

BI Norwegian Business School
Master Thesis

Stock Returns and Inflation in Norway

Name of Supervisor:
Professor Kjell Jørgensen

Examination Code:
GRA1900 – Master Thesis

Date of Submission:
01.09.2016

Campus:
BI Oslo

Program:
Master of Science in Business
Major in Finance

“This thesis is a part of the MSc program at BI Norwegian Business School. The school takes no responsibility for the methods used, results found and conclusions drawn.”

Abstract

We study the nexus between equity returns and inflation on Norwegian data, and test the explanatory power of the two most prevailing theories; the inflation illusion and the FED model. In addition, we test if the inflation-target policy introduced in 2001 has had an impact on this relationship. We segregate the dividend yield into three components and these components are used as dependent variables in a regression analysis during three time-periods. We find that inflation has a significant, but unstable relationship with the different components and that a significant break in the model in 2001 exists. We conclude that it is premature to assume a causal link between both the equity return-inflation relationship and that the change in this relationship can be related to the inflation-target introduction.

Acknowledgements

We would like to express our gratitude to our supervisor professor Kjell Jørgensen. Through our meetings he was able to guide us in the right direction and pinpoint weaknesses with our thesis. We would also thank Bernt Ødegaard for exceptional help collecting data from Oslo Stock Exchange database, and friends and family for proofreading and support throughout the whole period.

Nicholas Oskarsson

Jan Magnus Skjeggstad

Table of Contents

Abstract	i
Acknowledgements	ii
Table of Contents	iii
List of Tables	iv
List of Graphs	iv
Abbreviations	iv
Introduction	1
Background and Literature	2
Theory	5
Hypotheses	7
Method	8
Data	12
Results	17
Discussion	23
Conclusion	25
Bibliography	26
Appendix	29
Campbell and Shiller (1988) dynamic dividend-price ratio model	29
Compiled list of all companies used in this study	31
Preliminary Thesis Report	37

List of Tables

Table 1	Descriptive statistics of explanatory variables
Table 2	Correlation matrix
Table 3	Augmented Dickey-Fuller tests
Table 4	Explaining stock yield with a subjective risk-premium measure and inflation
Table 5	Vector autoregression
Table 6	Dividend yield decomposition
Table 7	Regression of dividend yield's components on inflation
Table 8	Chow test

List of Graphs

Graph 1	Dividend yield, subjective risk-premium and inflation
Graph 2	Components of dividend yield

Abbreviations

etc.	And so forth
VAR	Vector autoregression
OBI	Oslo stock exchange information
OSE	Oslo stock exchange
NIBOR	Norwegian interbank offered rate
US	United States of America
REIT	Real estate investment trust
ISIN	International securities identification number
SSB	Statistics Norway
OLS	Ordinary least squares
AIC	Akaike Information Criterion
SC	Schwarz Criterion

Introduction

The subject of this master thesis is the empirical relationship between equity returns and inflation for the Norwegian stock market. In addition, we will investigate if the governmental implementation of an inflation target had an impact on the relationship studied. We will model the relationship by following the dividend yield decomposition of Campbell and Vuolteenaho (2004a) who built on the earlier work of Campbell and Shiller (1988), and test the relationship between our constructed components of the dividend yield on inflation. We will run the regressions on different time-periods and compare results. As earlier research has primarily focused on US data, it gives us an opportunity to contribute new information to the research community.

We will outline theories and research already conducted in the background and literature chapter. In the theory section we will elaborate upon the two most prevailing theories, the FED-model (Yardeni 1997) and the inflation illusion (Modigliani and Cohn 1979). Method and theoretical implementation will be explained in the method chapter, while we discuss collection and derivation of data in the data section. Results will be presented and interpreted in the results chapter, while limitations and implications for our research will be explored in the discussion section. Finally, we draw conclusions from our findings.

Background and Literature

According to the Fisher hypothesis, monetary effects, nominal rates and inflation should have no effect on the real economy as nominal rates will move one-for-one with the expected inflation (Fisher 1986). This has led to equity investments being seen as a good hedge against inflation as the real returns should not be affected by it (Lee 2010). However, empirical research has often yielded results which conflict with this postulation. For example, Campbell and Vuolteenaho (2004a) found a negative relationship between stock returns and inflation, while Bekaert and Engström (2010) observed a high positive correlation between the movements of nominal bond yields and equity yields. This is hard to reconcile since expected inflation is a main driver behind the nominal bond yield and thus should not have a large effect on any of the real components of the equity yield (Fisher 1986).

Many theories have been posited to explain this discrepancy. Modigliani and Cohn (1979) propose the inflation illusion hypothesis; where the negative relationship between equity return and inflation is described as an error committed by investors when valuating common stocks. The investors fail to consider inflation when discounting future capital gains and discount equity earnings at a nominal interest rate rather than the correct real rate. In addition, Modigliani and Cohn (1979) discuss an investor's ability to consider the inflation's depreciation effect on the real value of nominal corporate liabilities. They find consistent evidence of a negative stock return-inflation relationship throughout their whole sample period.

Feldstein (1980) conveys the idea of a tax hypothesis; he states that in an environment of constant inflation, share price and pre-tax earnings move one-to-one. When inflation rises the share price will drop to a level consistent with the new rate of inflation and settle on an increased growth rate. This causes the share price-pre-tax earnings ratio to drop and then again move one-to-one consistent with the new level of inflation. Investors will then experience a reduced real net yield per unit of capital, due to a higher effective rate of tax on corporate income caused by inflation's effect on both historic cost depreciation and artificial capital gains.

Fama (1983, 1981) found evidence that the negative relationship between real stock return and inflation observed during the post-1953 period can be explained

with the positive relationship between real stock return and real activity (here defined as capital expenditures, the average rate of return on capital and output) and by the negative relationship between inflation and real activity. This leads to a spurious negative relationship between stock return and inflation, as noted by both Fama (1981) and Lee (2010). Fama (1981) proposes the proxy hypothesis which states that stock returns are determined by more relevant real variables and the negative stock return-inflation relationship is a result of the negative relationship between inflation and real activity.

Geske and Roll (1983) presented evidence that stock returns are negatively related to simultaneous changes in expected inflation because they signal a chain of events which results in a higher rate of monetary expansion. Random real shocks affect stock returns and in turn signal changes in corporate performance and unemployment rates. Therefore, shocks will lead to changes in tax revenue for the government. As government expenditures do not change with the change in income, it increases/decreases its public borrowing. This is in turn paid for by changing the growth rate of base money. A change in the growth rate of base money results in a change in inflation. Rational investors realize that a random shock will trigger this chain of events and alter the price of short-term securities.

Hess and Lee (1999) form a hypothesis that states that the relationship between stock returns and unexpected inflation can be either positive or negative, depending on the source of inflation in the economy. If there is a supply shock, there is a negative stock return inflation relationship, while a positive relationship is due to a demand shock. Consistent with the predictions of their model, they find evidence for positive stock return-inflation relationship in pre-war period (demand shock) and a negative relationship in the post-war period (supply shock).

Brandt and Wang (2003) propose a hypothesis that aggregated risk aversion varies in response to news about inflation and present empirical results that support this theory. They explain their results through agents with heterogeneous preferences, where less risk-averse agents mostly invest in nominal assets and highly risk-averse agents invest in real assets. An inflation-shock will have a larger negative effect for the less risk-averse agents' investments and, since aggregate risk-aversion depends on the cross-sectional distribution of real wealth, lead to an increase in aggregated risk-aversion.

Bekaert and Engström (2010) explain the FED model first outlined by Yardeni (1997). The theory is based on the idea that stocks and bonds compete for the same investors. Assuming investors are rational and utility maximizing, one would expect the return to risk ratio to be equal or at least highly correlated, since if one the assets suddenly has an increase in return, investors will flock to that and the other asset will have to adjust its return. Since inflation has a major impact on government bonds, the model suggests an indirect inflation-stock return relationship. They find that economies with high rate of stagflation, economic uncertainty and rising risk aversion have higher risk premiums which in turn increases yields on stocks.

Most of the seminal papers mentioned above are focused on US market data, in addition to more shallow analyses of international markets, for example Lee (2010). This existing data provides an international source of comparison for our results and context for prevailing theories. The conclusion of our paper could be of potential importance for the Norwegian government, as the relationship we study can have implications for their policy. For example, if the inflation illusion affects pricing in the stock market, policies for stabilizing inflation can help to prevent distortion and mispricing in the stock market. If there is no such effect, inflation policy has no impact on the equity market apart for its influence on real economic growth. In addition, if behavioral biases induced by inflation cause misvaluation in the equity market, the potential exists for informed practitioners to devise trading strategies to take advantage of this mispricing (Bekaert and Engström 2010). Moreover, as there are no published articles on this subject concerning Norwegian data, there exists an opportunity to contribute new information to the research community and expand knowledge on developed economies.

Theory

The two most prevailing theories explaining the inflation-stock return relationship are the inflation illusion by Modigliani and Cohn (1979), and the FED model explained by Bekaert and Engström (2010), Asness (2003) and Thomas and Zhang (2008).

The inflation illusion hypothesis has recently gained renewed interest (Lee 2010). This theory explains the nexus between inflation and equity yield as a mispricing error by investors. The hypothesis states that in inflationary periods, investors discount equity earnings with nominal interest rates instead of the real rate, meaning that the investors fail to consider inflation in their discount rate calculations and thus calculate erroneous equity prices. In addition, investors fail to correct reported accounting profits for the gain accrued for the stockholders as a result of the real depreciation in nominal corporate liabilities. This leads investors to overvalue the corporate performance, giving them a wrong impression of the firms results (Modigliani and Cohn 1979).

Assuming that the inflation illusion hypothesis holds; one would expect to observe a negative relationship between equity return and inflation, as when inflation rises, investors would tend to discount future earnings with a too high nominal rate, yielding low prices. This is in line with empirical evidence from Campbell and Vuolteenaho (2004a), Chordia and Shivakumar (2005), Acker and Duck (2013) and Hardin, Jiang and Wu (2012).

Campbell and Vuolteenaho (2004a) isolate a mispricing component as the difference between objective and subjective expected dividend growth. Their results provide strong support for the inflation illusion with statistically and economically significant results for a positive relationship between their mispricing component and inflation. Chordia and Shivakumar (2005) divide firms into 10 portfolios depending on their earnings growth. It is likely that firms with high earnings sensitivity to inflation are more suitable to have larger increases in earnings growth and the opposite for firms with low earnings sensitivity to inflation. Investors who fail to consider inflation when predicting future earnings growth could explain part of the earnings drift. They find evidence that firms with positive earnings sensitivities to inflation to be undervalued, and stocks with

negative earnings sensitivities to inflation to be overvalued – in line with the inflation illusion hypothesis.

Acker and Duck (2013) build on and defend the Campbell and Vuolteenaho (2004a) procedure. They find that the VAR and the forecast are only stable in a sub-period of the years analyzed, but find strong support for the inflation illusion hypothesis in these sub-periods. The critique from Long and Xinlei (2009) concerning the Campbell and Vuolteenaho (2004a) article, argues that the VAR model used is highly sensitive to misspecification, and the mispricing term that is backed out will include noise from the misspecified variables. Acker and Duck (2013) examined this critique by splitting up the estimated variables in the regression to see if noise carried through the VAR skew the results. They found a gap in the estimated variables, but that they correlated strongly and conclude that the critique is of little importance. Hardin, Jiang and Wu (2012) study the relationship between REIT dividend yield and expected inflation by decomposing the REIT dividend yield into three components, a long-run dividend growth rate, an equity risk premium and a mispricing term. Each variable is examined relative to expected inflation. It is found that changes in inflation explain a large share of the time-series variation of the mispricing term, and that the dividend yield is positively related to expected inflation in most cases.

The FED model explain the inflation-stock return relationship through the relationship between stocks and bonds. The idea is that investors can choose between investing in stocks or government bonds, thus creating a market where assets compete for investors who choose the asset yielding highest return to risk ratio. If either stocks or bonds increase their return, investors will flock to that asset and the other asset will follow, giving bonds and stocks a tight positive, if not perfect, relationship. As expected inflation has a major influence on government bonds, one would presume expected inflation and stock return to also be strongly correlated (Bekaert and Engström 2010). Given that the FED model holds, one could expect a positive relationship between inflation and stock returns. Empirical evidence for the theory has been presented by both Bekaert and Engström (2010) and Thomas and Zhang (2008).

Bekaert and Engström (2010) constructed a VAR containing 9 variables including equity risk premium, inflation risk premium and expected inflation. They find that

in an economy with frequent incidences of stagflation, one may observe higher risk aversion and economic uncertainty, which in turn increase equity risk premiums. If expected inflation also happens to be high, bond yields increase through expected inflation and the inflation risk premium components, and positive correlations emerge between equity, bond yields and inflation. In fact, they find the correlation between equity yield and a 10-year nominal bond to be 0.77 in the period from 1965 to 2010.

Thomas and Zhang (2008) model two environments; one with and one without inflation. They find that earnings yields are higher in the inflation scenario for different accounting income, since income rise with inflation while the linked historical costs remain the same. This leads to a strong positive correlation between equity yield and bond yield through the inflation component, and they conclude that one should embrace the FED model because it yields important insights about stock market valuation.

Hypotheses

As the mentioned empirical results show, there seems to be a link between inflation and the real economy, which contradicts the hypothesis of Fisher (1986). Though the results differ, we expect to find a relationship between Norwegian inflation and stock returns at Oslo Stock Exchange, in either direction. In addition, as Bank of Norway imposed an inflation target of 2.5% in 2001 to prevent unsound investment decisions and large fluctuations in the economy (Gjedrem 2002), we would like to investigate if this inflation stabilization policy has prevented distortion and mispricing in the Norwegian stock market. Following from the inflation illusion hypothesis, investors misinterpret inflation when calculating real rates, and an inflation target could potentially guide investors to make more precise valuations (Bekaert and Engström 2010). On the basis of this, we form the following three hypotheses:

1. Inflation has a positive effect on the Norwegian equity return.
2. Inflation has a negative effect on the Norwegian equity return.
3. The inflation target has reduced distortion and mispricing in the Oslo stock exchange.

Method

For the purpose of this thesis, we will mainly follow a method established by Campbell and Shiller (1988) and further developed by Campbell and Vuolteenaho (2004a) and Lee (2010). Their model builds on Gordon's growth model as shown in equation 1, where D_t is the dividend at time t , P_{t-1} is the price of the security the previous period, R is the discount rate and G is the growth rate.

$$\frac{D_t}{P_{t-1}} = R - G \quad (1)$$

The model is a first-order vector autoregression model based on a dynamic version of Gordon's growth model, allowing for time-varying discount- and growth rates. To test the relationship between inflation and equity yield, we will include the dividend yield (dy_t), a value weighted index from DataStream as a market return proxy (r_m), a proxy for the subjective market risk premium (λ^{SRC}) of Polk, Thompson and Vuolteenaho (2006) and the exponentially smoothed moving average of inflation as a proxy for expected inflation (π_t), as used by Campbell and Vuolteenaho (2004a) and Lee (2010). The calculation of the risk premium proxy is further explained in the data section.

We will first set up a regression of the demeaned dividend yield (dy_t) on the subjective risk premium measure (λ_t^{SRC}) and the expected inflation proxy (π_t), to see how much of the dividend yields movement can be explained by these variables.

$$dy_t = c + \lambda_t^{SRC} + \pi_t \quad (2)$$

Considering the classic Gordon growth model, we follow Campbell and Vuolteenaho (2004a) and subtract the risk-free rate (R_f) from the discount rate and the dividend growth rate to get:

$$R^e = R - R_f \quad (3)$$

$$G^e = G - R_f \quad (4)$$

When considering that some investors may be irrational and assuming that they use the present value formula calculated with an erroneous growth rate, the Gordon growth model is rewritten as:

$$\frac{D}{P} = R^{e,OBJ} - G^{e,OBJ} = R^{e,SUBJ} - G^{e,SUBJ} \quad (5)$$

$$\frac{D}{P} = -G^{e,OBJ} + R^{e,SUBJ} + (G^{e,OBJ} - G^{e,SUBJ}) \quad (6)$$

As we can see, the dividend yield is decomposed into three components; the negative of the objective excess dividend growth ($-G^{e,OBJ}$), the subjective risk premium ($R^{e,SUBJ}$) and a mispricing component ($G^{e,OBJ} - G^{e,SUBJ}$). This is then related to the dynamic dividend-price ratio model from Campbell and Shiller (1988). The derivation of their model can be seen in the appendix.

$$d_{t-1} - p_{t-1} \approx \frac{k}{\rho - 1} + \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e - \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} \Delta d_{t+j}^e \quad (7)$$

where $d_{t-1} - p_{t-1}$ is the log dividend-price ratio, r_{t+j}^e is the excessive log stock return and Δd_{t+j}^e is the excessive log dividend growth. ρ and k are linearization constants that are defined as:

$$\rho \equiv \frac{1}{1 + \exp(\bar{d} - \bar{p})} \quad (8)$$

$$k \equiv -\log \rho - (1 - \rho) \log\left(\frac{1}{\rho} - 1\right) \quad (9)$$

In accordance with Engsted, Pedersen and Tanggaard (2012), Lee (2010) and Campbell and Vuolteenaho (2004a), we use an approximation where $\rho = 0.97$. When this is compared to the rewritten Gordon growth model, Campbell and Vuolteenaho (2004a) note that $\sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e$ is analogous to $R^{e,OBJ}$ or $R^{e,SUBJ}$, and $\sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} \Delta d_{t+j}^e$ is analogous to $G^{e,OBJ}$ or $G^{e,SUBJ}$ depending on whether the expectations are objective or subjective. The model implies that if inflation does not affect either $E_t r_{t+j}^e$ or $E_t \Delta d_{t+j}^e$, it should not affect equity return. According to the Fischer hypothesis (Fisher 1986), expected inflation should raise both nominal discount rate and nominal growth rate and leave the dividend yield unaffected.

We set up an unrestricted VAR that includes the log demeaned elevated excess market return, the demeaned elevated subjective risk premium proxy, the log demeaned elevated excess dividend yield and the demeaned elevated expected inflation proxy. Let Z_t be a vector consisting of r^e , d^e , λ_t^{SRC} and π_t that describes the state variable of the economy at time t . We assume that Z_t follows a first-order VAR model:

$$Z_t = A_0 + AZ_{t-1} + e_t \quad (10)$$

where A_0 and A are a vector and a matrix of constant parameters, and e_t a vector of residuals.

$$\begin{bmatrix} r_t^e \\ \lambda_t^{SRC} \\ dy_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} c_{1,0} \\ c_{2,0} \\ c_{3,0} \\ c_{4,0} \end{bmatrix} + \begin{bmatrix} c_{1,1} & c_{1,2} & c_{1,3} & c_{1,4} \\ c_{2,1} & c_{2,2} & c_{2,3} & c_{2,4} \\ c_{3,1} & c_{3,2} & c_{3,3} & c_{3,4} \\ c_{4,1} & c_{4,2} & c_{4,3} & c_{4,4} \end{bmatrix} \times \begin{bmatrix} r_{t-1}^e \\ \lambda_{t-1}^{SRC} \\ dy_{t-1} \\ \pi_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \\ e_{3,t} \\ e_{4,t} \end{bmatrix} \quad (11)$$

Under objective expectations, this setup allowed us to solve for fitted values and back out of the VAR the objective excess market return ($\sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e$). From this we can infer the objective expected excess dividend growth through rearranging the dynamic Gordon growth model:

$$\sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} \Delta d_{t+j}^e \approx \frac{k}{\rho - 1} + \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e - (d_{t-1} - p_{t-1}) \quad (12)$$

This is implemented through defining $e1'$ as the vector $[1, 0, 0, 0]$ that picks the first component of the state vector, where I is the identity matrix. From that we can extract the objective excess market return from the VAR through:

$$\sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e = \rho e1' A (I - \rho A)^{-1} Z_{t-1} \quad (13)$$

We then define the vector $e3' = [0, 0, 1, 0]$ to get:

$$\begin{aligned} \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} \Delta d_{t+j}^e &= \frac{k}{\rho - 1} + \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e - (d_{t-1} - p_{t-1}) \\ &= \frac{k}{\rho - 1} + \rho e1' A (I - \rho A)^{-1} Z_{t-1} - e3' Z_{t-1} \end{aligned} \quad (14)$$

This method assumes that rational investors will value stocks in accordance with the dynamic log-dividend price ratio model. To find the subjective risk premium we ran a simple regression of the objective excess market return on the subjective risk premium proxy developed earlier.

$$\sum_{j=0}^{\infty} \rho^j E_{t-1}^{OBJ} r_{t+j}^e = c + \gamma \lambda_t + \varepsilon_t \quad (15)$$

The subjective risk premium is the fitted value of the subjective risk premium proxy in this regression. The mispricing component is the difference between the subjective and objective excess market return, here recognized as the residual of the regression. In periods when stocks are subjectively perceived to be very risky, the fitted value will be high. In periods when stocks are underpriced the mispricing component (the residual) will be high.

Finally, we ran a regression of the dividend yield and the three components of the dividend yield (the negative of the objective excess dividend growth, the subjective risk premium and the mispricing component) on the expected inflation proxy. We also ran the regression with the objective risk premium on inflation, which are the combined subjective risk premium and the mispricing component. The regression is defined as: $X_t = \alpha + \beta \pi_t + \mu_t$ where X_t is defined as: $-\sum E \Delta d^e$, $\gamma \lambda^{SRC}$, ε_t or $\gamma \lambda^{SRC} + \varepsilon_t$ respectively. We divided the period into two subperiods, pre-inflation target (1982-2000) and post-inflation target (2001-2011), and ran the regressions on the two subperiods and the period as a whole. This so we could capture any effects the inflation-target has had on any of the components of the dividend yield.

Data

We have used three databases when collecting data for our research. Data regarding firm-specific accounting items, equity returns and the risk free rate were collected from the Oslo Stock Exchange database (OBI 2016). OBI is a comprehensive source of data for the Norwegian stock market from 1980 to 2015, and when comparing its selection of Norwegian firm-level data with other databases such as DataStream it stands out as a clear choice, especially for older firms. When collecting data on inflation we extracted the monthly consumer price index from Statistics Norway (Statistics-Norway 2016). Last, we extracted a monthly series of a constructed market index from Thomson Reuters DataStream (Thomson-Reuters 2016), along with the monthly aggregated dividend yield for this index.

We collected the time-series for both the dividend yield and market index price from 1980 to 2015. The market return is calculated as the change in our index price: $(P_t - P_{t-1})/P_{t-1}$. We used the TOTMKNW index from DataStream which is a value weighted index, in line with both Lee (2010) and Campbell and Vuolteenaho (2004a). Its price is calculated from a representative list of stocks weighted by their share market value. The list of shares covers a minimum of 75-80% of total market capitalization. The aggregated dividend yield is calculated as the total dividend amount expressed as a percentage of the market value for the constituents. This provides an average of the individual yields of the constituents weighted by market value.

The risk-free rate is from 1986 estimated using both monthly and annual NIBOR rates. However, for the period before 1986 monthly NIBOR data is not available and the risk free rate is estimated by imperfect proxies for this period. Between 1982-1986 Ødegaard used the overnight NIBOR rate and before 1982 he used the shortest possible bond yield for treasuries from Eitrheim, Klovland and Qvigstad (2004) as estimates for the risk free rate (Ødegaard 2016).

The monthly equity returns are monthly discrete returns calculated as raw returns $(P_t - P_{t-1})/P_{t-1}$, adjusted for dividends and other corporate events such as stock splits etc. The returns are generated using the following algorithm when calculating the price; if close price is available, use that. Otherwise, if both bid and ask is available, use the average. If only bid or ask is available, use that (Ødegaard 2016).

When collecting equity returns and accounting items, we extracted a collection of all historical listings on the Oslo Stock Exchange from OBI. The sample originally consisted of 2736 listings and contained equity returns, ISIN identification number and a unique database identification. We then removed warrants, convertibles, funds, commodities and listings with less than 12 observations¹ and were left with 786 firms. Thereafter, we constructed a list of the remaining firms and extracted the following accounting items from OBI; dividend-price ratio, earnings-price ratio, price-book equity ratio, market value, share price, shares outstanding and cash flow. After structuring the data, we removed both accounting items and equity returns of firms which lacked either. The sample which was used for further calculations contained 716 firms. A compiled list of firms can be found in the appendix.

Monthly inflation is calculated as the change, $(P_t - P_{t-1})/P_{t-1}$, of the consumer price index. The consumer price index was extracted from SSB table 03013 and is a time-series containing information about the total consumer price, not adjusted to sector or season. This will give the best depiction, as our dataset contain information for all sectors. We also calculated the monthly exponentially smoothed moving average of the last 6 observations to serve as a proxy for expected inflation in accordance with Acker and Duck (2013).

When developing a proxy for the subjective risk premium, we followed Polk, Thompson and Vuolteenaho (2006) and used their subjective risk premium measure, the Spearman rank correlation coefficient. From our extracted accounting data of all firms on Oslo Stock Exchange we composed four accounting ratios: dividend to price, book equity to market equity, earnings to price and cash flow to price. These were computed on a yearly basis for all

¹ Following from Polk, Thompson and Vuolteenaho (2006), beta calculations demand at least 12 observations.

individual firms and spread as equal numbers each month for the given year. To transform each ratio into a relative percentile rank, we divided each ratio with the number of firms with available data for that ratio each month. To get a single measure for each firm, we took the average of the available percentile ranks for the individual firms each year. We then re-ranked this average across all firms as a percentile of the total spread, so each firm was assigned a value between zero and one, with zero corresponding to the lowest valuation ranking and one corresponding to the highest. This resulted in an expected return measure, $VALRANK_{i,t}$. High values of $VALRANK_{i,t}$ corresponds to low prices and, according to the logic of Graham and Dodd (1934) and the empirical findings of Basu (1983, 1977), Fama and French (1992) and Lakonishok, Shleifer and Vishny (1994) also to high expected subsequent returns.

We then calculated betas for the individual stocks using at least 12 and up to 36 months of monthly returns in an OLS regression on a constant and the excess return on our index. To limit the influence of extreme outliers, we censored each firm's individual monthly return to the range (-50%, 100%) as outliers can potentially bias the estimates (Martin and Simin 2003). Betas were updated monthly. To find our proxy for the subjective risk premium, each month we calculated the correlation between the betas and the valuation ranking of the firms. This gave us a series for the whole period for the markets cross-sectional beta premium. Polk, Thompson and Vuolteenaho (2006) mention several advantages for this proxy. First, our averaging of the ranks deals with missing data in the valuation multiples. Second, ranking of the variables eliminate any hardwired link between the level of the market's valuation and the magnitude of the cross-sectional spread in valuation levels. And last, the ranking procedure is also robust to outliers in firm-specific data.

Table 1 shows an overview of descriptive statistics for the explanatory variables to be used in the VAR. We immediately note that the cross-sectional price of risk on average holds a negative value, which implies that the relationship between $VALRANK_{i,t}$ and $\beta_{i,t}$ evolves in a negative fashion. Notably, this means that a higher level of systematic risk yields a lower level of expected return – contradicting the capital asset pricing model.

Table 1 – Descriptive statistics of explanatory variables

This table shows descriptive statistics for the different variables before they are demeaned and dy_t and r_t^e are calculated to logarithmic values. The variables are monthly dividend yield, monthly excess index return, monthly 6-months exponentially smoothed moving average inflation and the monthly Spearman rank correlation coefficient. Calculations and information can be found in the data section. Sample period is 1982:01-2011:12 with monthly observations.

	Obs.	Mean	Median	Max	Min	Stdev
dy_t	370	0.026	0.024	0.063	0.011	0.009
r_t^e	370	0.012	0.016	0.226	-0.268	0.072
π_t	370	0.003	0.002	0.015	-0.004	0.003
λ_t^{SRC}	370	-0.072	-0.079	0.214	-0.460	0.133

Table 2 shows us the correlation matrix of the explanatory variables used in the VAR. We observe a positive correlation of 0.242 between the dividend yield and the expected inflation proxy, giving evidence in line with Bekaert and Engström (2010) which finds a high correlation between dividend yield and nominal bond yield. We also see a negative correlation between market return and dividend yield. This is as expected, as the increased share price will drive the dividend yield downwards. In addition, we note that there is a positive correlation between expected inflation and the subjective risk-premium proxy. This indicates that periods with higher subjective risk-premium seem to coincide with periods of higher expected inflation. Finally, we observe that expected inflation has a notable correlation with all the other variables, contradicting Fisher (1986).

Table 2 – Correlation matrix

This table shows the correlation matrix for the different variables before they are demeaned and dy_t and r_t^e are calculated to logarithmic values. The variables are monthly dividend yield, monthly excess index return, monthly 6-months exponentially smoothed moving average inflation and the monthly Spearman rank correlation coefficient. Calculations and information can be found in the data section. Sample period is 1982:01-2011:12 with monthly observations.

	dy_t	r_t^e	π_t	λ_t^{SRC}
dy_t	1.000			
r_t^e	-0.185	1.000		
π_t	0.242	-0.047	1.000	
λ_t^{SRC}	0.173	0.004	0.152	1.000

To test for stationarity, we conducted an augmented Dickey-Fuller test. The results are presented in table 3. The test shows that dividend yield, excess index return, exponentially smoothed moving average inflation and our cross-sectional price of risk all have a significant t-stat at 1% level. This means we can reject the null hypothesis of unit roots, and conclude that the variables are stationary.

Table 3 – Augmented Dickey-Fuller tests

This table shows the results of the augmented Dickey-Fuller tests to investigate if the dependent variables can be characterized with a trend. The test is conducted on monthly dividend yield, monthly excess index return, monthly 6-months exponentially smoothed moving average inflation and the monthly Spearman rank correlation coefficient. Calculations and information can be found in the data section. The test is done on full samples, 1980:01-2015:12. We use the least-squares method, while lag selection is based on SIC and are respectively 1, 0, 13, 0.

	t-statistic	Critical values 1%
dy_t	-3.491	-3.445
r_t^e	-18.531	-3.445
π_t	-3.964	-3.446
λ_t^{SRC}	-3.680	-3.448

Following from Campbell and Vuolteenaho (2004b), we want our variables to have an expected value of 0 and therefore demean all four variables. In addition, we will in our VAR and dividend yield components regressions use the logarithmic values of dividend yield and excess index return. As the variables fluctuate around 0, we elevate the variables so that the lowest value of all four variables takes the value of 1. This allows us to operate with logarithmic values.

Due to lack of firm-specific accounting data from 2012:01 and onwards, in addition to data instability before 1982:01, we will limit our sample to the range 1982:01 to 2011:12 in the VAR estimates and all subsequent regressions.

Results

In our initial test we ran a simple regression on the dividend yield with the cross-sectional beta premium and expected inflation as explanatory variables. The regression shows that both variables are significant at the 1% level, though the R^2 is very low and only explains 7.1% of the variation of the dividend yield.

Table 4 – Explaining stock yield with a subjective risk-premium measure and inflation

This table reports the estimation result of our stock yield measure on our subjective risk-premium measure and a nominal yield measure. The dependent variable is the monthly dividend yield, while the explanatory variables are the monthly Spearman rank correlation coefficient and the monthly 6-months exponentially smoothed moving average inflation. The sample period is 1982:01-2011:12 and contain monthly observations. The fitted values are reported over standard errors in (.) and t-statistics in [.]. The R^2 is adjusted for the degrees of freedom.

	c	λ^{SRC}	π_t	R^2
dy_t	0.024 (0.001) [30.270]	0.010 (0.004) [2.847]	0.825 (0.193) [4.272]	0.071

Campbell and Vuolteenaho (2004a), Bekaert and Engström (2010) and Lee (2010) all used a one lag VAR model. We ran a lag selection test and got confirmed that one lag indeed was appropriate for our VAR, as both AIC and SC suggests a 1 lag model. Table 5 reports the results for A_0 and A in the first order VAR model for the whole period, January 1982 to December 2011. We can see that the results from the VAR are quite robust with high R^2 for three of the four variables, which closely follow the results from Lee (2010) when using the same cross-sectional beta risk premium and the expected inflation proxy.

Table 5 – Vector autoregression

This table reports the OLS parameter estimates of the first-order VAR model $Z_t = A_0 + AZ_{t-1} + e_t$, where Z_t is a vector consisting of r_t^e , λ_t^{SRC} , dy_t and π_t . The dependent variables included in the VAR are the demeaned log excess index return, demeaned subjective risk-premium, demeaned log dividend yield and the demeaned 6-months exponentially smoothed moving average inflation. Sample period for the dependent variables are 1982:01-2011:12 and contain monthly observations. The fitted values are reported over standard errors in (.) and t -statistics in [.]. The R^2 is adjusted for the degrees of freedom.

	c	r_{t-1}^e	λ_{t-1}^{SRC}	dy_{t-1}	π_{t-1}	R^2
r_t^e	1.585 (1.549) [1.023]	0.152 (0.053) [2.857]	0.002 (0.021) [0.752]	0.752 (0.433) [1.737]	-1.121 (1.136) [-0.986]	0.017
λ_t^{SRC}	-0.727 (1.489) [-0.488]	-0.026 (0.051) [-0.499]	0.924 (0.020) [45.748]	0.003 (0.416) [0.003]	0.605 (1.092) [0.554]	0.858
dy_t	-0.069 (0.068) [-1.007]	-0.006 (0.002) [-2.467]	0.001 (0.001) [0.926]	0.931 (0.019) [48.905]	0.066 (0.050) [1.326]	0.886
π_t	0.220 (0.039) [5.582]	0.004 (0.001) [3.111]	0.000 (0.001) [0.446]	0.016 (0.011) [1.448]	0.837 (0.029) [28.988]	0.720

Our regression of the dividend yield on its three components, the negative of the objective excess dividend growth, the subjective risk premium and a mispricing component shows that all three variables are highly significant and the results are quite robust with a high R^2 . This shows that our theoretical deconstruction of the dividend yield into three components has high explanatory power for the actual data we have extracted. We can see that the subjective risk premium component has the largest effect on the dividend yield.

Table 6 – Dividend yield decomposition

This table shows the OLS parameter estimates on the three decomposed elements of the demeaned log dividend yield, following from the method section. The three components are the negative of the long-run expected dividend growth, the subjective risk-premium and a mispricing component. The derivation of all components can be seen in the method section. The sample period is 1982:01-2011:12 and contain monthly observations. The fitted values are reported over standard errors in (.) and t -statistics in [.]. The R^2 is adjusted for the degrees of freedom.

	$-\sum E \Delta d^e$	$+\gamma \lambda^{SRC}$	$+\varepsilon_t$	R^2
dy_t	0.962 (0.019) [50.063]	1.157 (0.179) [6.473]	0.0922 (0.020) [46.214]	0.886

In table 7 we show the results of the regression of the dividend yield and its three components on inflation in our three time periods. The regression is $X_t = \alpha + \beta\pi_t + \mu_t$ where X_t is $-\sum E \Delta d^e$, $\gamma\lambda^{SRC}$, ε_t and $\gamma\lambda^{SRC} + \varepsilon_t$ respectively. This yields several interesting results.

First, the dividend yield and inflation are positively related and significant for the whole period. However, the relationship is significantly positive pre-inflation target, but insignificantly negative in the last period. This indicates that the relationship has changed or disappeared after the Bank of Norway introduced the inflation target of 2,5%. The first period falls in line with the inflation illusion hypothesis, in which irrational investors fail to adjust growth rates with increased inflation and stocks are underpriced, and accordingly the dividend yield goes up.

Moreover, one can also explain the positive relationship with the FED-model, which postulates that since inflation is the main driver behind nominal bond yields, inflation and equity yields should be strongly related. As the relationship seems to disappear after the introduction of the inflation target, one can argue that the inflation illusion no longer holds as the government policy change reduces insecurity in the market and this sort of mispricing is eliminated. However, it contradicts the FED-model, as the relationship between bond yields and equity yields always should be positively correlated.

Second, according to the inflation illusion hypothesis, inflammatory environments will lead to underpricing of stocks and yield a high mispricing component. We find no evidence for inflation illusion in the first-sub period, as the estimated coefficient is insignificantly positive. However, the mispricing is significantly negative in the second sub-period, in stark contrast to the positive relationship the inflation illusion proclaims.

Third, expected inflation's effect on the subjective risk-premium is strongly positive significant in the first period, but we find no evidence for a relationship in the second period. This positive relationship shows us that investors seem to have a higher subjective risk-premium in inflammatory environments, indicating that they do consider inflation when investing in the stock market. However, if they are able to incorporate the expected inflation in their derivation of stock prices is uncertain.

It is interesting to observe that the mispricing in the market seems to increase with changes in inflation after the inflation target was introduced, and periods of high inflation lead to overpricing in the market. When seen in conjunction with the change in the subjective risk premium component related to inflation, it could be interpreted as irrational investors are less likely to consider inflation when calculating their discount rate in the post-inflation target period, leading to higher mispricing.

Table 7 – Regression of dividend yield’s components on inflation

This table shows the simple regression coefficients of demeaned dividend yield, its three components and a measure of objective risk premium on demeaned 6-months exponentially smoothed moving average inflation and the corresponding R^2 . Derivation and information for variables is elaborated in the method section. We report estimates from three different time periods; full sample 1982:01-2011:12, pre inflation-target period 1982:01-2000:12 and post inflation-target period 2001:01-2011:12, where all periods contain monthly data. The fitted values are reported over standard errors in (.) and t-statistics in [.]. The R^2 is adjusted for the degrees of freedom.

	1982-2011		1982-2000		2001-2011	
		R^2		R^2		R^2
dy_t	0.648 (0.140) [4.574]	0.053	1.577 (0.144) [10.982]	0.345	-0.212 (0.288) [-0.739]	-0.004
$-\sum E \Delta d^e$	0.934 (0.187) [5.008]	0.063	1.240 (0.236) [5.259]	0.105	0.576 (0.395) [1.457]	0.009
$+\gamma\lambda^{SRC}$	0.030 (0.014) [2.098]	0.009	0.048 (0.020) [2.394]	0.020	-0.018 (0.023) [-0.773]	0.005
$+\varepsilon_t$	-0.340 (0.185) [-1.838]	0.007	0.301 (0.227) [1.354]	0.004	-0.941 (0.381) [-2.468]	0.037
$+\gamma\lambda^{SRC} + \varepsilon_t$	-0.310 (0.186) [-1.670]	0.005	0.356 (0.228) [1.564]	0.006	-0.958 (0.383) [-2.501]	0.039

To test if there exist a significant parameter change in 2001 when the government implemented an inflation-target policy, we performed a Chow test for structural breaks. We tested all models from table 7. The results are significant for all variables except for the subjective risk premium and we can reject the null hypothesis that there is no structural break in 2001. From the test results, we can confirm that there has been a change in the relationship between dividend yield and its components to inflation. However, if this change comes from the inflation-target alone is unlikely and hard to interpret from the chow test.

Table 8 – Chow test

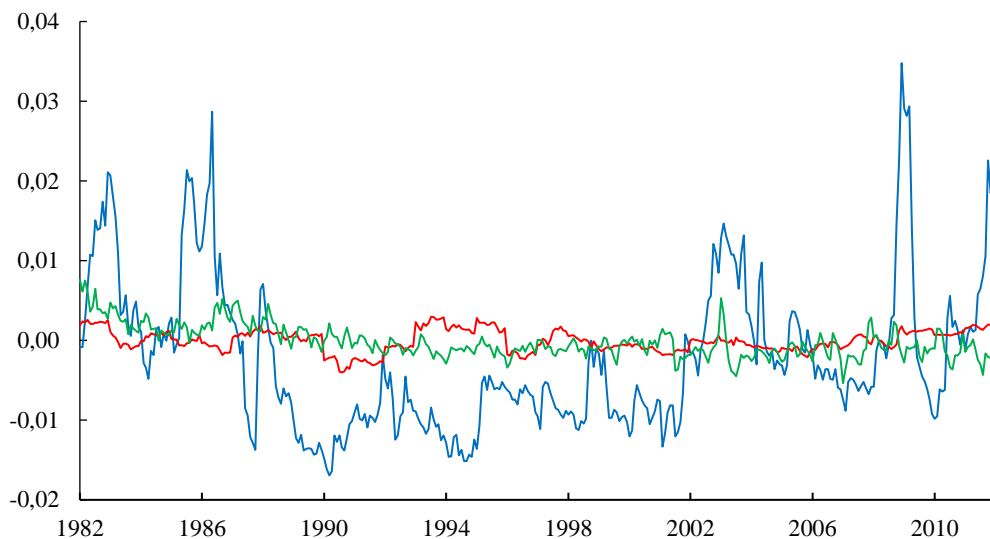
This table shows the results of a Chow test conducted on the five models from table 7. The dependent variables indicate which model is tested. We investigate if there exist a structural break when the inflation-target was imposed by the government in 2001. The null hypothesis says that there exist no breaks, and a high t-statistic yields rejection of the null.

	t-statistic	Probability
dy_t	56.799	0.000
$-\sum E \Delta d^e$	2.355	0.096
$+\gamma\lambda^{SRC}$	1.768	0.172
$+\varepsilon_t$	12.342	0.000
$+\gamma\lambda^{SRC} + \varepsilon_t$	12.749	0.000

Graph 1 plot the time-series of the components in the regression in table 4. We observe that the movements of the explanatory variables explain little of the total movements of the dividend yield. This is as expected, as the R^2 from table 4 was 0.071.

Graph 1 – Dividend yield, subjective risk-premium and inflation

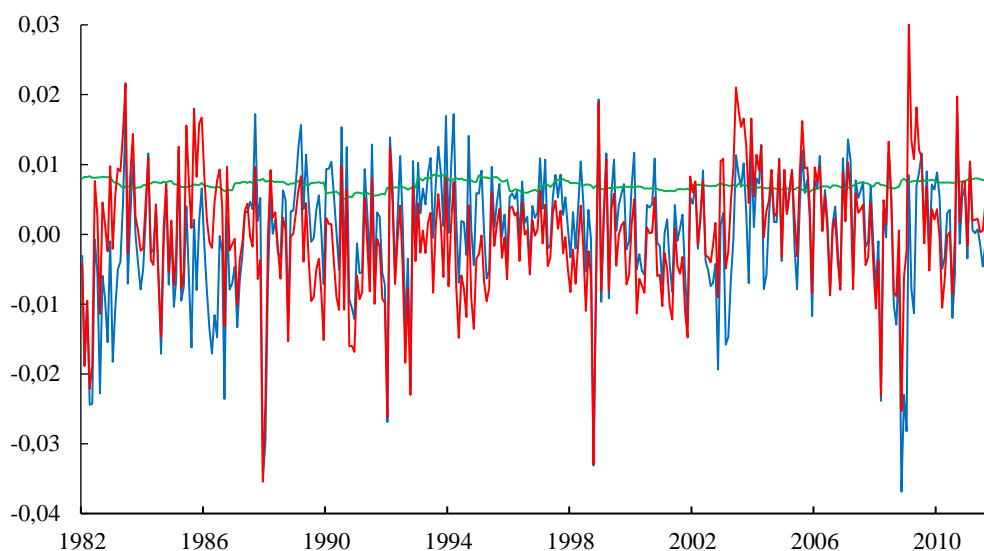
This graph plot the time-series of three variables; demeaned dividend yield (blue), demeaned subjective risk-premium (red) and the demeaned 6-months exponentially smoothed moving average inflation (green). Subjective risk-premium and inflation are multiplied by their respective coefficients from the regression in table 4. The sample period is 1982:01-2011:12 with monthly observations.



Graph 2 plot the three components of the dividend yield from table 6. We observe a tight fit between expected dividend growth and the mispricing component, which also stands for most of the variance as the subjective risk-premium is reasonably stable. The subjective risk-premium also seems to keep stable throughout the whole sample. Notably, a high rate of objective growth seems to coincide with mispricing, indicating that investors fail to use the correct growth rates when valuating stocks.

Graph 2 – Components of dividend yield

This graph plot the time-series of the three components that adds up to demeaned log dividend yield as shown in table 6; the long-run expected dividend growth, calculated as deviation from its unconditional mean (blue), the demeaned subjective risk-premium (green) and the mispricing component (red). Calculation and information about the components can be found in the method section. The sample period is 1982:01-2011:12 with monthly observations.



Discussion

The purpose of this thesis was to analyze the relationship between stock returns and inflation, and to see if the inflation target imposed by the government had any effect on this relationship. Our segregation of the dividend yield into our three theoretical parts should by definition explain its total movement and our results from table 6 shows this claim to be valid. Though we have had single results from table 7 under the different sub-periods that can give support to both inflation-illusion and the FED-model, it has not yielded any consistent results over the whole time period. In addition, although our results give some evidence for the prevailing theories their reliability can be affected by major weaknesses.

First, although having a large sample size, we are concerned about the short time-span. When modeling relationships with short time-series one is subject to the risk of conducting a spurious regression, and that shocks and lesser deviations are given a too high weight when running our regressions. Second, it can be discussed if our dividing into sub-periods is appropriate. There have been both equity return and inflation shocks in both late 1980's and in 2008 which would be interesting to test. In addition, the issues with having a short time-series as mentioned before are even more applicable for our short sub-periods.

Third, the fact that we use monthly data can be a potential problem. Even though Statistics Norway release monthly data about the consumer price index, investors may consider these numbers inconsequential and it might be more appropriate to infer quarterly or even semi-annually numbers in the analysis. Fourth, as the mispricing component is an error term derived from the regression of objective excess market return, which again is extracted from our VAR, any misspecification of our variables will create a bias. Although Acker and Duck (2013) control for the criticism of Campbell and Vuolteenaho (2004a) by Long and Xinlei (2009), one cannot know if the error term in fact is the mispricing component or just an omitted variable, misspecification or simply something else.

Fifth, in our study we do not consider growth opportunities for the individual companies when creating our subjective risk-premium component. This can cause an omitted variable bias if growth opportunities are somewhat related to betas. The cross-sectional price of risk measure, λ_t^{REG} , of Polk, Thompson and Vuolteenaho (2006) which control for growth opportunities can serve as an independent variable to give more realistic results from the regressions. Lee (2010) attains a higher R^2 when using λ_t^{REG} instead of λ_t^{SRC} .

Sixth, our proxy for expected inflation is in fact a proxy and can potentially bias our results as it may contain untrue information. For further research, one could try to follow Bekaert and Engström (2010) and use an survey of professional forecasters to give a more realistic and reliable time-series of expected inflation. Seventh, the fact that dividend payouts largely follow arbitrary rules set by individual companies, our yield measure may fail to capture the real equity return. We propose, in accordance with Campbell and Vuolteenaho (2004b), to also run the analysis with earnings yield as a measure of return. This will also serve as a robustness test and can give a better indication about the true relationship.

Conclusion

Our goal for this master thesis was to analyze the relationship between inflation and the Norwegian stock market and test if this relationship could be explained by one of the two most prevailing theories, the inflation illusion hypothesis or the FED-model. Our analysis has shown inconsistent results. Although some of the results for the dividend yield and its components fit well with both the inflation illusion and the FED-model in the sub-periods, these results are not stable through both time-periods. As such, we have to reject our hypothesis one and two, which both state that there should be a stable relationship. Since the mispricing term has increased to a statistically significant level in our post-inflation target period from the former period, we will also have to reject our third hypothesis, that the inflation target introduced in 2001 has reduced mispricing on the Norwegian equity market. Although the Chow-test show suggests break in our models in 2001, one cannot conclude that the change is a result of the introduction of the inflation-target policy, or something else.

From our results the effect of expected inflation on the mispricing component has increased to a statistically significant level after 2001 and has a negative relationship with increased expected inflation. This contradicts the theories tested, where there should exist a positive relationship according to both the inflation illusion hypothesis and the FED-model. In our model, it is clear that inflation has an effect on the dividend yield and its three components, but this effect has changed over time. We can see from our results that changes in expected inflation in the pre-inflation target period had a clear effect on the dividend yield and the expected dividend growth. This seems to dissipate after 2001. The mispricing component, which should have a positive relationship with expected inflation according to inflation illusion, is not significant in the first period and, although significant in the second sub-period, it moves in the opposite direction.

Though the relationship between the dividend yield and expected inflation has changed after the introduction of the inflation-target, it is too early to claim a causal link between the two. Moreover, it is premature to assume a causal link between inflation and equity returns based on the results derived in this thesis.

Bibliography

- Acker, Daniella and Nigel W. Duck. 2013. "Inflation illusion and the US dividend yield: Some further evidence." *Journal of International Money and Finance* 33: 235-254. doi: <http://dx.doi.org/10.1016/j.jimonfin.2012.11.018>.
- Asness, Clifford. 2003. "Fight the Fed Model." *Journal of Portfolio Management* 30 (1): 11.
- Basu, S. 1977. "Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis." *Journal of Finance* 32 (3): 663-682.
- . 1983. "The relationship between earnings' yield, market value and return for NYSE common stocks." *Journal of Financial Economics* 12 (1): 129-156. doi: [http://dx.doi.org/10.1016/0304-405X\(83\)90031-4](http://dx.doi.org/10.1016/0304-405X(83)90031-4).
- Bekaert, Geert and Eric Engström. 2010. "Inflation and the stock market: Understanding the "Fed Model"." *Journal of Monetary Economics* 57 (3): 278-294. doi: <http://dx.doi.org/10.1016/j.jmoneco.2010.02.004>.
- Brandt, Michael W. and Kevin Q. Wang. 2003. "Time-varying risk aversion and unexpected inflation." *Journal of Monetary Economics* 50 (7): 1457-1498. doi: <http://dx.doi.org/10.1016/j.jmoneco.2003.08.001>.
- Campbell, John Y. and Robert J. Shiller. 1988. "The dividend-price ratio and expectations of future dividends and discount factors." *Review of Financial Studies* 1 (3).
- Campbell, John Y. and Tuomo Vuolteenaho. 2004a. "Inflation Illusion and Stock Prices." *American Economic Review* 94 (2): 19-23.
- . 2004b. Inflation Illusion and Stock Prices, working paper 10263. National Bureau of Economic Research Working Paper Series.
- Chordia, Tarun and Lakshmanan Shivakumar. 2005. "Inflation Illusion and Post-Earnings-Announcement Drift." *Journal of Accounting Research* 43 (4): 521-556. doi: <http://dx.doi.org/10.1111/j.1475-679X.2005.00181.x>.
- Eitrheim, Øyvind, Jan T. Klovland and Jan F. Qvigstad. 2004. *Historical Monetary Statistics for Norway 1819-2003*. 35. Oslo: Norges Bank.
- Engsted, Tom, Thomas Q. Pedersen and Carsten Tanggaard. 2012. "Pitfalls in VAR based return decompositions: A clarification." *Journal of Banking & Finance* 36 (5): 1255-1265. doi: <http://dx.doi.org/10.1016/j.jbankfin.2011.11.004>.
- Fama, Eugene F. 1981. "Stock Returns, Real Activity, Inflation, and Money." *American Economic Review* 71 (4): 545-565.
- . 1983. "Stock Returns, Real Activity, Inflation, and Money: Reply." *American Economic Review* 73 (3): 471.
- Fama, Eugene F. and Kenneth R. French. 1992. "The Cross-Section of Expected Stock Returns." *Journal of Finance* 47 (2): 427-465.

- Feldstein, Martin. 1980. "Inflation and the Stock Market." *American Economic Review* 70 (5): 839-847.
- Fisher, Irving. 1986. *The theory of interest: as determined by impatience to spend income and opportunity to invest it*. Fairfield NJ: A.M. Kelly.
- Geske, Robert and Richard Roll. 1983. "The Fiscal and Monetary Linkage Between Stock Returns and Inflation." *Journal of Finance* 38 (1): 1-33.
- Gjedrem, Svein. 2002. ""Inflasjonsmålet og samspillet i den økonomiske politikken."." Norges-Bank Accessed 23.5 2016. <http://www.norges-bank.no/Publisert/Foredrag-og-taler/2002/2002-10-16/>.
- Graham, B. and D. L. Dodd. 1934. *Security Analysis*. 1 ed. New York: McGraw-Hill.
- Hardin, William, Xiaoquan Jiang and Zhonghua Wu. 2012. "REIT Stock Prices with Inflation Hedging and Illusion." *Journal of Real Estate Finance & Economics* 45 (1): 262-287. doi: <http://dx.doi.org/10.1007/s11146-010-9259-y>.
- Hess, Patrick J. and Bong Soo Lee. 1999. "Stock returns and inflation with supply and demand disturbances." *Review of Financial Studies* 12 (5).
- Lakonishok, Josef, Andrei Shleifer and Robert W. Vishny. 1994. "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance* 49 (5): 1541-1578.
- Lee, Bong Soo. 2010. "Stock returns and inflation revisited: An evaluation of the inflation illusion hypothesis." *Journal of Banking & Finance* 34 (6): 1257-1273. doi: <http://dx.doi.org/10.1016/j.jbankfin.2009.11.023>.
- Long, Chen and Zhao Xinlei. 2009. "Return Decomposition." *Review of Financial Studies* 22 (12): 5213-5249. doi: <http://dx.doi.org/10.1093/rfs/hhp017>.
- Martin, R. Douglas and Timothy T. Simin. 2003. "Outlier-Resistant Estimates of Beta." *Financial Analysts Journal* 59 (5): 56-69.
- Modigliani, Franco and Richard A. Cohn. 1979. "Inflation, Rational Valuation and the Market." *Financial Analysts Journal* 35 (2): 24-44.
- OBI. 2016. Oslo Stock Exchange Database. <http://finance.bi.no/~bernt//obidata/obidata/>: Oslo Stock Exchange.
- Polk, Christopher, Samuel Thompson and Tuomo Vuolteenaho. 2006. "Cross-sectional forecasts of the equity premium." *Journal of Financial Economics* 81 (1): 101-141. doi: <http://dx.doi.org/10.1016/j.jfineco.2005.03.013>.
- Statistics-Norway. 2016. "Consumer Price Index." Statistics Norway Accessed 13.1. 2016. <https://www.ssb.no/statistikkbanken/selecttable/hovedtabellHjem.asp?KortNavnWeb=kpi&CMSSubjectArea=priser-og-prisindekser&PLanguage=1&checked=true>.
- Thomas, Jacob and Frank Zhang. 2008. Dont Fight the FED Model. Unpublished paper, Yale University, School of Management.

- Thomson-Reuters. 2016. DataStream. Serie: TOTMKNW 1980M1-2015M12.
Variables: Dividend Yield, Index Price.
- Yardeni, E. 1997. FED's Stock Market Model Finds Overvaluation. Topical Study #38, US Equity Research, Deutsche Morgan Granfell.
- Ødegaard, Bernt A. 2016. Empirics of the Oslo Stock Exchange. Basic, Descriptive Results 1980-2015. <http://finance.bi.no/~bernt/>; Norwegian School of Economics.

Appendix

Campbell and Shiller (1988) dynamic dividend-price ratio model

As Gordon's growth model assumes both dividend growth and discount rates to be constant, Campbell and Shiller developed a dynamic version where they think of log dividends and discount rates as two elements in a possibly large vector of variables that summarize the state of the economy. The following derivation is sourced from Campbell and Shiller (1988).

The state vector evolves through time as a multivariate linear stochastic process with constant coefficients. The proposition can be tested informally by comparing history of actual log dividend-price ratio with optimal forecast from a linear vector autoregressive model:

$$h_t = \log(P_{t+1} + D_t) - \log(P_t) \quad (16)$$

where P_t is the real price of the stock, D_t the real dividend paid and h_t the realized log gross return on portfolio. h_t is approximated by variable ε_t , which gives $h_t \cong \varepsilon_t$ where ε_t is defined as follows:

$$\begin{aligned} \varepsilon_t &= k + \rho \log(P_{t+1}) + (1 - \rho) \log(D_t) - \log(P_t) \\ &= k + \rho p_{t+1} + (1 - \rho) d_t - p_t \end{aligned} \quad (17)$$

where lowercase letters denote the log of uppercase letters, and shows log sum of price and dividends that is replaced by a constant k , plus a weighted average.

They assume a constant world view where $h_t = h$, $\Delta d_t = g$ and the ratio:

$$\frac{P_t}{P_t + D_t} = e^{g-h}$$

In their empirical work they construct ρ using $\rho = e^{g-h}$, setting h equal to the sample mean stock return and g equal to the sample mean divided growth rate. They then define $\delta_t = d_{t-1} - p_n$ (log-dividend price ratio), and since δ_t is constant, we have $\delta_t = \delta = \log\left(\frac{1}{\rho-1}\right)$.

This leads to:

$$k = -\log(\rho) - (1 - \rho)\delta \quad (18)$$

Rewriting eq. (17) in line with the dividend-price ratio:

$$h_t \cong k + \delta_t - \rho\delta_{t+1} + \Delta d_t \quad (19)$$

Impose terminal condition $\lim_{i \rightarrow \infty} \rho^i \delta_{t+i} = 0$

$$\delta_t \cong \sum_{j=0}^{\infty} \rho^j (h_{t+j} - \Delta d_{t+j}) - \frac{k}{1 - \rho} \quad (20)$$

Since there is no economic content in eq. (20), an economic model can be obtained of the dividend-price ratio by imposing restrictions on h_t . For a theory that provides an ex-post discount rate r_t , that satisfies:

$$E_t h_t = E_t r_t + C \quad (21)$$

where E_t is a rational expectation from the information set I_t available at the beginning of period t , where h_t and r_t is measured at the end of period t .

Eq. (21) says that there is some variable whose beginning-of-period rational expectation plus a constant term C , equals the ex-ante return on stock over the period. This implies that $E_t h_{t+j} = E_t r_{t+1} + C$, so they can substitute in expected future discount rate r_{t+1} to get:

$$\delta_t \cong E_t \sum_{j=0}^{\infty} \rho^j (r_{t+j} - \Delta d_{t+j}) + \frac{C - k}{1 - \rho} \quad (22)$$

Eq. (22) is the dynamic version of the Gordon's growth model Campbell and Shiller derive in their seminal paper. Campbell and Vuolteenaho (2004a) further develop the model, by adding both subjective and objective expectations. In addition, they rewrite the model to fit their empirical framework. Notably the constant term C does not appear, as all variables are defined as deviations from their means (Campbell and Shiller 1988).

$$d_{t-1} - p_{t-1} \approx \frac{k}{\rho - 1} + \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} r_{t+j}^e - \sum_{j=0}^{\infty} \rho^j E_{t-1}^{obj} \Delta d_{t+j}^e \quad (23)$$

Compiled list of all companies used in this study

Arendals Fossekompani	Norsk Hydro	Toten Sparebank
Christiania Glasmagasin	Saga Petroleum A	Rogalandsbanken
Det Norske Oljeselskap (DNO)	Saga Petroleum Frie aksjer	Den norske Creditbank (DnC)
Det Norske Oljeselskap (DNO) B-aksjer	Saga Petroleum B	Sparebanken Midt-Norge
Elektrisk Bureau	Forretningsbanken	Vital Forsikring
Norske Skogindustrier	Norges Hypotekinstitutt	Vital Forsikring Frie
Freia Marabou A-aksjer	Alkatel STK	Gambit A/S
Freia Marabou B-aksjer	Sydvaranger	Ross Offshore
Idun-Gjaerfabrikken	Skipskredittforeningen	Forenede-Gruppen
Investa	SpareBank 1 Nøtterøy - Tønsberg	Ambra
Nora Industrier	Geophysical Comp. of Norway A.S (GECO)	Laly
Nora Industrier B-aksjer	Kvaerner Industrier	Maritime Group AS
Nora Industrier Frie aksjer	Kvaerner Industrier B-aksjer	Den norske Bank
Norema A-aksjer	Kvaerner Industrier Frie aksjer	Den norske Bank Frie aksjer
Norema B-aksjer	Olav Thon Eiendomsselskap	Den norske Bank Frie aksjer
Oslo Havnelager	Statoil	Sandsvaerbanken
Viking Askim, ord. B	Raufoss A/S	Fokus Bank
Den norske Amerikalinje	Realia	Fokus Bank Frie aksjer
Christiania Bank og Kreditkasse	Unitor	Fokus Bank
Christiania Bank og Kreditkasse Frie aksjer	SAS AB	Havtor
Christiania Bank og Kreditkasse	GPI	Hav B-aksjer
Christiania Bank og Kreditkasse	Tofte Industrier A/S	Sparabanken Rogaland
Vesta-gruppen	Vestenfjeldske Bykreditt	SpareBank 1 SR-Bank
Orkla	Eiendomsselskapet Aker Brygge I	Sparebanken Sør
Orkla B	Vesteraalens D/S	Finansbanken
Orkla Frie aksjer	Sparebanken Nordland	Sparebanken NOR
Dyno Industrier	Oslobanken A/S	Bergensbanken
Elkem	Norgeskreditt	Hafslund Nycomed A-aksjer
Elkem Frie aksjer	Sparebanken Eiker Drammen	Hafslund Nycomed B-aksjer
Norcem	Sparebanken Vest	Hafslund Nycomed frie A-aksjer
Norsk Data	Sparebanken Møre	Aker RGI
Norsk Data B-aksjer		Aker B-aksjer

Aker Frie aksjer	Bergen Nordhordaland Rutelag	Framnaes Industriutvikling
Bolig- og Naeringsbanken	Bergesen d.y. A-aksjer	Industriinvestor
Nordlandsbanken	Bergesen d.y. A-aksjer	Frysja Elektro
Color Line A.S.	Bergesen d.y. B-aksjer	Gabriel Venture Fund A/S
Storebrand	Bik Bok Gruppen	G.Block-Watne
UNI Storebrand Frie	Bik Bok Gruppen B-aksjer	Gimsoy Kloster
UNI Storebrand Bundne Pref.	Billabong	Gresvik
UNI Storebrand Frie Pref.	Bilsped. Transp. & Logistics	Waterfront Shipping
Avantor AS	Bjolsen Valsemolle	Gyldendal Norsk Forlag
Sparebanken Nord-Norge	Blom A/S	H.C.A. Melbye A/S
Askia Invest	Bona Shipholding	Hansa Bryggeri
Adelsten A	Braathens SAFE	Hardanger Sunnhordalandske DS
Adelsten B	Buskerudbanken	Helikopter Service A/S
Adresseavisen	C.Tybring-Gjedde A/S	Helly-Hansen
Laboremus	Sagatex	H&M Hennes & Mauritz
Bjolvefossen	SAS Norge	Hitec
Grand Hotel	DNL N	Hunsfos Fabrikker
Grand Hotel Frie aksjer	Dale	Haag
Ganger Rolf	David Livsforsikring	I.M.Skaugen
Bonheur	Det Stavangerske D/S.	Ican a.s.
Borgestad A	Det Sondenfelds Norske D/S	International Farvefabrik
Borgestad B	Det Sondenfelds Norske D/S B-aksjer	Jotul
Borgaa	Dyvi	Kaldnes
Atlantic Container Line	E.C.Dahl Eiendom	Kenor
Arcen	E.C.Dahls Bryggeri	Kirkland
Aust-Agder Trafikkselskap	EEG-Henriksen Gruppen	Kjopmandsbanken
Atlantica	Eiendomsutvikling	Kranor a/s
Autronica	Einersen Kontor og Data A/S	Kristiansand Dyrepark
Awilco	Elkjop Norge	Kverneland
Awilco B	Farstad Shipping A/S	Larvik Scandi Line
Axis Biochemicals	First Olsen Tankers	Larvik-Fredrikshavnferjen
Bachke & Co.	Norge, Forsikringsselskapet	Lehmkuhl Elektronikk A/S
Belships Co.	Fosen Trafikklag	Leif Hoegh & Co A/S
Benor Tankers		Liva Bil
Bergehus		Loki

Loki	Petroleum Geo-Services	Smedvig B
MIF	Porsgrunds Porselaensfabrik	Sparebanken Vestfold
Media Vision A/S	Pronova	Star Holding A/S
Mercurius	Protector Forsikring	Star Paper Mill B
Merkantildata A/S	Rena Karton	Stavanger Aftenblad
Moelven	Rica Hotell- og Restaur.- kjede	Steen & Strom
Mycron	Rieber & Son	Stentofon
Namsos Trafikkselskap	Rieber & Son B-aksjer	Stolt Partner
Goodtech	Stento	Stord Bartz a.s
NEK Kabel B-aksjer	Rosshavet	Multi Media Publishing
Nidar	Rottefella	Sunnmorsbanken
Kvaerner Shipping A/S	Vestfold Sparebank	Sysdeco Group
ICS	Scanvest-Ring A	SE Labels
Jonas Oglænd	Scanvest-Ring B	Sorlandsbanken
Noboe Fabrikker	Schibsted	Tandberg A/S
Nomadic Shipping	SDS Shipping og Offshore A/S	Tandberg Data A/S
Nora Eiendom a.s	Sea Farm A/S	Tiki-Data A.S
Nordstroem & Thulin B	Navia	Tomra Systems
Norex Offshore	Selmer Sande A/S	Tou
Norhav A/S	SensoNor	Transocean
Norhval	Sigmalm	Transworld Communication A/S
Norminol A/S	Simrad A	Tromsbanken a.s
Norse Petroleum	Simrad B	NCL Holding
NEBB	Simrad Optronics	Vard B-aksjer
Kongsberg Gruppen	Mikkelservice	Veidekke
Norving	Skaugen Petrotrans	Vestlandsbanken
Norwegian Petroleum Consultants	Storli A	Viking Supply Ships A.S
Norwegian Rig Consultants A/S	Storli B	Voss Veksel- og Landmandsbank
Notodden Elektronikk A.S	Solvang	Western Bulk Shipping
Nydalens Compagnie	Dalfonn	Wilh. Wilhelmsen A
Nydalens Compagnie B- aksjer	Skiens Aktiemolle	Wilh. Wilhelmsen B
Orkla Industrier	Eidsiva	Wilrig AS
Oslo Handelsbank	ARK	Wilrig M.K.
Peppes Pizza	Smedvig a.s	Actinor Shipping
		Actinor A/S

Arcade Shipping A/S	Nordic Am. Tanker Shipping	Medi-Cult
Arcade Drilling as	Santech Micro Group	Wenaas-gruppen
Bondernes Bank	Selmer	ASK
Kosmos	Sandnes Spareban	Transocean Offshore
Moss Glasvaerk A	Agresso Group	P4 Radio hele Norge
Kosmos Holding	Mercur Tankers	Aker Maritime
Kaldnes	Alvern Norway	Saevik Supply
Ugland Nordic Shipping	Sparebanken Rana	SpareBank 1 Østfold Akershus
Jinhui Shipping	Visma	Ocean Rig
MultiSoft	Scana Industrier	Indre Sogn Sparebank
Viking Media	Mosvold Shipping Ltd.	Norwegian Applied Technology
Ecuator	Pan Fish	Tandberg Television
Norsk Vekst	Alphatron Industrier	Thrane-Gruppen
Bohler-Gruppen	KredittBanken	I.M. Skaugen
Nera	Stolt-Nielsen B	Seateam Technology
Ivarans Rederi	Stolt Nielsen Ordinaere	ContextVision
Avantor AS	Computer Advances Group	Kitron
Norske Skogindustrier	SuperOffice	ProSafe
Norske Skogindustrier B	Norman Data Def. Sys.	Choice Hotels Scandinavia
Norske Skog A	Intex Resources	Petrolia Drilling ASA
A-pressen	Media Holding	Norex Industries
Kongsberg Automotive	Opticom	Norway Seafoods
Ekornes	Mercur Subsea Products	Discoverer
TTS Technology	Nordic VLSI	RC Gruppen
Oslo Reinsurance Comp.	Provida	CorrOcean
CanArgo Energy Corporation	NetCom	Stolt Comex Seaway
Fountain Oil	Marine Drilling	Stolt Offshore A
Brovig Offshore	Ringerike Sparebank	Multi-Fluid
Micro Software Group	Nycomed A	EDB - Elekt. Databeh.
Fesil	Nycomed B	Technor
Legra	Narvesen	Norsk Lotteridrift
IBY Eiendom	PC-Systemer	Royal Caribbean Cruises
Chr. Bjelland & Co.	Hydralift	Aker
Nordic Water Supply	Hydralift B	Tordenskjold Shipping
Ivar Holding	Logisoft	Norsk Wallboard

AF Gruppen A	Luxo	Scandinavia Online
AF Gruppen B	Sysdeco	iGroup
Helgeland Sparebank	Profdoc	Mefjorden
Iplast	Rieber Shipping	Customax
Iterated Systems	Stavdal	InFocus Corporation
Ulstein Holding	Havila Supply	TeleComputing
Fred. Olsen Energy	Hol Sparebank	Zenitel
Hjellegjerde	Aurskog Sparebank	Exense
Solstad Offshore	Synnøve Finden	Intellinet
Swan Reefer	Otrum	Hands
Nycomed Amersham A	Eltek	Fjord Seafood
Nycomed Amersham B	Wabo	Component Software Group
Amersham	Nortrans Offshore	Jæren Sparebank
Nopec International	Software Innovation	Home Invest
VMetro	Skue Sparebank	OfficeShop Holding
Teco Maritime	Melhus Sparebank	DOF
Logisoft	Industrifinans	Northern Offshore
Aktiv Inkasso	Boligeiendom	Northern Offshore
Int. Gold Exploration IGE	Itera	Komplett
Motegruppen	Axis-Shield	Office Line
Jahre Tankers	Industrifinans Forvaltning	Sense Communications International
District Offshore	Infostream	SinOceanic Shipping
Norcool Holding	Enitel	Unit 4 Agresso
Fredrik Lindegaard	Håland og Setskog Sparebank	Frontier Drilling
Evercom Network	EVRV	Siem Shipping
Navis	PC LAN	Sinvest
Team Shipping	Inmeta Crayon	Pan Pelagic
Sonec	Telenor	Oceanor Holding
Natural	Crew Gold Corporation	Enwa
Northern Offshore	StepStone	Scribona AB ser. B
Industrifinans Næringseiendom	Investra	PSI Group
Tecmar Technologies Int.	Expert	Telecom Group
Voice	Bionor Pharma	Fast Search & Transfer
Tanker Navigation	Sparebanken Flora-Bremanger	Golar LNG
Frontline	Photocure	Domstein
Frontline		

OHI	Petrojack	Norda
Agasti Holding	GC Rieber Shipping	Confermit
PA Resources	Wilson	DeepOcean
Q-Free	APL	Funcom
Apptix	Imarex	Reservoir Exploration Technology
Lerøy Seafood Group	Polymoon	Trefoil
Birdstep Technology	Oslo Areal	Petrobank Energy and Resources
Gjensidige NOR	Awilco Offshore	Scorpion Offshore
Subsea 7	Vizrt	Aker Drilling
Troms Fylkes Dampskibsselskap	Havfisk	Fara
Tandberg Storage	Havila Shipping	Songa Offshore
Norwegian Air Shuttle	Allianse	SeaBird Exploration
NextGenTel Holding	Questerre Energy Corporation	BWG Homes
Opera Software	Kongsberg Automotive	Dolphin Group
Yara International	Eidesvik Offshore	Navamedic
Catch Communications	Wintershall Norge ASA	Captura
Akastor	Eastern Drilling	Hurtigruten
Guinor Gold Corporation	Simrad Optronics	REC Silicon
Mamut	Wentworth Resources	BW Offshore Limited
Findexa	American Shipping Company	Weifa
Medistim	Siem Offshore	Telio Holding
STX Europe	Cermaq	Odfjell Invest
Axxessit	Norstat	Nordic Mining
Teco Maritime	Unison Forsikring	AGR Group
Conseptor	Biotech Pharmacon	Aker Floating Production
Jason Shipping	Deep Sea Supply	Trolltech
Privatbanken	Powel	InterOil Exploration and Production
IBAS Holding	Seadrill	Teekay Petrojarl
Norman	Consafe Offshore	Austevoll Seafood
NEL	Norgani Hotels	Marine Farms
SeaDrill Invest	Odim	Codfarmers
Active 24	Fairstar Heavy Transport	Northland Resources
Sevan Marine	Grenland Group	Det norske oljeselskap
Golden Ocean Group	B+H Ocean Carriers	Norwegian Property
Bjørge	DOF Subsea	
Nio		

AKVA Group	Etman International	Polaris Media
Eitzen Chemical	24Seven Technology Group	Polarcus
Intex Resources	Zoncolan	Golar LNG Energy
Faktor Eiendom	EMAS Offshore	FLEX LNG
Spits	London Mining	North Energy
Repant	Dockwise	IDEX
Deep Sea Supply	Grégoire	Bakkafrost
Oceanteam Shipping	Ability Drilling	The Scottish Salmon Company
Copeinca	Seajacks International	Panoro Energy
Simtronics	Pronova BioPharma	Sølvtrans
Comrod Communication	Fornebu Utvikling	Bridge Energy
NEAS	Scandinavian Clinical Nutrition	Avocet Mining
Transeuro Energy Corp.	Norwegian Energy Company	Dannemora Mineral
Algeta	Lighthouse Caledonia	NetConnect
Electromagnetic Geoservices	IGE Nordic	Wilh. Wilhelmsen
Rem Offshore	PetroProd	Morpol
Nexus Floating Production	Infratek	Storm Real Estate
Wavefield Inseis	NattoPharma	Saga Tankers
Ocean HeavyLift	Thin Film Electronics	Eqology
SalMar	Aker Philadelphia Shipyard	Cellcura
ScanArc	Aqua Bio Technology	Statoil Fuel & Retail ASA
Bouvet	Exense Consulting	Floatel International
Cecon	Bergen Group	Archer
Fred. Olsen Production	Camposol Holding	Prospector Offshore Drilling
Maritime Industrial Services	Prosafe Production Public	S.D. Standard Drilling
Petromena	PCI Biotech Holding	Norway Royal Salmon
Protector Forsikring	Norway Pelagic	Discovery Offshore
Wega Mining	BW Gas Limited	Awilco Drilling
InvivoSense	Spectrum	Håegh LNG Holdings
SCAN Geophysical	Global IP Solutions	Kværner
RomReal	Remedial Public	Awilco LNG
Badger Explorer	Havila Ariel	
Grieg Seafood	Borgestad Industries	
Tribona	Nordic Health	
Det norske oljeselskap		

Nicholas Oskarsson - 0912997
Jan Magnus Skjeggstad - 0930670

BI Norwegian Business School
Preliminary Thesis Report

**Stock Returns and Inflation in
Norway**

Name of Supervisor:
Professor Kjell Jørgensen

Program:
Master of Science in Business
Major in Finance

Date of Submission:
15.01.2016

Campus:
BI Oslo

Examination Code:
GRA19002 – Master Thesis

Abstract

The objective of this preliminary thesis report is to set a starting point of our master thesis in finance. We will study if there exists a relationship between stock-returns and inflation, and if this relationship somewhat changed after Norges-Bank introduced an inflation target in 2001. The preliminary thesis will address relevant literature and theory, discuss data and data collection briefly, outline our model and methodology and in the end, a progression plan.

Table of Contents

Abstract	ii
Table of Contents	iii
Introduction	1
Motivation	1
Literature and Theory	2
Data	5
Methodology	6
VAR derivation	8
Progression plan	12
Bibliography	I

Introduction

The subject of this master thesis is an empirical modeling of the relationship between inflation and stock returns. As a point of departure, we consider the discussion of the FED model which relates the yield on stocks to the yield on nominal treasury bonds (Campbell and Vuolteenaho 2004). They state that the major influence on nominal bond yields has been the rate of inflation. Thus, the FED model implies that stock yields are highly correlated with inflation.

The empirical regularity of the model is strong. In fact, Bekaert and Engstrom (2010) presents a scatterplot of the yield for a 10-year nominal bond and the equity yield for the US aggregated stock market with a correlation of 0,77. This strong relationship drives us to hope for a similar results for our Norwegian data, as Lee (2010) finds similar evidence for large developed international economies. At the same time, both Asness (2003) and Santoli (2012) argues that the FED model returns answers using bad endogenous variables.

To investigate if the relationship is non-structural and to introduce new thought to the field, we will study the nexus between inflation and equity yield both pre- and post-2001 when the Central Bank of Norway introduced an inflation target of 2,5%, and compare the results.

The rest of this preliminary thesis report is organized as follows. Motivation is introduced in section 2 while the literature and theory is discussed in section 3. In section 4, we briefly explain which data is considered relevant to our thesis. Section 5 outlines our methodology and model, while section 6 presents a progression plan for finalizing our thesis.

Motivation

Our research could give an explanation on how stocks are influenced by macroeconomic factors. According to the Fisher hypothesis, monetary effects, nominal rates and inflation should have no effect on the real economy, as nominal rates will move one-for-one with the expected inflation (Fisher 1986). Equity investments have been seen as a good hedge against inflation as the real returns should not be affected by inflation. Empirical research has many times yielded

conflicting results, with negative correlation between stock returns and inflation. Moreover, there seems to be a high correlation between the movements of nominal stock bond yields and equity yields. This is hard to reconcile since expected inflation is a main driver behind the nominal stock bond yield, and this should not have a large effect on any of the real components on the dividend equity yield. Many theories have been posited to explain this discrepancy, and some of these articles will be further discussed in the literature section. Our focus will be on the inflation illusion hypothesis and the FED model, as these are two of the theories that have had considerable momentum the last years, while still being heavily criticized. We are interested in finding what effect macroeconomic events have, if any, on the risk premium investors want for their investment. These hypotheses will be further explained in the literature and theory section.

Literature and Theory

The link between inflation and stock returns has been widely studied. Two of the most prevailing theories are the FED model, often used by practitioners, and the inflation illusion hypothesis. These seem to be contradicting, where the FED-model states that the yield on nominal bonds and real return on equity should follow each other closely, if not exactly. The idea is that bonds and equity compete for capital from investors, and if one has higher returns than the other, investors will flock to that asset. As expected inflation has major influence on treasury bonds, one would expect inflation and equity returns to be strongly correlated.

The inflation illusion hypothesis states that when expected inflation rises, bond yields duly increases, and equity investors incorrectly discount real cash flows using nominal rates. Increase in nominal yields leads to equity underpricing, and vice versa.

This could have implications for government policy, as if inflation illusion affects pricing in the stock market, policies for stabilizing inflation can help to prevent distortion and mispricing in the stock market. If there is no such effect, inflation policy has no effect on the equity market apart for its effect on real economic growth (Bekaert and Engstrom 2010).

Bekaert and Engstrom (2010) examines the high correlation between a 10-year nominal bond yield and the equity yield. A comparison between the two from 1965 to 2010 gives a correlation of 0,77.

From the Gordon model, you get the two equations for the dividend yield and the nominal bond yield:

$$EY = (-EDIV) + RRF + ERP \quad (1)$$

$$BY = EINF + RRF + IRP \quad (2)$$

Were $EDIV$ is expected growth rate of real equity dividends, RRF is the real risk free rate of interest and ERP is the equity risk premium. The $EINF$ is expected inflation and IRP is the inflation risk premium. Expected inflation is a dominant source of variation in nominal yields, but earlier literature has concluded that it is impossible that expected inflation has a large effect on any real component of the equity cash yield. Because of this, different behavioral models have been used to explain this discrepancy. Campbell and Vuolteenaho (2004) states that there is serious difficulty with using this model as a rational explanation of stock prices, despite its empirical success as a behavioral description. This can be seen in the Gordon Growth model:

$$\frac{D_t}{P_{t-1}} = R - G \quad (3)$$

Where R is the long-term discount rate and G is the long-term growth rate of dividends. According to the FED-model, the discount rate on stocks is the yield on bonds plus a proxy for the risk premium of stocks over bonds. Neither R nor G should in real terms change with inflation. It can be written in nominal terms, but then dividend growth would also have to be measured in nominal terms. Then you should expect that a change in long-term expected inflation would move nominal G one-for-one, offsetting the effect on nominal R and leaving the dividend-price ratio unaffected.

Lee (2010) investigated if the inflation illusion hypothesis could explain the stock return-inflation relation. They focus on the pre-war positive relation and post-war

negative relation in USA. They find that it does not explain the pre-war relation well and that it is hard to give a rational explanation to the theory that investors get more sensitive to the inflation illusion over time. They introduce a two-regime hypothesis by identifying the presence of two types of stock return-inflation relations without imposing a particular permanent and temporary restriction, which is compatible with pre- and post-war relations.

Bekaert and Engstrom (2010) conclude that the FED-model has high explanatory power in economies with a large number of incidences of stagflation. They postulate that in periods with recessions, economic uncertainty and risk aversion may increase and lead to higher equity risk premiums which increases yield on stocks. If then expected inflation also happens to be high, bond yields increase through expected inflation and maybe through their inflation risk premium components. Positive correlations emerge between equity yields, bond yields and inflation.

Acker and Duck (2013), contrary to Bekaert and Engstrom (2010) and Lee (2010), find evidence for the inflation-illusion hypothesis. They use the Campbell and Vuolteenaho (2004) procedure and find that the dividend-yield puzzle only exists as a stable phenomenon from the 1950s and onwards. They reject the FED-model, and only find partial support for the proxy-hypothesis.

Wei and Joutz (2011) tests Campbell and Vuolteenaho (2004) conclusions and find structural instability in their predictions equation for the excess return. They reject the hypothesis that there are no structural breaks in 1952. They find that the dividend yield and inflation is more positively correlated in the post-war period, when inflation is negatively correlated with the mispricing component. In addition, they find that the post-war data shows a negative relation between rationally expected excess dividend growth rate and inflation that is consistent with the rational explanation pursued by Wei (2010).

Hardin, Jiang and Wu (2012) identify that both hedging effects and the inflation illusion exists in REIT stock prices, and that the inflation illusion effect dominate over time. It supports the Modigliani and Cohn (1979) hypothesis and show that both effects can exist over time, and that the dominant effect will determine empirical relationship between dividend yield and expected inflation. The

existence of the inflation illusion in REIT stocks may indicate that the effect is common in asset pricing.

Santoli (2012) strongly critiques the FED-model, and claims that it only holds some explanatory power in 1980- and 90s where bond yields were steadily declining and stock values consistently rising as inflation and interest rates were slowly strangled. It limits itself to only compare two different investment opportunities for investors and ignore all other.

Modigliani and Cohn (1979) argues in their study that asset traders consistently undervalues stocks, as they discount all future cash flows with the real rate of return and not the nominal rate, and thus leading to an undervaluation of the stock market. This hypothesis is more commonly known as the inflation illusion as discussed earlier.

Data

The required data for conducting this study is time-series data. The amount of data will be somewhat significant, and we will mainly follow the approach from Lee (2010) who builds his model from Campbell and Shiller (1988). The model we will be elaborated further in the methodology section. We will need to collect data of the consumer price index for Norway and the risk free rate. Stock returns, dividends and beta values for the relevant assets will be collected. We will also need to obtain a proxy for the market portfolio and information about expected inflation.

Monthly data considering CPI development is collected from Norwegian Statistics (SSB.no 2016). The time horizon is from the 1st month of 1979 to the 12th month of 2015. When collecting data from the stock market, we have gained access to “Oslo Børs Informasjon”, which is Oslo Stock Exchanges database (OBI 2016). From here, we are able to extract data for yearly stock-returns, betas, dividends and shares outstanding regarding all OSE assets. In addition, we will collect an OBX time-series as a market proxy. The OBX series and the asset data has a time horizon from 1987 to 2012.

OBI (2016) also gives access to data-series of forward looking risk-free rates calculated by Ødegaard (2015). These are estimated from governmental bonds and NIBOR. The series span from 1979 to 2014 and are one-year rates.

Expected inflation will be extracted from monetary policy reports from the Central Bank of Norway (2016). This time-series will span from 3th quarter 1994 to 4th quarter of 2015.

Methodology

We want to follow Campbell and Shiller (1988) approach for analyzing the relationship between stock-prices and inflation. They develop a dividend-ratio model, spanning out of Gordon growth model (eq. 3). All derivation in the following section is a direct explanation of their derivation, and no calculations are the work from the authors of this report.

The Gordon model assumes bot dividend growth and discount rate to be constant. They develop a dynamic version of this model, were they think of log dividends and discount rates as two elements in a possibly large vector of variables that summarize the state of the economy. The state vector evolves through time as a multivariate linear stochastic process with constant coefficients. Log dividend-price ratio should be an optimal linear forecaster of the present value of future dividends, growth rate and discount rates. The proposition can be tested informally by comparing history of actual log dividend-price ratio with optimal forecast from a linear vector autoregressive model:

$$h_t = \log(P_{t+1} + D_t) - \log(P_t) \quad (4)$$

Where P_t is the real price of the stock, D_t the real dividend paid and h_t the realized log gross return on portfolio. The exact relationship is non-linear since it involves log of the sum of the price and dividend.

h_t is approximated by variable ε_t , which gives $h_t \cong \varepsilon_t$ were ε_t is defined as follows:

$$\begin{aligned} \varepsilon_t &= k + \rho \log(P_{t+1}) + (1 - \rho) \log(D_t) - \log(P_t) \\ &= k + \rho p_{t+1} + (1 - \rho) d_t - p_t \end{aligned} \quad (5)$$

In eq. (5), lowercase letters denote the log of uppercase letters, and shows log sum of price and dividends that is replaced by a constant k , plus a weighted average. They assume a constant world view where $h_t = h$, $\Delta d_t = g$ and the ratio $\frac{P_t}{P_t + D_t} = e^{g-h}$.

In their empirical work they construct ρ using $\rho = e^{g-h}$, setting h equal to the sample mean stock return and g equal to the sample mean divided growth rate. They then define $\delta_t = d_{t-1} - p_n$ (log-dividend price ratio), and since δ_t is constant, we have $\delta_t = \delta = \log\left(\frac{1}{\rho-1}\right)$.

This leads to:

$$k = -\log(\rho) - (1 - \rho)\delta \quad (6)$$

Rewriting eq. (5) in line with dividend-price ratio:

$$h_t \cong k + \delta_t - \rho\delta_{t+1} + \Delta d_t \quad (7)$$

Impose terminal condition $\lim_{i \rightarrow \infty} \rho^i \delta_{t+i} = 0$

$$\delta_t \cong \sum_{j=0}^{\infty} \rho^j (h_{t+j} - \Delta d_{t+j}) - \frac{k}{1 - \rho} \quad (8)$$

Since there is no economic content in eq. (7), an economic model can be obtained of the dividend-price ratio by imposing restrictions on h_t . For a theory that provides an ex-post discount rate r_t , that satisfies:

$$E_t h_t = E_t r_t + C \quad (9)$$

Where E_t is a rational expectation from the information set I_t available at the beginning of period t , where h_t and r_t is measured at the end of period t .

Eq. (9) says that there is some variable whose beginning-of-period rational expectation, plus a constant term C equals the ex-ante return on stock over the period. This implies that $E_t h_{t+j} = E_t r_{t+1} + C$, so we can substitute in expected future discount rate r_{t+1} to get:

$$\delta_t \cong E_t \sum_{j=0}^{\infty} \rho^j (r_{t+j} - \Delta d_{t+j}) + \frac{C - k}{1 - \rho} \quad (10)$$

Eq. (10) is an dynamic Gordon model, which explains the log dividend-price ratio as an expected discounted value of all future one-period “growth adjusted discount rates” $r_{t+j} - \Delta d_{t+j}$. The model will allow a free constant term C (constant risk premium in stock returns), while restricting only the dynamics of the dividend-price ratio and not its mean level.

VAR derivation

Campbell and Shiller (1988) uses the model they derived in the previous section to derive their vector autoregressive framework.

A linear approximation to the log stock-returns implies that the log dividend-price ratio can be written as a discounted value of the expected future dividend growth rates and discount rates. Their approach explicitly compares movements in the dividend-price ratio with the movements that are implied by the model, and they include the log dividend-price ratio itself as one variable in the VAR.

The VAR generates a forecast of dividends and discount rates that equals the log dividend-price ratio. The analyst does not have to observe everything that the market participants do, as all relevant information is included in this variable.

In this section all variables are redefined as deviations from means; this enables them to drop all constant terms. It is assumed that at the start of period t , market participants observe a vector of state variables Y_t . The information set I_t is the history $[Y_t, Y_{t-1}, \dots]$.

Assumed that Y_t follows a linear stochastic process with constant coefficients that are known to market participants, it follows that any subset of the variables in Y_t also follows this stochastic process. They now define a vector X_t that include the variables in Y_t that market participants have observed. The information set H_t is the history $[X_t, X_{t-1}, \dots]$.

A parsimonious choice for X_t is the vector $[\delta_t, r_{t-1} - \Delta d_{t-1}]$, where the means from the data is removed, since these are unrestricted and lag the growth-adjusted discount rate by one period to ensure that it is known to the market by the start of the period t . This vector X_t is the smallest vector that allows for testing the restrictions of the dividend-ratio model. It is assumed that the linear process for X_t can be written as a VAR with p lags: $C_1 X_{t-1} + C_2 X_{t-2} + \dots + C_p X_{t-p} + u_t$. Where C_i for $i = 1, 2, \dots, p$ are each 2×2 matrices. Since p can be large, the assumption involves little further loss of generality. They write the (j, k) element of C_i as C_{ijk} ; thus, C_{ijk} is the coefficient of the j^{th} variable in X_t on the k^{th} variable lagged i times.

Then the VAR is rewritten in first-order form. This enables them to convert a p^{th} -order autoregression into a first-order autoregression, for which the formula for conditional expectations has a simple form. This is done by defining a new vector Z_t , which includes $2p$ rather than 2 elements; δ_t with $(p - 1)$ lags, and $r_{t-1} - \Delta d_{t-1}$ with $(p - 1)$ lags. If $p = 2$ it can be written:

$$Z_t = \begin{bmatrix} \delta_t \\ \delta_{t-1} \\ r_{t-1} - \Delta d_{t-1} \\ r_{t-2} - \Delta d_{t-2} \end{bmatrix}, V_t = \begin{bmatrix} u_{1t} \\ 0 \\ u_{2t} \\ 0 \end{bmatrix}$$

The vector then follows a first order VAR, where the rows corresponding to δ_t and Δd_{t-1} are stochastic and the other are deterministic:

$$\begin{bmatrix} \delta_t \\ \delta_{t-1} \\ r_{t-1} - \Delta d_{t-1} \\ r_{t-2} - \Delta d_{t-2} \end{bmatrix} = \begin{bmatrix} C_{111} & C_{211} & C_{112} & C_{212} \\ 1 & 0 & 0 & 0 \\ C_{121} & C_{221} & C_{122} & C_{222} \\ 0 & 0 & 1 & 0 \end{bmatrix} \times \begin{bmatrix} \delta_{t-1} \\ \delta_{t-2} \\ r_{t-2} - \Delta d_{t-2} \\ r_{t-3} - \Delta d_{t-3} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ 0 \\ u_{2t} \\ 0 \end{bmatrix}$$

The VAR system can be written more parsimoniously as:

$$Z_t = AZ_{t-1} + V_t \tag{11}$$

The vector Z_t has the useful property that to forecast it ahead k periods, given the information set H_t , you can multiply Z_t by the k^{th} power of the matrix A : $E(Z_{t+k}|H_t) = A^k Z_t$.

A vector $(e1)'$ is defined such that $(e1)'Z_t \equiv \delta_t$, and a vector $(e2)'$ such that $(e2)'Z_t \equiv r_{t-1} - \Delta d_{t-1}$. That is, $(e1)'$ and $(e2)'$ pick out the elements δ_t and $r_{t-1} - \Delta d_{t-1}$ from Z_t . In the example above, this becomes:

$$(e1)' = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}, (e2)' = \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Now the restrictions of the dividend-ratio model can be stated on the VAR. The dividend-ratio model imposes a tight set of cross-equation restrictions on the VAR. To define these, you can take expectations of eq. (10), conditional on that the VAR information set H_t left-hand side is unchanged since δ_t is *in* H_t . The right-hand side becomes an expected value conditional on H_t (since H_t is a subset of I_t which defines expectations in eq. (10)). When the constant terms are dropped, you have:

$$\delta \cong E\left(\sum_{j=0}^{\infty} \rho^j (r_{t+j} - \Delta d_{t+j}) \mid h_t\right) \equiv \delta'_t \quad (12)$$

Eq. (12) says δ_t should equal the unrestricted VAR forecasting formula, and you can rewrite eq. (12) as:

$$\delta_t = (e1)'Z_t = \sum_{j=0}^{\infty} \rho^j (e2)'A^{j+1} = \delta'_t \quad (13)$$

Since eq. (13) is to hold for all realizations of Z_t , we must have:

$$(e1)' = \sum_{j=0}^{\infty} \rho^j (e2)'A^{j+1} = (e2)'A(I - \rho A)^{-1} \quad (14)$$

The second equality follows by evaluating the infinite sum, noting that it must converge since the elements of Z_t are stationary. Eq. (14) defines a set of $2p$ nonlinear restrictions on the VAR coefficients that are tested by using a nonlinear WALD test. The estimated vector of VAR coefficients is written as γ , the estimated variance-covariance matrix is written as θ and the vector of deviations of the estimated system is written as λ .

The WALD test statistic: $\lambda' \left(\frac{\partial \lambda}{\partial \gamma'} \theta \frac{\partial \lambda}{\partial \gamma} \right)^{-1} \lambda$

Under the null hypothesis it is distributed χ^2 , with degrees of freedom equal to the number of restrictions.

Another regression approach to the model would be to post multiply the restrictions in eq. (14) by $(I - pA)$. This gives $2p$ linear restrictions, one for each column of the matrix A :

$$(e1)'(I - \rho A) - (e2)'A = 0 \quad (15)$$

Eq. (14) has a dividend-price ratio restriction, while eq. (15) has a one-period stock-return restriction. Since this approach involves a VAR with only two variables, it enables them to test for expected stock return by using eq. (14) or (15) and to compute the implications of predictable excess returns for the log dividend-price ratio by using eq. (13). This two-variable approach does not allow judging the relative importance for the log dividend-price ratio of expectations of future dividends and discounting factors. To address this, it is possible to expand the vector of variables observed from X_t to include Δd_{t-1} and r_{t-1} separately. It is necessary to redefine Z_t and A , and define $(e1)'$, $(e2)'$ and $(e3)'$ to pick out δ_{t-1} , $A d_{t-1}$ and r_{t-1} respectively. Then eq. (13) is rewritten:

$$(e1)'Z_t = \sum_{j=0}^{\infty} \rho^j ((e3)' - (e2)') A^{j+1} Z_t \quad (16)$$

$\delta_t = \delta'_t \equiv \delta'_{rt} + \delta'_{dt}$ is now defined to equal the right-hand side of eq. (16). δ'_{rt} is the component of δ'_t that forecasts future dividend rates and δ'_{dt} is the component that forecasts dividend growth rates: $\delta'_{rt} \equiv (e3)'A(I - pA)^{-1}Z_t$ and $\delta'_{dt} \equiv -(e2)'A(I - pA)^{-1}Z_t$. This three variable system enables them to see if expectations of δ'_{dt} or δ'_{rt} have historically been more important in determining the dividend-price ratio.

So far in this model, it is assumed that the ex-post discount rate r_t itself is observed. The authors gives two examples where this is not the case. In their first example, real consumption growth ΔC_t is observed, which is related by $r_t = \alpha \Delta C_t$, where α is the coefficient of relative risk aversion. In their second example,

the squared ex-post stock return V_t is observed, and the model shows that $r = \alpha V_t$ while α is not known and must be estimated from data.

This model is used by Lee (2010) and Bekaert and Engstrom (2010) with modifications for the variables they are using. Lee (2010) uses data for stock return, dividend yields, three-month T-bill rates for the risk-free rate, and two proxies for subjective risk premium that are based on ordinal association measures between a stock's beta and its valuation ratios. While Bekaert and Engstrom (2010) use the yield to maturity on a 10-year US treasury bond, an estimate of the 5 year zero coupon real rate provided in Ang, Bekaert and Wei (2008) as a proxy for the real rate and a proxy for expected inflation from SPF (the Survey of Professional Forecasters). In addition, a subjective expectations regarding earnings growth from SPF, and data from the S&P500 regarding real earnings, dividend growth and equity yield.

As we will follow the same approach as Lee (2010), we will have to calculate both dividend yields and a proxy for the market risk premium to be able to conduct our analysis from the model he derived. Dividend yields will be calculated as $\frac{\text{Dividend per Share}_t}{\text{Price per Share}_t}$ for each of the assets in the study. The market risk premium will be derived using the CAPM, where we derive the $R_{m,t}$ from the CAPM equation $R_{s,t} = R_{f,t} + \beta_{s,t}(R_{m,t} - R_{f,t})$. We will focus our analysis on the 25 firms being listed in the OBX index for every year in the time-series, and therefore rotate which firms being studied. We will develop filters to sift out assets not being suited for the model for each year, and hopefully increase the model consistency and reliability.

Progression plan

We aim to finalize the thesis by the start of June. Some of the data is already collected and most of the literature revised and considered. As other courses will demand significant attention in February, the thesis will be set on hold in this period. We will set up a plan with milestone to reach until finalization, to help us progress steadily throughout the semester.

By 15th of March: All data is collected and filtered. In addition, all literature is gathered and considered.

By 1st of April: Model defined and data structured.

By 1st of May: Analysis done, as well as a first write-up of the thesis. The draft will be sent to Kjell for feedback.

By 1st of June: Thesis fully written. This will leave time for proofreading and corrections.

Bibliography

- Acker, Daniella and Nigel W. Duck. 2013. "Inflation illusion and the US dividend yield: Some further evidence." *Journal of International Money and Finance* 33: 235-254. doi: <http://dx.doi.org/10.1016/j.jimonfin.2012.11.018>.
- Ang, Andrew, Geert Bekaert and M. I. N. Wei. 2008. "The Term Structure of Real Rates and Expected Inflation." *Journal of Finance* 63 (2): 797-849. doi: 10.1111/j.1540-6261.2008.01332.x.
- Asness, Clifford. 2003. "Fight the Fed Model." *Journal of Portfolio Management* 30 (1): 11.
- Bekaert, Geert and Eric Engstrom. 2010. "Inflation and the stock market: Understanding the "Fed Model"." *Journal of Monetary Economics* 57 (3): 278-294. doi: <http://dx.doi.org/10.1016/j.jmoneco.2010.02.004>.
- Campbell, John Y. and Robert J. Shiller. 1988. "The dividend-price ratio and expectations of future dividends and discount factors." *Review of Financial Studies* 1 (3).
- Campbell, John Y. and Tuomo Vuolteenaho. 2004. "Inflation Illusion and Stock Prices." *American Economic Review* 94 (2): 19-23.
- Fisher, Irving. 1986. *The theory of interest: as determined by impatience to spend income and opportunity to invest it*. Fairfield, NJ: A.M. Kelley.
- Hardin, William, Xiaoquan Jiang and Zhonghua Wu. 2012. "REIT Stock Prices with Inflation Hedging and Illusion." *Journal of Real Estate Finance & Economics* 45 (1): 262-287. doi: 10.1007/s11146-010-9259-y.
- Lee, Bong Soo. 2010. "Stock returns and inflation revisited: An evaluation of the inflation illusion hypothesis." *Journal of Banking & Finance* 34 (6): 1257-1273. doi: <http://dx.doi.org/10.1016/j.jbankfin.2009.11.023>.
- Modigliani, Franco and Richard A. Cohn. 1979. "Inflation, Rational Valuation and the Market." *Financial Analysts Journal* 35 (2): 24.
- Norway, Central Bank of. 2016. "Monetary Policy Report." Accessed 1. January 2016. <http://static.norges-bank.no/Publisert/Publikasjoner/Pengepolitisk-rapport-med-vurdering-av-finansiell-stabilitet/>.
- OBI. 2016. "Oslo Børs Informasjon." Accessed 1. January 2016. <http://finance.bi.no/~bernt/obidata/obidata/>.
- Santoli, Michael. 2012. "The Flaws in the Fed Model." *Barron's* 92 (24): 11.
- SSB.no. 2016. "Consumer Price Index." Accessed 1. January 2016. <https://www.ssb.no/statistikkbanken/selecttable/hovedtabellHjem.asp?KortNavnWeb=kpi&CMSSubjectArea=priser-og-prisindekser&PLanguage=1&checked=true>.
- Wei, Chao. 2010. "Inflation and Stock Prices: No Illusion." *Journal of Money, Credit & Banking (Wiley-Blackwell)* 42 (2/3): 325-345. doi: 10.1111/j.1538-4616.2009.00289.x.

Wei, Chao and Fred Joutz. 2011. "Inflation illusion or no illusion: what did pre- and post-war data say?" *Applied Financial Economics* 21 (21): 1599-1603. doi: 10.1080/09603107.2011.587771.

Ødegaard, Bernt A. 2015. Empirics of the Oslo Stock Exchange. Basic, descriptive, results 1980-2014.: Norwegian School of Economics.