2010.4	Norges Bank
		5-year Government Bond	1985.4-2010.12	1985.3-2010.4	Norges Bank
Sweden	Market Index	OMX Stockholm	1995.12-2010.12	1996.1-2010.4	Nasdaq OMX
	Sector Index	All, BA CD, CS, DF, HC, ID, IT, MA, RE	1995.12-2010.12	1996.1-2010.4	Nasdaq OMX
	Price Indicies	Inflation	1990.1-2010.12	1990.1-2010.4	Statistics Sweden
	Short-term interest rates	1- month and 3-month Treasury Bill	1983.1-2010.12	1983.1-2010.4	The Riksbank
	Long-term interest rates	2-year Government Bond	1987.1-2010.12	1987.1-2010.4	The Riksbank
		5-year Government Bond	1985.1-2010.12	1985.1-2010.4	The Riksbank

Short names for the sector indices are written in full in 3.3 Stock Indices

3.1 Inflation

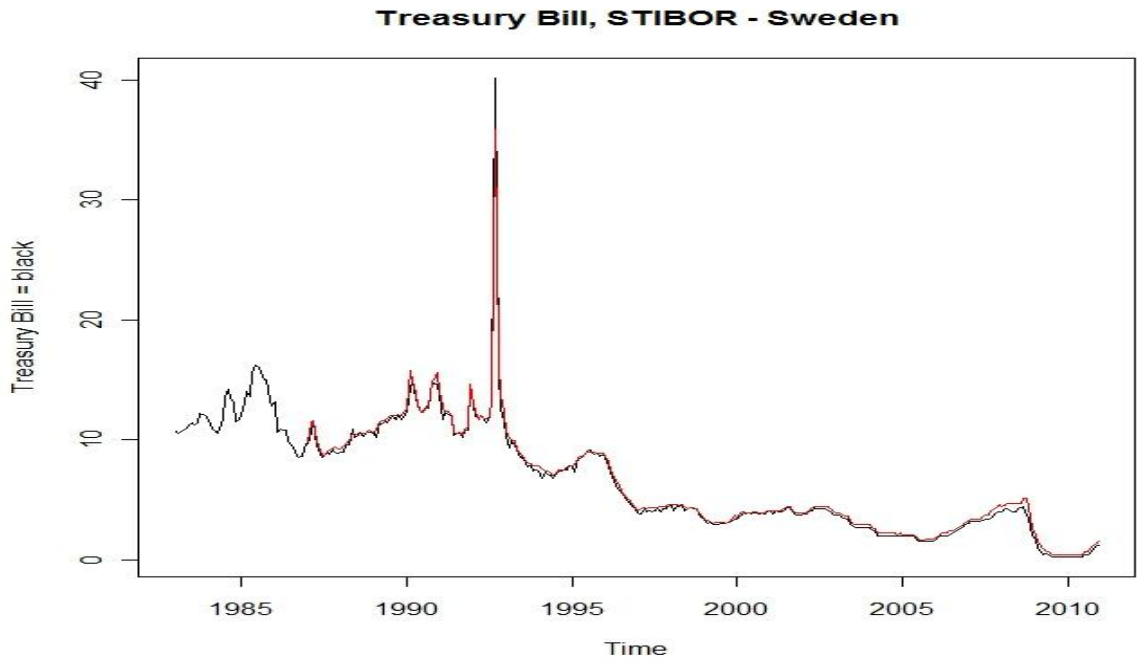
CPI is provided by Statistics Denmark, Statistics Norway, Statistics Finland and Statistics Sweden. In line with U.S. CPI used by Fama and Schwert (1977) it is measured in the middle of every month. The official CPI of Sweden includes interest rates expenses for the Swedish population. (Sweden is the only country using this method as standard.) The CPI may therefore give a false illustration. Because if the Central Bank chooses to raise the repo rate as a reaction to lately increase in inflation it creates the risk of CPI to even be higher since consumers interest expense may go up. Thus a CPI without interest expenses have been applied in the tests. In the testing of asset hedge against inflation, data from a survey by Prospera is also used, which makes the result of Fama's method comparable. Jaffee and Mandelker (1975) points out that many studies have used Wholesale Price Index in the procedure to estimate the Fisher Effect. The authors themselves have used a regular CPI in their study arguing that it is more relevant which is explained by the simple fact that it shows the prices consumers have paid for goods and services. Fama and Schwert (1977) makes the same argument, which was first pointed out by Fisher (1930).

Price controls may have a dampening effect on inflation. Sweden had several types of price controls during 1970:3 to 1982:2 (Hansson 1983) but not during the sample period. No information were found for Denmark, Finland, and Norway. It is believed that there were no price controls during the sample period since the global trend was to have free markets. At least, no significant price controls are believed to have occurred.

3.2 Interest rates

The short-term interest rates are from treasury bills and interbank loans. There is only proper data for Swedish treasury bills. Norway only has data for seven years, while the data for Denmark and Finland were inaccessible and could not be provided by the Central Banks. Nor could they be found in an external database. For the two countries, interbank rates have been used as proxy. This is also the case for Norway, since the data length for treasury bills cover to few years. Just as interest rates for treasury bills are regarded as rates of interest for short-term loans, so is interbank rates. The difference is that interbank rates concern short-term loans between banks. The interbank rates are depended on money available in the bank sector and maturity on the loans. The data for short-term interest rates have been provided by the respective country's Central Bank, but in the case of Finland, an external database had to be used since the data provided by Bank of Finland did not cover enough years. The graph

illustrates that STIBOR (Stockholm Interbank Offered Rate) in red, follow treasury bill close. The deviation is so small that it is negligible. Berument and Jelassi (2002) uses lending rate as proxy for countries where no treasury bill rates were accessible, arguing that the lending rate is regarded as the risk-free measure of interest rates after treasury bills. The same could be said about interbank rates, however, it should be mentioned that during the recession the interbank market collapsed since trust among banks were gone after the bankruptcy of Lehmann Brothers.



Government bonds are used as long-term interest rates, to determine whether they are more appropriate as hedge against inflation than stocks. It may be of interest to compare low risk assets to high risk assets. For Denmark and Sweden, both 2-year and 5-year government bonds are used, while for Finland only a 5-year government bond benchmark were used since the Bank of Finland did not provide actual rates. No data were available for a 2-year government bond benchmark. In contrast to the other countries, Norway has a 3-year government bond rather than a 2-year, but as the others, the government also issue a 5-year bond.

3.3 Stock indices

Data for the indices of Denmark, Finland and Sweden are provided by Nasdaq Stock Exchange, while the Oslo Stock Exchange provided data for Norwegian indices. The samples consist of nine sector indices for Denmark and Sweden, eight for Norway, and seven for

Finland. The indices reflect the main sectors listed on the Exchanges except Banks, Diversified Financials and Real estate. These are subsectors of the Financial sector. Since inflation may have different effects within the Financial Sector it may be appropriate to use the subsectors. For instance, inflation may affect the banking sector differently from the Real Estate sector. An increase in inflation is usually followed by a rise in repo rate by Central Banks. The new level of repo rate implies a higher level of lending cost for the commercial banks who try to seek compensation by raising the lending rate or commission for its customers. This may provide the opportunity for Banks to improve their net interest income margin which have proven to be the case in Sweden. The change in inflation may result in an opposite outcome for the Real Estate Sector. A rise in the repo rate will probably increase interest expenses lowering the profit of Real Estate companies due to their capital structure that is often debt dominated. It should be mentioned that Real Estate companies many times uses interest rates swaps to hedge against floating interest rates.

Tabel 2: Sector Indices

Denmark				Finland				Norway				Sweden			
Sector		Ticker	No. of Stocks	Sector		Ticker	No. of Stocks	Sector		Ticker	No. of Stocks	Sector		Ticker	No. of Stocks
Banks	BA	CX4010PI	36	Banks	BA	HX4010PI	5	Consumer Discretionary	CD	OSE25GI	10	Banks	BA	SX4010PI	7
Consumer Discretionary	CD	CX25PI	21	Consumer Discretionary	CD	HX25PI	17	Consumer Staples	CS	OSE30GI	14	Consumer Discretionary	CD	SX25PI	39
Consumer Staples	CS	CX30PI	8	Consumer Staples	CS	HX30PI	8	Energy	EG	OSE10GI	51	Consumer Staples	CS	SX30PI	10
Diversified Financials	DF	CX4020PI	18	Health Care	HC	HX35PI	7	Health Care	HC	OSE35GI	14	Diversified Financials	DF	SX4020PI	24
Health Care	HC	CX35PI	18	Industrial	ID	HX20PI	39	Industrial	ID	OSE20GI	37	Health Care	HC	SX35PI	29
Industrial	ID	CX20PI	44	Material	IT	HX45PI	26	Information Technology	IT	OSE45GI	23	Industrial	ID	SX20PI	74
Information Technology	IT	CX45PI	10	Real Estate	RE	HX4040PI	5	Material	MA	OSE15GI	9	Information Technology	IT	SX45PI	49
Material	MA	CX15PI	8									Material	MA	SX15PI	17
Real Estate	RE	CX4040PI	18									Real Estate	RE	SX4040PI	21

Table 2 displays the sector indices used in this paper. Because of an agreement between the Nordic countries same standard methods are used to calculate and categorize the indices. The Diversified Financial sector for Norway is replaced by the Energy sector because of two reasons. Diversified Financials only consist of one stock while the Energy sector is the largest in Norway with 51 stocks. It is the second largest index of the Nordic countries. Only Sweden's industrial index consists of more stocks. To exclude the Energy sector may imply valuable information losses. It can be argued that the Norwegian Bank sector only constitutes of two stocks and therefore may not be representative for the specific sector in general. However, there is no perfect replaceable sector index that constitute significantly more number of stocks. Also, the results can be directly compared to the results of the Swedish and Finish banking sectors. The Diversified Financial sector for Finland is also excluded due to the same reason. Data for the Finish material sector was not available in the same length as the others, and that's why it is not part of the sample.

Tabel 3: Market Indices

Country	Market Index	Description	Ticker	No. of Stocks	GI/PI
Denmark	OMX Copenhagen	All shares listed on Copenhagen Exchange	OMXCPI	189	PI
Finland	OMX Helsinki	All shares listed on Helsinki Exchange	OMXHPI	131	PI
Norway	OBX Total Return Index	The most traded stocks on the Oslo Exchange	OBX	25	GI
Sweden	OMX Stockholm	All shares listed on Stockholm Exchange	OMXSPI	285	PI

The indices for Norway includes dividend while the sector indices for the other three countries do not. In other words, the computed return does not reflect the total return. Obviously, gross indices had been preferable but the length of Danish, Finish and Swedish gross indices have too few observations to be considered. Branch's (1976) study was conducted using price indices. He argued that it was not an issue since firms can offset raise in costs by increasing prices which would lead to profits being independent of inflation. He recognized that the real value of stocks should not alter if profits remain unchanged. Yet Branch is aware that his discussion may pose two possible objections. First, countries facing high inflation rate may choose to insert guidelines or price policies in order to control the inflation. Policies of such kind may manifest itself negatively for large firms, which are likely to weigh heavily in indices. Secondly, inertia in adjustment of exchange rate may be a problem for countries with inflation increasing at fast pace. This may result in an overvalued currency thus discouraging exports and stimulating imports.

Since the data for all stocks are price indices, except for Norway that has total return indices, the return rate has to be computed before testing stock-inflation relationship. Monthly and quarterly return rate is computed for each index by applying a standard formula

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \qquad (4)$$

Where P_t is the index value at time t and P_{t-1}, the value at time t-1.

3.4 Statistical Properties of the Data

Fama (1975) argues that the market efficiency assumption is only useful if past change in purchasing power contain relevant information about future change in purchasing power. The table of autocorrelations for inflation are very high indicating the past changes in purchasing power embodies information about future changes in purchasing power. Since both inflation and interest rates are very high at lower lags, and decay at higher lags, there series might be non-stationary process, for instance random walk.

5: Statistical proporties of Interest rate and Inflation

Short-term interest rate	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}	ρ_{11}	ρ_{12}	Mean	St. Dev
Denmark	0.96	0.94	0.92	0.90	0.88	0.86	0.86	0.85	0.82	0.80	0.78	0.75	0.86	0.07
Finland	0.97	0.95	0.91	0.88	0.84	0.82	0.79	0.76	0.72	0.69	0.66	0.61	0.80	0.12
Norway	0.96	0.94	0.95	0.90	0.90	0.89	0.87	0.89	0.84	0.84	0.83	0.82	0.89	0.05
Sweden	0.90	0.88	0.86	0.85	0.84	0.84	0.83	0.83	0.83	0.80	0.79	0.78	0.84	0.04
Inflation	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}	ρ_{11}	ρ_{12}	Mean	St. Dev
Denmark	0.98	0.95	0.93	0.90	0.87	0.84	0.82	0.79	0.76	0.74	0.71	0.68	0.83	0.10
Finland	0.99	0.98	0.97	0.95	0.93	0.91	0.89	0.87	0.85	0.83	0.80	0.78	0.90	0.07
Norway	0.99	0.97	0.96	0.94	0.92	0.91	0.89	0.87	0.85	0.83	0.80	0.78	0.89	0.07
Sweden	0.97	0.93	0.89	0.84	0.80	0.76	0.70	0.65	0.59	0.53	0.47	0.42	0.71	0.18

The autocorrelations are regression coefficients

4. Methodology

4.1 Methods and Definitions

There are three common methods used in the literature that deals with the issue of how to define common stocks as being hedge against inflation. In the first method, a specific value is estimated which Bodie (1976) identifies as "floor" value. To determine whether stocks can be used as a hedge, the possibility of stock returns to fall below the specific "floor" value is examined. In the second method, the alternative definition of inflation hedge is independency. If common stocks are independent of inflation then they function as a hedge. This is expressed with a beta being equal to zero in a regression which implys that there is no relationship between real return rate and inflation. None of the two methods are used in the thesis. Instead, the method introduced by Fama and Schwert (1977) is applied, where the definition of hedge is expressed as nominal stock returns has a one-to-one relationship with inflation. By regressing nominal rate of return onto inflation, one can examine if the nominal return increases with one unit given that the inflation increases with one unit. In other words, the estimated beta coefficient shall equal one. This means that a change in inflation is offset by an equal change in nominal return rate.

4.2 Fama's Fisher Hypothesis Method

The Fisher hypothesis implies that nominal interest rate is a sum of the real interest rate and inflation which is expressed in (1). By replacing i_n with TB_{t-1} we get the nominal interest rate for Treasury Bills which is the sum of expected real rate, ER_{t-1} and expected inflation, EI_{t-1}.

$$TB_{t-1} = ER_{t-1} + EI_{t-1} \qquad (8)$$

By rearrange the equation, expected inflation is given.

$$EI_{t-1} = -ER_{t-1} + TB_{t-1} \qquad (9)$$

By assuming adaptive inflation, one assumes that the current inflation rate is equal to past rate of expected inflation. $I_t = EI_{t-1}$. By also including possible uncertainties η_t we can rewrite the model.

$$I_t = -ER_{t-1} + TB_{t-1} + \eta \qquad (10)$$

1) The model can be estimated through a regression where ER_{t-1} is replaced by α_{t-1}

$$I_t = -\alpha_{t-1} + \beta TB_{t-1} + \eta \qquad (11)$$

The Fisher Hypothesis holds if β equals to one. That means future inflation is fully reflected in current interest rates.

2) From the regression, one decompose the model into expected inflation and unexpected inflation by extracting $-\alpha_{t-1} + \beta TB_{t-1}$ and η_t

$$EI_{t-1} = -\alpha + \beta TB_{t-1} \qquad (12)$$

$$UI_{t-1} = \eta_t \qquad (13)$$

This means that the expected inflation is equal to the real rate of return and the interest rate while the unexpected inflation is equal to the error term.

3) After extracting expected and unexpected inflation, the last step is to estimate a regression that determines stock index returns relation to the two components of inflation

$$RS_t = \alpha + \beta_1 EI_{t-1} + \beta_2 UI_{t-1} + \varepsilon_t \qquad (14)$$

The model tells us not only about the relationship between nominal stock returns and expected inflation, but also relationship between nominal stock index returns and unexpected inflation. If β_1 and β_2 are equal to one, then the stock indices are considered to be fully hedge against inflation. However, if only one of the coefficients are equal to one, then the indices are

considered to be partial hedge against inflation. In the case of government bonds relation to inflation, the yields replaces the stock returns.

5. Empirical Results & Analysis

5.1 The Fisher Hypothesis

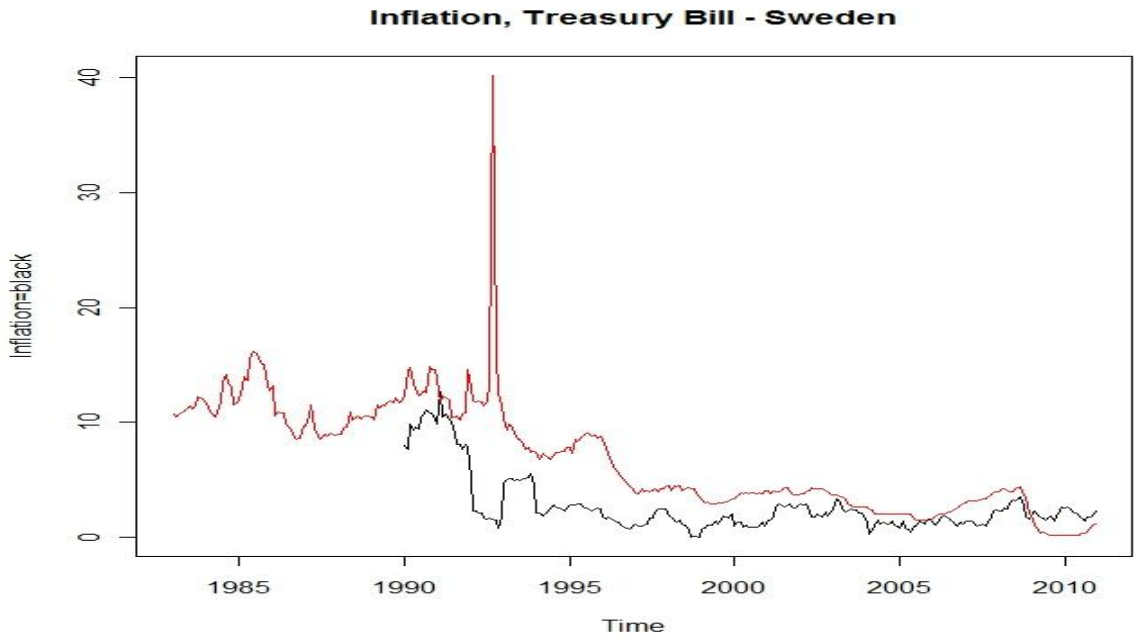
The results for the Fisher effect (11) is shown in table 4. It illustrates that the hypothesis do not hold in Denmark and Finland where the coefficients for expected real rate of interest are positive and very large. Particularly Denmark has very large alphas, 1.958 for monthly data and 2.073 for quarterly. According to the market efficient hypothesis, the alphas should be close to zero. Furthermore, the interest rate coefficients are relatively small for both countries. The results for the quarterly data deviates more than for the monthly data. In the case of Sweden, the results differ to an extent. The expected real rate for the quarterly data is not as large as for Denmark and Finland but still positive. Also, the interest rate for both data samples is not as small, 0.341 respectively 0.424, and the R-squared is significant larger than for Denmark and Finland. The regression results for the quarterly data do not deviate from the Fisher hypothesis as much as the monthly data. To compare interbank rate to interest rate of treasury bills, STIBOR (Stockholm Interbank Offered Rate) has also been tested for the Fisher effect. The sample length is the same as for the treasury bill since it is dictated by data availability of inflation. The results are slightly better for STIBOR, with a lower expected real rate for both monthly and quarterly data, 0.681 and 0.187, compared to 0.883 and 0.338. But the coefficients for the interest rate do not differ noticeably. However, the tests for quarterly data do not deviate as much as for monthly data.

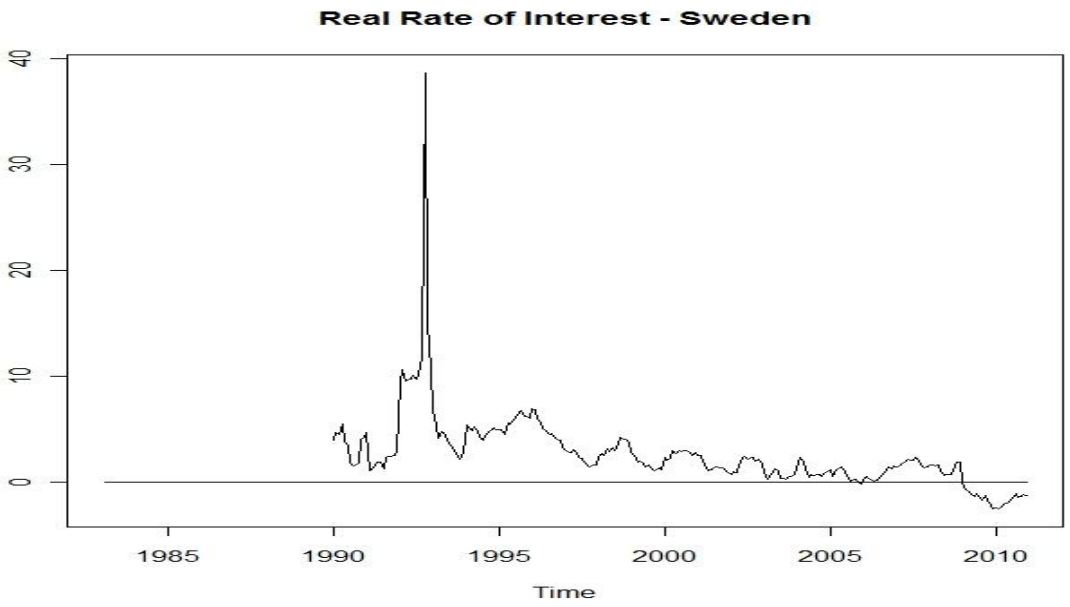
Both the interbank rate and the treasury bill interest rate has also been applied for Norway. The sample length of NIBOR covers considerable more years than the treasury bill, 16 more years to be precise. The results differ significantly between the two. Surprisingly, it is the NIBOR that seem to illustrate partial Fisher effect with negative alphas of -0.230 and -0.628, and relatively large betas of 0.536 and 0.580. The R-squared is also significantly larger for the NIBOR. Since NIBOR is superior to interest rate of Norwegian treasury bills in predicting inflation, it has been used as interest rate proxy for examining the relationship between inflation and stock index returns. The standard errors for the coefficient estimates are greater for quarterly data than monthly data. For the STIBOR, the standard error for the quarterly data is almost twice as high as the coefficient estimate, while for NIBOR, the standard errors for both monthly and quarterly data are almost equal to the coefficients.

Tabel 4:The Fisher Effect

Country	Interest Rates	Period	Sample size	Estimates	Expected Real Rate of Interest (α)	Interest Rate (β)	R-squared
Denmark	Monthly, CIBOR	1988.6-2010.12	271	Coefficients	1.958	0.061	0.053
				t-statistic	20.162	4.014	
				p-value	0.000	0.000	
				Standard Error	0.097	0.015	
	Quarterly, CIBOR	1988.3-2010.4	89	Coefficients	2.073	0.034	0.007
				t-statistic	12.023	1.262	
				p-value	0.000	0.210	
				Standard Error	0.172	0.027	
Finland	Monthly, Interbank rate	1991.6-2010.12	234	Coefficients	0.839	0.185	0.237
				t-statistic	7.281	8.574	
				p-value	0.000	0.000	
				Standard Error	0.115	0.022	
	Quarterly, Interbank rate	1991.2-2010.4	78	Coefficients	0.866	0.173	0.199
				t-statistic	4.117	4.490	
				p-value	0.000	0.000	
				Standard Error	0.210	0.039	
Norway	Monthly, Treasury Bill	2003.2-2010.12	95	Coefficients	0.920	0.328	0.122
				t-statistic	3.131	3.736	
				p-value	0.002	0.000	
				Standard Error	0.294	0.088	
	Quarterly, Treasury Bill	2003.2-2010.4	30	Coefficients	1.094	0.282	0.068
				t-statistic	2.081	1.764	
				p-value	0.047	0.089	
				Standard Error	0.526	0.160	
	Monthly, NIBOR	1979.1-2010.12	384	Coefficients	-0.239	0.536	0.520
				t-statistic	-0.955	20.371	
				p-value	0.340	0.000	
				Standard Error	0.250	0.026	
	Quarterly, NIBOR	1979.1-2010.4	128	Coefficients	-0.628	0.580	0.559
				t-statistic	-1.453	12.669	
				p-value	0.149	0.000	
				Standard Error	0.432	0.046	
Sweden	Monthly, Treasury Bill	1990.1-2010.12	253	Coefficients	0.883	0.341	0.352
				t-statistic	4.417	11.708	
				p-value	0.000	0.000	
				Standard Error	0.200	0.029	
	Quarterly, Treasury Bill	1990.1-2010.1	84	Coefficients	0.338	0.434	0.455
				t-statistic	0.988	8.383	
				p-value	0.326	0.000	
				Standard Error	0.342	0.052	
	Monthly, STIBOR	1990.1-2010.12	253	Coefficients	0.681	0.365	0.3806
				t-statistic	3.346	12.459	
				p-value	0.001	0.000	
				Standard Error	0.024	0.029	
	Quarterly, STIBOR	1990.1-2010.1	84	Coefficients	0.187	0.440	0.4665
				t-statistic	0.534	8.578	
				p-value	0.595	0.000	
				Standard Error	0.342	0.052	

An explanation to why Sweden and Norway gets positive values on the constant (11) could be that the real rates of return in the countries are negative (8) but that does not seem to be the case. By plotting inflation and nominal interest rates, one can see that during the 1990s the nominal interest rates were substantially greater than inflation which is explained by the financial crisis that hit the Nordic countries. The Swedish interest rate peaked in October 1992 reaching 40.2 percent which is illustrated by the spike in the graph. The interest rates of Denmark, Finland and Norway did not reach the same level but were still very high in the last quarter of 1992 (see Appendix). Overall, the nominal interest rates has most of the time been greater than inflation. It is only in 2010 that inflation were greater than the interest rates. This is best illustrated by plotting the real interest rate which is given by subtracting inflation the nominal interest rate, in accordance with the Fisher equation. The interest rates of Swedish treasury bills seem to follow a similar path as STIBOR. There is no noticeable difference. The interest rates are more volatile than inflation which may indicate the ability of predicating inflation is not precise.




Real Rate of Interest - Sweden
40
30
20
10
0
1985
1990
1995
2000
2005
2010
Time

5.2 Stock Returns and Inflation

In this section is the results for the relationship between stock returns and inflation. The estimation of the equation (14) is displayed in nine separate tables. Four tables present the results for monthly data. Another four tables show the results for quarterly data, and the reaming table is for the tests regarding the Swedish survey for inflation expectations.

5.2.1Tests for Monthly Data

The results indicate that stocks don't function as hedge against inflation. Almost all coefficients of expected inflation and unexpected inflation are negative for the Nordic markets, implying a negative correlation between stock returns and inflation. Healthcare and Material for Denmark, Consumer Discretionary and Real Estate for Finland, Healthcare for Norway and Information Technology for Sweden are the indices with one inflation coefficient that is not negative. Four at of these six indices have a positive correlation with unexpected inflation. However, the estimates are very small for the six indices and therefore may be considered as independent of expected or unexpected inflation. But even sector indices with negative estimates may be considered independent of one component of inflation. For all countries, the expected inflation is more negatively related to stock returns than unexpected inflation. Also, the standard errors are relatively high for all four countries.

The market index return is negatively correlated with expected and unexpected inflation for the four countries, with estimates that are similar to most of the sector indices. The coefficients are relatively small which makes them almost independent of inflation. For instance, If the expected inflation increases with 1 percent, the finish market index decreases with 0.007 percent. That is almost unobservable.

Government bonds seem to be partial hedge against inflation. The results for 2-year, 3-year and 5-year bonds are similar. Government bonds are fully hedged against expected inflation but offers only some protection against unexpected inflation. Danish government bonds are the ones that offer most protection against unexpected inflation while Finish government bonds offer no protection at all. The coefficient estimates for expected inflation are in all cases significantly larger than 1. Particularly, the Danish bonds have coefficients of 11.585 and 11.827. The standard errors for government bonds are not as high as those for stock returns.

Table 6a: Hedge against expected and unexpected inflation, Denmark

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.158	-0.007	0.063
1995.12-2010.12		t-value	-3.056	-1.096	
		p-value	0.003	0.275	
		Standard Error	0.052	0.006	
	Banks	Coefficient	-0.175	-0.015	0.049
		t-value	-2.227	-1.662	
		p-value	0.027	0.098	
		Standard Error	0.078	0.009	
	Consumer Discretionary	Coefficient	-0.079	-0.004	0.001
		t-value	-1.156	-0.481	
		p-value	0.250	0.631	
		Standard Error	0.069	0.008	
	Consumer Staples	Coefficient	-0.159	-0.019	0.079
		t-value	-2.395	-2.472	
		p-value	0.018	0.014	
		Standard Error	0.066	0.008	
	Diversified Financials	Coefficient	-0.310	-0.004	0.085
		t-value	-3.927	-0.431	
		p-value	0.000	0.667	
		Standard Error	0.079	0.009	
	Health Care	Coefficient	-0.108	0.002	0.006
		t-value	-1.727	0.333	
		p-value	0.086	0.740	
		Standard Error	0.062	0.007	
	Industrial	Coefficient	-0.173	-0.012	0.037
		t-value	-2.131	-1.294	
		p-value	0.035	0.197	
		Standard Error	0.081	0.010	
	Information Technology	Coefficient	-0.231	-0.010	0.031
		t-value	-2.260	-0.828	
		p-value	0.025	0.409	
		Standard Error	0.102	0.012	
	Material	Coefficient	-0.179	0.001	0.038
		t-value	-2.887	0.139	
		p-value	0.004	0.890	
		Standard Error	0.062	0.007	
	Real Estate	Coefficient	-0.141	-0.014	0.032
		t-value	-1.787	-1.494	
		p-value	0.076	0.137	
		Standard Error	0.079	0.009	
Government Bonds	2-year maturity	Coefficient	11.585	0.667	0.848
1988.1-2010.12		t-value	37.381	8.648	
		p-value	0.000	0.000	
		Standard Error	0.314	0.077	
	5-year maturity	Coefficient	11.827	0.703	0.847
		t-value	37.523	9.101	
		p-value	0.000	0.000	
		Standard Error	0.315	0.077	

Table 6b: Hedge against expected and unexpected inflation, Finland

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.007	-0.015	0.029
1995.12-2010.12		t-value	-0.713	-2.891	
		p-value	0.004	0.004	
		Standard Error	0.009	0.005	
	Banks	Coefficient	-0.051	-0.001	0.045
		t-value	-1.585	-1.294	
		p-value	0.115	0.197	
		Standard Error	0.032	0.007	
	Consumer Discretionary	Coefficient	0.004	-0.016	0.060
		t-value	0.155	-3.017	
		p-value	0.877	0.003	
		Standard Error	0.026	0.005	
	Consumer Staples	Coefficient	-0.004	-0.004	0.354
		t-value	-0.193	-1.027	
		p-value	0.847	0.306	
		Standard Error	0.020	0.004	
	Health Care	Coefficient	-0.021	-0.003	0.001
		t-value	-0.811	-0.501	
		p-value	0.419	0.617	
		Standard Error	0.025	0.005	
	Industrial	Coefficient	-0.063	-0.007	0.085
		t-value	-2.423	-1.394	
		p-value	0.016	0.165	
		Standard Error	0.026	0.005	
	Material	Coefficient	-0.030	-0.011	0.061
		t-value	-1.163	-2.093	
		p-value	0.247	0.038	
		Standard Error	0.025	0.005	
	Real Estate	Coefficient	-0.067	0.000	0.047
		t-value	-2.669	0.084	
		p-value	0.008	0.933	
		Standard Error	0.025	0.005	
Government Bonds	5-year maturity	Coefficient	4.346	-0.361	0.832
1992.1-2010.12		t-value	32.995	-5.505	
		p-value	0.000	0.000	
		Standard Error	0.132	0.066	

Table 6c: Hedge against expected and unexpected inflation, Norway

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.023	-0.010	0.037
1995.12-2010.12		t-value	-3.061	-1.577	
		p-value	0.003	0.117	
		Standard Error	0.008	0.006	
	Consumer Discretionary	Coefficient	-0.023	-0.010	0.040
		t-value	-3.060	-1.576	
		p-value	0.003	0.117	
		Standard Error	0.008	0.006	
	Consumer Staples	Coefficient	-0.024	-0.004	0.058
		t-value	-3.307	-0.630	
		p-value	0.001	0.530	
		Standard Error	0.007	0.006	
	Energy	Coefficient	-0.021	-0.009	0.042
		t-value	-3.137	-1.681	
		p-value	0.002	0.094	
		Standard Error	0.006	0.006	
	Health Care	Coefficient	-0.010	0.003	0.009
		t-value	-1.290	0.440	
		p-value	0.199	0.660	
		Standard Error	0.007	0.006	
	Industrial	Coefficient	-0.024	-0.016	0.073
		t-value	-3.866	-3.053	
		p-value	0.000	0.003	
		Standard Error	0.006	0.005	
	Information Technology	Coefficient	-0.020	-0.005	0.017
		t-value	-2.147	-0.667	
		p-value	0.033	0.506	
		Standard Error	0.009	0.008	
	Material	Coefficient	-0.017	-0.012	0.025
		t-value	-2.415	-2.045	
		p-value	0.017	0.044	
		Standard Error	0.007	0.006	
Government Bonds	3-year maturity	Coefficient	1.571	0.359	0.869
1987.4-2010.12		t-value	39.066	6.903	
		p-value	0.000	0.000	
		Standard Error	0.040	0.052	
	5-year maturity	Coefficient	1.500	0.401	0.868
		t-value	43.077	8.082	
		p-value	0.000	0.000	
		Standard Error	0.035	0.050	

Table 6d: Hedge against expected and unexpected inflation, Sweden

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.029	-0.013	0.003
1995.12-2010.12		t-value	-2.821	-2.026	
		p-value	0.005	0.044	
		Standard Error	0.010	0.006	
	Banks	Coefficient	-0.031	-0.013	0.019
		t-value	-2.310	-1.704	
		p-value	0.022	0.090	
		Standard Error	0.013	0.008	
	Consumer Discretionary	Coefficient	-0.014	-0.011	0.006
		t-value	-1.311	-1.734	
		p-value	0.192	0.085	
		Standard Error	0.011	0.006	
	Consumer Staples	Coefficient	-0.009	-0.001	-0.002
		t-value	-1.125	-0.129	
		p-value	0.268	0.897	
		Standard Error	0.008	0.005	
	Diversified Financials	Coefficient	-0.029	-0.014	0.025
		t-value	-2.454	-1.997	
		p-value	0.015	0.047	
		Standard Error	0.012	0.007	
	Health Care	Coefficient	-0.011	-0.005	-0.005
		t-value	-1.016	-0.831	
		p-value	0.311	0.407	
		Standard Error	0.011	0.006	
	Industrial	Coefficient	-0.036	-0.013	0.050
		t-value	-3.377	-1.975	
		p-value	0.000	0.050	
		Standard Error	0.011	0.006	
	Information Technology	Coefficient	0.098	-0.306	-0.003
		t-value	0.162	-0.849	
		p-value	0.871	0.397	
		Standard Error	0.023	0.014	
	Material	Coefficient	-0.025	-0.007	0.020
		t-value	-2.353	-1.152	
		p-value	0.020	0.251	
		Standard Error	0.011	0.006	
	Real Estate	Coefficient	-0.036	-0.015	0.055
		t-value	-3.484	-2.446	
		p-value	0.000	0.015	
		Standard Error	0.010	0.006	
Government Bonds	2-year maturity	Coefficient	2.110	0.394	0.835
1990.1-2010.12		t-value	34.624	8.723	
		p-value	0.000	0.000	
		Standard Error	0.061	0.045	
	5-year maturity	Coefficient	1.830	0.350	0.797
		t-value	30.414	7.853	
		p-value	0.000	0.000	
		Standard Error	0.060	0.045	

5.2.2 Tests for Quarterly Data

The results for quarterly data are consistent with the monthly data, showing that stocks and inflation do not constitute one-to-one relationship. Also consistent with the monthly data is that most coefficients are negative. Even though the estimate is very low, the indices that have a positive correlation with at least one component of inflation are Information Technology for Denmark, Healthcare and Real Estate for Finland, and Consumer Discretionary, Consumer Staples and Healthcare for Norway. None of the Swedish indices have a positive correlation with inflation. But as mentioned, most estimates are very low and could be considered independent of the specific inflation component. The Consumer Discretionary index for Norway is the only index in the tests that display a positive correlation with both expected and unexpected inflation. In the case of Denmark, the coefficients for expected inflation are relatively high. For instance, Diversified Financials has a value of -3.251. Overall, the tests for quarterly data are very similar to monthly data, but the difference is that most estimates are not so low that the indices can be regarded as independent of either expected or unexpected inflation, or both. Just as for the monthly data, the relation between stock returns and inflation is more negative correlated for expected inflation than unexpected inflation. Worth to be mentioned, is that the standard errors for both monthly and quarterly data are relatively high.

The market index for Denmark has relatively strong negative correlation with expected inflation. If inflation increases with 1 percent, the Danish market index decreases with 0.89 percent. However, there is no noticeable difference between the market indices for the other countries since they have a negative correlation with inflation, but as with the monthly data, the estimates are relatively small. This could make them considered as independent of inflation.

The tests for government bonds are similar to the results for monthly data. Just as previous tests, Danish government bonds have extremely high coefficients for expected inflation. Danish bonds do not offer full protection against unexpected inflation. The relation between expected inflation and government bonds for the other three countries do not deviate from the tests of monthly data. However, for unexpected inflation, Norwegian and Swedish government bonds offers less protection in comparison to the results of monthly data. The 5-year government bond for Finland proves also in the tests for quarterly data to have a negative relation to unexpected inflation. It is the only bond with a negative estimate. The R-squared

are around 0.8 for the most tests which is very high in comparison the results for stock indices. Particularly the Swedish 2-year bond has a R-squared of 0.91. Also, all coefficients for expected and unexpected inflation are significant regardless of maturity. The standard errors are relatively low in comparison with those for stock returns.

There is a significant difference in the tests for stock indices and government bonds. In opposite to stock indices, government bonds has a positive relation to inflation which implies protection against rise in inflation. The tests illustrates that a percentage increase in inflation is followed by an even greater increase in government bond yields. The regression coefficients are also significant for bonds which is in contrast to stock indices. Also, as mentioned above, R-squared is far higher for bonds.

Table 7a: Hedge against expected and unexpected inflation, Denmark

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.898	-0.025	0.142
1995.4-2010.4		t-value	-2.774	-1.271	
		p-value	0.007	0.209	
		Standard Error	0.324	0.020	
	Banks	Coefficient	-0.563	-0.039	0.039
		t-value	-1.194	-1.375	
		p-value	0.237	0.174	
		Standard Error	0.471	0.028	
	Consumer Discretionary	Coefficient	-1.154	-0.055	0.147
		t-value	-2.377	-1.886	
		p-value	0.021	0.064	
		Standard Error	0.486	0.029	
	Consumer Staples	Coefficient	-0.741	-0.047	0.100
		t-value	-1.753	-1.842	
		p-value	0.085	0.071	
		Standard Error	0.423	0.026	
	Diversified Financials	Coefficient	-3.251	0.059	0.025
		t-value	-1.879	0.561	
		p-value	0.065	0.577	
		Standard Error	1.730	0.104	
	Health Care	Coefficient	-0.036	-0.764	0.004
		t-value	-0.764	-1.056	
		p-value	0.448	0.296	
		Standard Error	0.474	0.029	
	Industrial	Coefficient	-0.850	-0.030	0.082
		t-value	-2.036	-1.203	
		p-value	0.046	0.234	
		Standard Error	0.418	0.025	
	Information Technology	Coefficient	-1.362	0.003	0.040
		t-value	-2.060	0.067	
		p-value	0.044	0.947	
		Standard Error	0.661	0.040	
	Material	Coefficient	-0.949	-0.011	0.076
		t-value	-2.397	0.442	
		p-value	0.020	0.660	
		Standard Error	0.396	0.024	
	Real Estate	Coefficient	-0.384	-0.015	-0.019
		t-value	-0.697	-0.456	
		p-value	0.489	0.650	
		Standard Error	0.551	0.033	
Government Bonds	2-year maturity	Coefficient	20.983	0.810	0.827
1988.1-2010.4		t-value	19.730	6.630	
		p-value	0.000	0.000	
		Standard Error	1.063	0.144	
	5-year maturity	Coefficient	18.624	0.723	0.778
		t-value	16.938	4.858	
		p-value	0.000	0.000	
		Standard Error	1.100	0.149	

Table 7b: Hedge against expected and unexpected inflation, Finland

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β)	R-squared
Stock indices	Market	Coefficient	-0.022	-0.045	0.046
1995.4-2010.4		t-value	-0.592	-2.312	
		p-value	0.556	0.235	
		Standard Error	0.037	0.019	
	Banks	Coefficient	-0.185	-0.021	0.125
		t-value	-1.812	-1.103	
		p-value	0.075	0.275	
		Standard Error	0.102	0.019	
	Consumer Discretionary	Coefficient	-0.019	-0.045	0.175
		t-value	-0.224	-2.944	
		p-value	0.823	0.005	
		Standard Error	0.083	0.016	
	Consumer Staples	Coefficient	-0.010	-0.018	0.021
		t-value	-0.142	-1.375	
		p-value	0.887	0.175	
		Standard Error	0.070	0.013	
	Health Care	Coefficient	-0.132	0.005	0.017
		t-value	-1.572	0.338	
		p-value	0.122	0.736	
		Standard Error	0.084	0.015	
	Industrial	Coefficient	-0.244	-0.016	0.261
		t-value	-3.122	-1.098	
		p-value	0.003	0.277	
		Standard Error	0.078	0.014	
	Material	Coefficient	-0.138	-0.028	0.002
		t-value	-1.595	-1.748	
		p-value	0.116	0.086	
		Standard Error	0.087	0.016	
	Real Estate	Coefficient	-0.229	0.002	0.140
		t-value	-2.882	0.110	
		p-value	0.007	0.913	
		Standard Error	0.091	0.015	
Government Bonds	5-year maturity	Coefficient	4.556	-0.309	0.826
1992.1-2010.4		t-value	18.584	-2.717	
		p-value	0.000	0.008	
		Standard Error	0.245	0.114	

Table 7c: Hedge against expected and unexpected inflation, Norway

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.057	-0.011	0.035
1995.4-2010.4		t-value	-2.273	-0.501	
		p-value	0.027	0.618	
		Standard Error	0.025	0.022	
	Consumer Discretionary	Coefficient	0.014	0.008	-0.034
		t-value	0.628	0.364	
		p-value	0.553	0.717	
		Standard Error	0.023	0.021	
	Consumer Staples	Coefficient	-0.048	0.012	0.083
		t-value	-1.781	0.514	
		p-value	0.080	0.609	
		Standard Error	0.027	0.024	
	Energy	Coefficient	-0.055	-0.015	0.096
		t-value	-2.674	-0.819	
		p-value	0.010	0.416	
		Standard Error	0.024	0.018	
	Health Care	Coefficient	-0.022	0.015	0.018
		t-value	-0.869	0.669	
		p-value	0.388	0.506	
		Standard Error	0.025	0.022	
	Industrial	Coefficient	-0.057	-0.025	0.105
		t-value	-2.960	-1.478	
		p-value	0.004	0.145	
		Standard Error	0.019	0.017	
	Information Technology	Coefficient	-0.059	-0.019	0.030
		t-value	-1.860	-0.663	
		p-value	0.068	0.510	
		Standard Error	0.032	0.028	
	Material	Coefficient	-0.027	-0.006	-0.008
		t-value	-1.129	-0.281	
		p-value	0.263	0.780	
		Standard Error	0.024	0.021	
Government Bonds	3-year maturity	Coefficient	1.452	0.264	0.849
1985.2-2010.4		t-value	19.182	2.508	
		p-value	0.000	0.014	
		Standard Error	0.076	0.105	
	5-year maturity	Coefficient	1.441	0.284	0.890
		t-value	26.347	3.366	
		p-value	0.000	0.001	
		Standard Error	0.057	0.084	

Table 7d: Hedge against expected and unexpected inflation, Sweden

Asset	Description	Estimates	Expected Inflation (β_1)	Unexpected Inflation (β_2)	R-squared
Stock indices	Market	Coefficient	-0.074	-0.025	0.051
1995.4-2010.4		t-value	-2.231	-1.211	
		p-value	0.030	0.231	
		Standard Error	0.033	0.021	
	Banks	Coefficient	-0.073	-0.041	0.046
		t-value	-2.158	-1.811	
		p-value	0.035	0.075	
		Standard Error	0.034	0.023	
	Consumer Discretionary	Coefficient	-0.030	-0.026	-0.004
		t-value	-1.042	-1.326	
		p-value	0.302	0.190	
		Standard Error	0.029	0.020	
	Consumer Staples	Coefficient	-0.021	-0.003	-0.013
		t-value	-0.928	-0.202	
		p-value	0.358	0.841	
		Standard Error	0.022	0.015	
	Diversified Financials	Coefficient	-0.053	-0.026	0.007
		t-value	-1.555	-1.121	
		p-value	0.125	0.267	
		Standard Error	0.034	0.023	
	Health Care	Coefficient	-0.024	-0.013	-0.021
		t-value	-0.875	-0.707	
		p-value	0.385	0.483	
		Standard Error	0.027	0.018	
	Industrial	Coefficient	-0.074	-0.025	0.087
		t-value	-2.658	-1.311	
		p-value	0.010	0.195	
		Standard Error	0.028	0.019	
	Information Technology	Coefficient	-0.040	-0.030	-0.028
		t-value	-0.551	-0.617	
		p-value	0.584	0.539	
		Standard Error	0.072	0.048	
	Material	Coefficient	-0.047	-0.010	0.018
		t-value	-1.560	-0.497	
		p-value	0.124	0.621	
		Standard Error	0.030	0.020	
	Real Estate	Coefficient	-0.083	-0.035	0.120
		t-value	-3.155	-1.947	
		p-value	0.003	0.056	
		Standard Error	0.026	0.018	
Government Bonds	2-year maturity	Coefficient	1.992	0.167	0.910
1990.1-2010.4		t-value	28.846	2.615	
		p-value	0.000	0.011	
		Standard Error	0.069	0.064	
	5-year maturity	Coefficient	1.738	0.149	0.876
		t-value	24.144	2.233	
		p-value	0.000	0.028	
		Standard Error	0.072	0.067	

5.2.3 Expected Inflation Survey

The negative relationship between stock returns and expected inflation is supported by the tests including the Swedish survey of inflation expectations. The regression coefficients are negative and relatively low, just as the tests based on the Fisher hypothesis. But contrary, the estimates are also significant. Also, there is no observable difference between the sector indices and the market index. Overall, the results reject the hypothesis of stock being hedge against expected inflation.

The tests regarding government bonds proves that the relationship is positive. However, it is only the 2-year bond that has a one-to-one relationship with expected inflation since the 5-year bond only offer 0.6 protection if inflation increases with one percent. The R-squares are very low in comparison to the tests based on Fisher hypothesis.

Table 8: Hedge against expected inflation, Swedish survey

Asset	Description	Estimates	Expected Inflation (β_1)	R-squared
Stock indices	All	Coefficient	-0.090	0.179
1996.1-2010.4		t-value	-3.694	
		p-value	0.000	
	Banks	Coefficient	-0.095	0.147
		t-value	-3.266	
		p-value	0.002	
	Consumer Discretionary	Coefficient	0.195	0.140
		t-value	-3.252	
		p-value	0.002	
	Consumer Staples	Coefficient	-0.041	0.053
		t-value	-2.081	
		p-value	0.042	
	Diversified Financials	Coefficient	-0.076	0.088
		t-value	-2.588	
		p-value	0.012	
	Health Care	Coefficient	-0.057	0.077
		t-value	-2.438	
		p-value	0.018	
	Industrial	Coefficient	-0.085	0.161
		t-value	-3.515	
		p-value	0.001	
	Information Technology	Coefficient	-0.116	0.068
		t-value	-1.858	
		p-value	0.068	
	Material	Coefficient	-0.090	0.168
		t-value	-3.595	
		p-value	0.001	
	Real Estate	Coefficient	-0.058	0.074
		t-value	-2.387	
		p-value	0.020	
Government Bonds	2-year maturity	Coefficient	1.032	0.156
1996.1-2010.4		t-value	3.452	
		p-value	0.001	
	5-year maturity	Coefficient	0.611	0.054
		t-value	2.089	
		p-value	0.041	

6. Discussion

6.1 The Fishyer Hypothesis

The tests for Fisher effect proves that the hypothesis do not hold in Denmark, Finland and Sweden, where the real return are positive in the regression and the coefficients for interest rates are relatively small. The tests on monthly data deviates more than the tests on quarterly data for Denmark and Finland, while it is the reverse scenario for Sweden. However, the tests including NIBOR indicate that the Norwegian interbank rate predict future inflation to certain extend. This raises the question whether interbank rates are appropriate proxy for interest rates of treasury bills as short-term interest rates. The graph of STIBOR and Swedish treasury bills illustrates no significant deviation, and together with the tests for Norwegian data, this indicate that interbank rates may be suitable as short-term interest rate in Fama's method.

The peculiar results for Denmark, Finland and Sweden with large positive values in (11) raises the concern whether the real rate of return is negative in (8). This was however rejected by the graphs displaying real rate of interest which makes one wonder what other reasons it could be. The argument of Carlson (1977) may be relevant for the Nordic countries. He argues that the assumption of the real rate of interest being constant is not applicable. Consistent with Carlson (1977) the real interest rate falls during the recession of 2008 and 2009. However, during the recession in the 1990s the real interest rate were rising significantly. The extreme volatility in uncertain economic environment may support Carlson's argument. The author believes that the supply and demand of treasury bills can be affected by different types of stimuli, which may for instance decrease the nominal interest rates for a very short period, causing the real rate of interest to fall. The results for the relation between inflation and interest rate do also raise questions. The relatively low coefficients suggests that short-term interest rates are not able to predict future inflation. This is to some extend consistent with the reasoning of Carlson, who included an employment to population ration in (11) to illustrate that that short-term interest rates unable to predict subsequent inflation.

It is difficult to compare the results with previous research since they deviates significantly. There is no study with results that reminds of this thesis. These results are surprising since the data span is very long, just as the data of Fama (1975). There is no doubt that these results contradict previous research. Studies of Berument and Jelassi (2002), Evan and Lewis (1995),

Berument, Ceylan and Olgun (2007), Paul (1983), Wallace and Warner (1993), Yuhn (1994). Since the Fisher hypothesis do not hold at all in the Nordic countries, it may be reasonable to question whether the assumption of a constant real rate of return, and market efficiency are appropriate for the Nordic markets.

6.2 Stock return and Inflation

The relationship between stock returns and inflation proves to be negative for the Nordic markets, which reject the hypothesis that stocks are hedge against inflation. A few indices have positive correlation with inflation, but most of them also have very low estimates, and therefore could be considered independent of either expected or unexpected inflation. The two sector indices that distinguish themselves are Real Estate of Finland, and Healthcare of Norway. These indices are the only indices that have positive correlation with the same inflation component in the test for both monthly and quarterly data, which for the two happened to be unexpected inflation. But the estimates are also very low estimates which could make them be considered independent of inflation. Regarding market indices, there were no noticeable difference between them and sector indices. The tests based on the Swedish expected inflation survey is consistent with the regressions based on Fama's method, showing stocks to be negatively related to expected inflation. Since the last tests is based on actual inflation expectations, it should be considered more valid than the theoretical model of Fama. To summarize, the majority of the indices have a negative relation to inflation, but in many cases the estimates are so low that the indices can be considered independent of inflation. The rejection of stocks being a hedge against inflation is consistent with Nelson (1976), Fama and Schwert (1977), Chatrath et al (1996), and Durai and Bhaduri (2009).

Wei and Wong (1992) finds banks to be stronger reversely related to inflation than Industrial sectors such as mining, petroleum and railroads. The results in this thesis gives no indication to support these findings. Lajeri and Dermine (1999) finds that unexpected inflation has greater effect on banks than non-financial firms. Once again, the results of the thesis have no evidence of supporting those findings.

Fama and Schwert (1977) finds expected and unexpected inflation to be negatively related to stock returns for monthly, quarterly and semiannually data. The authors have no certain explanation why stock returns are negatively related to expected inflation, but suggest that markets may be inefficient in incorporating relevant information about future inflation into

stocks. Another explanation is that there might be an unidentified parameter which has an impact on the equilibrium real rate of return causing it to be negatively correlated to expected inflation. Furthermore, Fama and Schwert finds one-to-one relationship between treasury bill rates and inflation, while the correlation between stocks and inflation is negative. The authors are aware that this may raise concern that return on risky assets would be less than return on risk-free assets, which is inconsistent with theory of market efficiency. In their attempt to investigate the matter, the find indication of a negative relationship between expected return on stocks and interest rate of treasury bills.

Stocks negative relation to inflation was explained by Fama (1982), suggesting that the relationship is spurious which reflect the inverse correlation between inflation and real activity. Real activity is measured by growth rates of monetary base, industrial production and GNP. As mentioned in section 2.2, Fama includes real variables, the coefficient for expected and unexpected inflation in equation (11) to see the changes that occurs. The results illustrate that stocks are determined by forecast of real variables. The hypothesis of a proxy relationship between stocks and inflation is also noted by Benderly and Zwick (1985), Zhao (1998), and Andrangi and Chatrath (2002). On a little different path, Madsen (2005) find supply shocks are important determinants of stock returns relation to inflation. The author find it more difficult to reject the hypothesis of stocks being hedge against inflation when supply variables are accommodated in the models. The importance of accommodating supply variables stems from the fact that supply shocks has a simultaneously impact on inflation and profits. If supply variables are omitted from the equation, the coefficient of expected inflation will be biased downwards and render the hypothesis easier to reject. Consistent with Fama and Madsen, Khil and Lee (2000) find real and monetary shocks to interact with the relationship between stocks and inflation. Li et al (2010) proves that whether stocks are hedge against inflation do also depend on the holding period, and the types of inflationary regimes and inflationary economies.

There might be several reasons why the results illustrates a negative relation between stock returns and inflation. The data span for sector indices are not very long which imply that there is a higher probability of shocks of any kind to have significant influence on the relationship. The sample period cover the IT-bubble and the financial crisis. The later resulted in the most severe recession since the great depression in 1930s. Even though the Nordic countries have not experienced the crisis to same extend as other European countries, it had a significant

impact on the economies. For instance, there were real shocks in terms of immediate slowdown on production and investments. Another reason for the negative correlation may be that the regressions for stocks and inflation are spurious, due to the inverse relationship of inflation and real activity. Also, markets may simply be unable to incorporate relevant information about future inflation into stocks, although, the relationship being spurious is more likely. However, Lintner (1975) state that it is possible for stocks to be negatively correlated with expected inflation, which makes the results less surprising, even though it is contrary to ones intuition.

The tests for government bonds are consistent for both monthly and quarterly data. The bonds are complete hedge against expected inflation and partial hedge against unexpected inflation. It is only the finish government bond that is negatively related to the unexpected inflation. These results are to some extend consistent with Fama and Schwert, who's tests shows government bonds to be complete hedge against expected inflation but reversly correlated with unexpected inflation. The authors offers a possible explanation for the reverse relation, stating that current expected inflation may incorporate information about future expected inflation, having an impact on government bonds nominal returns. This may be manifested by an unexpected increase in expected inflation depressing current bond prices resulting in higher nominal returns in the future. The results for Denmark are similar to those of Engsted and Tanggaard, who finds Danish government bonds to be weakly correlated with inflation. Most research examining the relationship between government bonds and inflation, applies bonds that are inflation protected (Laatsch and Klein 2002, Reschreiter 2010, Barr and Campbell 1997). Previous research find a positive correlation between government index-linked bonds and inflation.

Why is government nominal bonds positively correlated with inflation while stocks are not? There may be several reasons. The link between bonds and inflation may not be spurious as Fama (1982) showed for stocks-inflation relationship, and government bonds may be less affected by real activity and shocks. Also, investors purchasing government bonds may be more cautions and concern about inflation thus causing the government bond market to adjust prices to anticipated price changes.

6.3 Strengths and Weaknesses

The strength of this thesis is the long span of data for testing the Fisher hypothesis which cover around 20 years for the four countries, similar to Fama (1975). However, the data span for testing the stocks relation to inflation is not as long as the test for Fisher hypothesis. Another strength is that same tests has been applied to more than one country which makes observed patterns more convincing than if the study only involved one country.

The old methodology of Fama may be considered as a limitation since there exist modern methods. To determine the existence of Fisher effect, one may think that a cointegration test is the appropriate method. The absence of unit root tests to determine stochastic trend in inflation and interest rates may be considered as a limitation. Fama applies serial correlation tests to determine if the proxies for expected and unexpected inflation has the required properties. This has not been conducted in this thesis. Another weakness may be the usage of interbank rates as substitute for treasury bill rates. However, there were no noticeable difference between interbank rates and treasury bill rates of Norway and Sweden, but that may not be the case for Denmark and Finland.

7. Conclusion

This study has proven that the Fisher hypothesis do not hold for the Nordic Countries. The rejection of the hypothesis is inconsistent with previous studies. Since the results differ substantially from previous research, it is difficult to make any comparison to draw concluding remarks. The unusual results may be an indication that the assumptions of Fama's method for the hypothesis are questionable. Future research on the Nordic countries may therefore be conducted with another method. Furthermore, this study shows a negative correlation between stock returns and inflation. The Finish Real Estate sector and the Norwegian Healthcare Sector have a positive correlation with unexpected inflation, but since the estimations are very low, the sectors may be considered to be independent of unexpected inflation. However, there is no sector than distinguish itself significantly, which indicate that the relation between stocks and inflation do not differ across sectors. Value-weighted portfolios and market indices are still appropriate measures for stock returns. The relation between government bonds and inflation is, in contrast to stocks, positive. Government bonds are complete hedge against expected inflation and partial hedge against unexpected inflation. Beside examining the Fisher hypothesis, and asset returns relation to inflation, this study provides indication that interbank rates are appropriate proxies as short-term interest rates when estimating the Fisher hypothesis.

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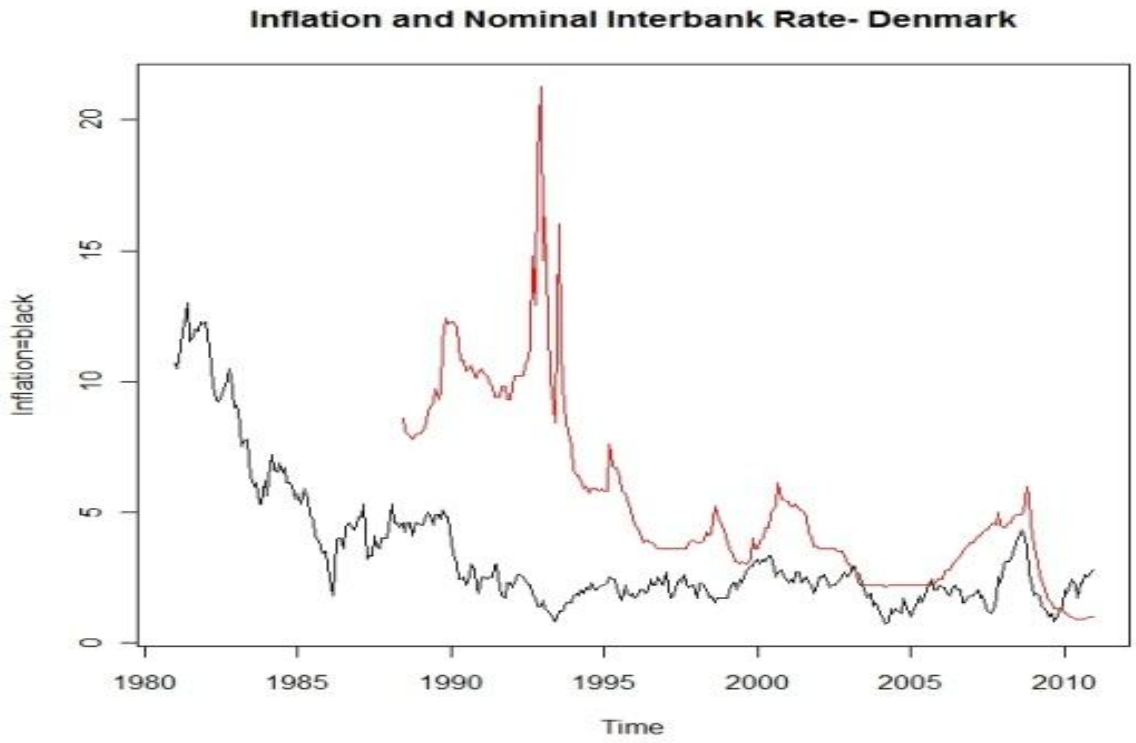
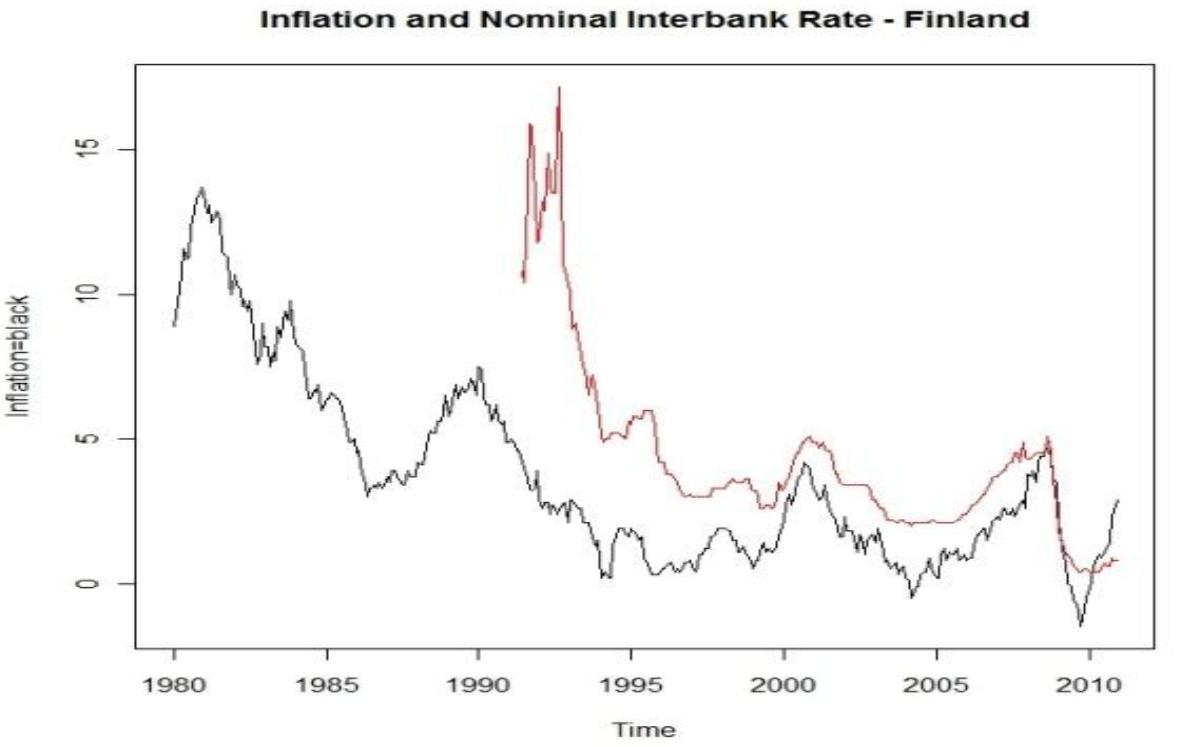
9. Appendix

Inflation and Nominal Interest Rates




Inflation and Nominal Interbank Rate - Finland
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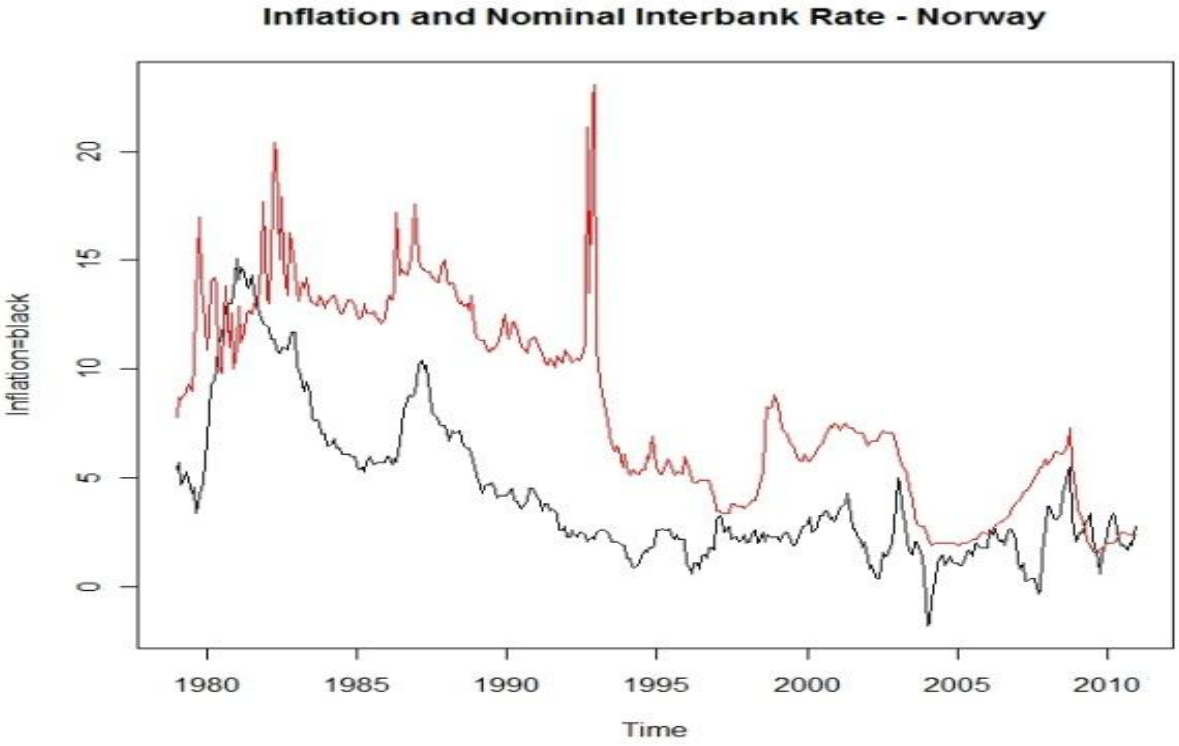
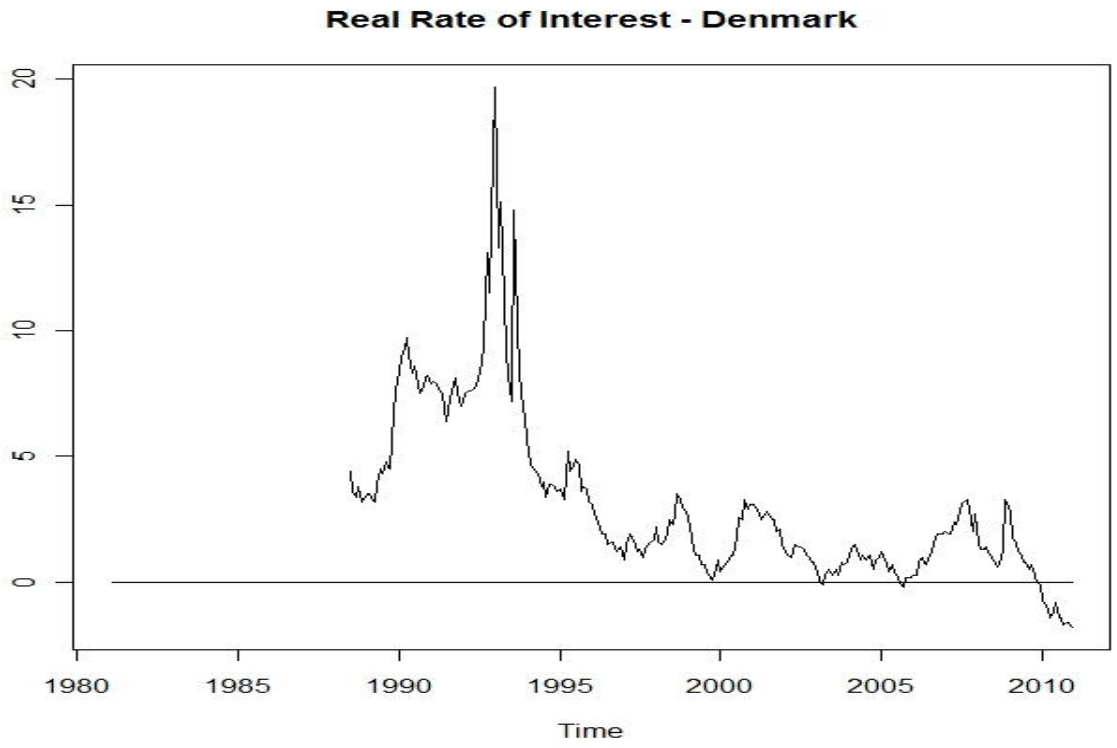
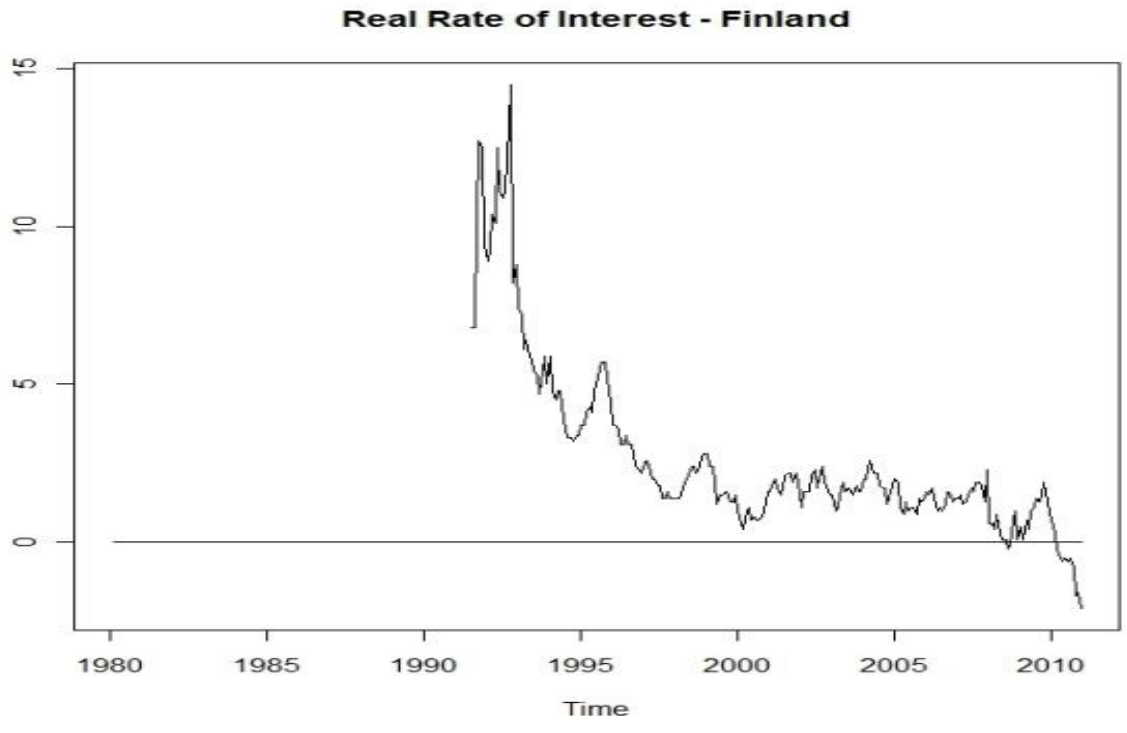
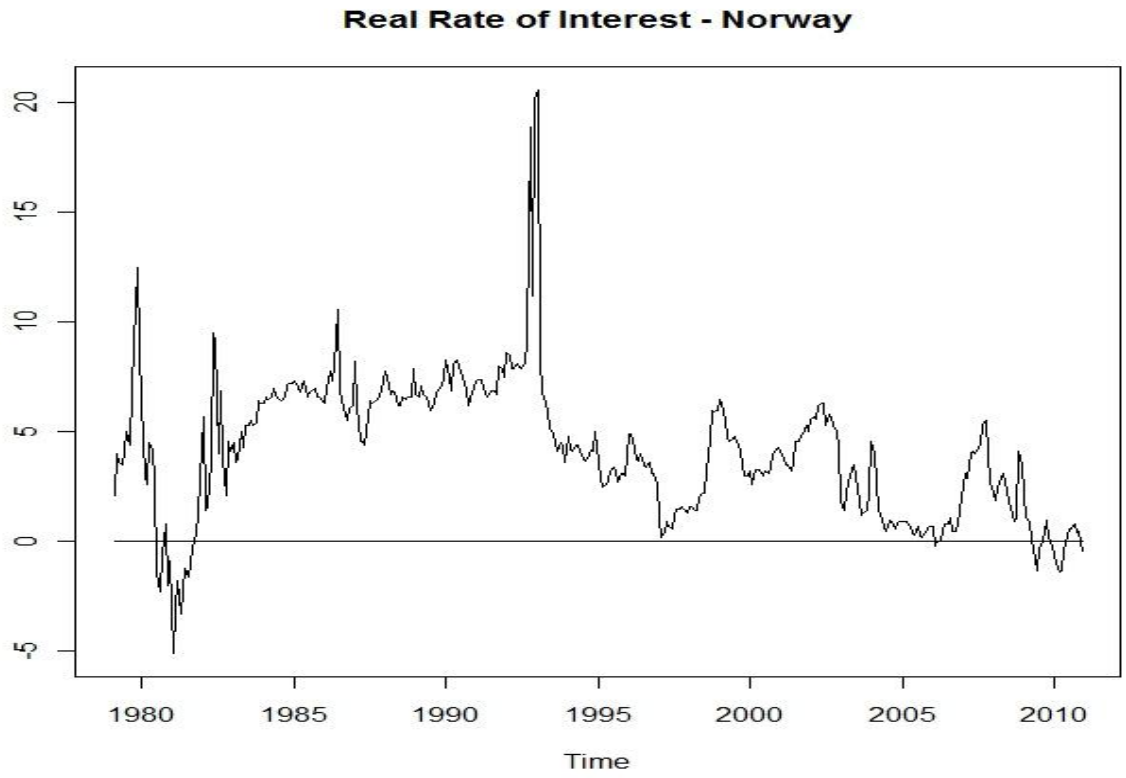
2010
Time


Inflation and Nominal Interbank Rate - Norway
Inflation=black
0
5
10
15
20
1980
1985
1990
1995
2000
2005
2010
Time

Real rate of Interest






Real Rate of Interest - Norway
20
15
10
5
0
-5
1980
1985
1990
1995
2000
2005
2010
Time