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An Analysis of Bull and Bear Markets in the U.S. and Norway

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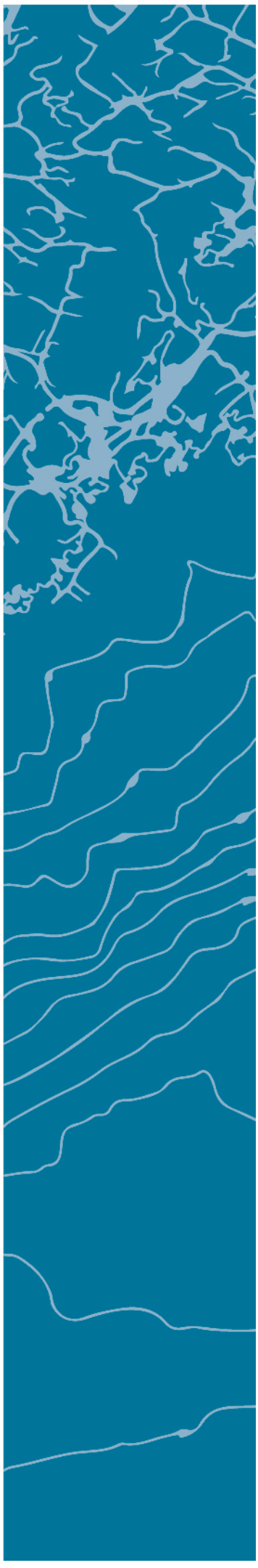

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Master Thesis, MSc, Finance

UNIVERSITY OF AGDER

Preface

This master thesis concludes our Master of Science (M.Sc.) in Economics and Business Administration at the University of Agder (UIA). The purpose of this thesis is to analyze the U.S. and the Norwegian bull and bear market cycles during the period from 1914 to 2016. The thesis is formulated in the same article structure as the inspirational academic research papers we have encountered when completing our research. We would like to thank our supervisor Valeri Zakamouline for his technical supervision and feedback, which is much appreciated.

Contents

An Analysis of Bull and Bear Markets in the U.S. and Norway

Andreas Frøystad and Jørgen Solberg Johansen*

Thursday 1st June, 2017

Abstract

There is no previous research on the dating of bull and bear cycles in the Norwegian stock market. Even for the U.S., few researchers have conducted a thorough analysis of the bull and bear markets. The purpose of this thesis is to provide an analysis of bull and bear markets in the U.S. and Norway from 1914 to 2016. Bull and bear markets are identified using a formal dating method. We divide our datasets into two sub-periods, to account for the robustness of our results. We find that bull markets are longer and bear markets are shorter in the U.S. compared to Norway. We perform a structural break analysis and find a major break in the growth rate in the U.S. and the Norwegian stock market. We see that the dominance of bull markets are almost identical for the U.S. and Norway post-structural break. Additionally, we test the return differences between the first (last) six months and the remaining months of bull and bear market states. These tests reveal evidence that returns are greater (smaller) in the first (last) six months than the remaining for all bull and bear markets, except Norwegian bear markets. Finally, we test the investor overreaction hypothesis on the bull and bear market amplitude and find that the dynamics of the U.S. stock market can partially be explained by investor overreaction.

*University of Agder (UIA), NO-4604 Kristiansand, Norway. We would like to thank our supervisor Valeriy Zakamoulin for his guidance and feedback, which is much appreciated. Main program used in this study is R. Codes are available from the authors upon request.

1 Introduction

Market trends regarding bull and bear markets is a common way of describing cycles in equity prices. Chauvet and Potter (2000) seem to describe the notions in a good way: " In stock market terminology, bull (bear) market corresponds to periods of generally increasing (decreasing) market prices." Still, the dating of bull and bear markets divides the financial community into two groups. One group requires the market price to increase (decrease) substantially to qualify as a bull (bear) market. The other group believes the market price should increase (decrease) over a substantial period, to pass for a bull (bear) market. As of today, there is no unique definition of bull and bear markets. This can partially explain why there is no single preferred method for identifying bull and bear periods in stock price cycles.

Even for the U.S., few researchers have conducted a thorough analysis of the bull and bear markets. Pagan and Sossounov (2003) analyze bull and bear markets in the U.S. using a dating algorithm with the requirement of a minimum length of bull and bear periods. This dating algorithm is based on the formal dating method for identifying turning points in business cycles by Bry and Boschan (1971). In the same line of research, Gonzalez, Powell, Shi, and Wilson (2005) adopt the dating algorithm and illustrate how bull and bear markets can be characterized as time periods with distinct and persistent mean return shifts. Lunde and Timmermann (2004) present another rule-based dating algorithm. They impose a minimum on the price change since the last peak or trough for a new peak or trough to qualify as a turning point (Kole and van Dijk,2010).

Maheu and McCurdy (2000) see to another dating method. This method is the Markow-switching model, which comprises duration dependence to capture non-linear structure in the conditional mean and variance of stock returns. This method was proposed by Hamilton (1989), to model changes in nonstationary time series and the business cycle. To the best of our knowledge, there is no previous research that conducts any of these methods to identify and analyze bull and bear markets in Norway. We are motivated to fill this gap in the literature.

We replicate the studies from Pagan and Sossounov (2003) and Gonzalez et al. (2005) to detect turning points in the U.S. stock market. We wish to analyze the characteristics and dynamics of the bull and bear cycles in the same manner as these studies. Difference between these studies and ours is that Pagan and Sossounov (2003) use stock price data from 1835 to 1997, whereas Gonzalez et al. (2005) use data from 1800 to 2000. We extend their research by using stock price data from January 1802 to December 2016. We also extend their research to study the Norwegian bull and bear markets, by using the U.S. stock market as a benchmark.

We replicate the sample-split analysis from Grobys (2012) to examine the dynamics of the U.S. stock market over time and to check the robustness of our results. However, he uses the 2-state-Markov-switching model by Hamilton (1989) to identify bull and bear markets. Grobys (2012) uses stock price data from January 1954 to February 2011, meaning each sub- sample consists of about 28 years. We create two equal sub-samples from our main sample period (1914 to 2016), such that each sub-sample consists of about 52 years. We extend his research by implementing the sample-split analysis to the Norwegian stock market data.

In the same manner, as Zakamouline (2017), we aim to find the structural break in the growth rate and to analyze the bull and bear markets in these periods. Inspired by the methodology proposed by Muggeo (2003), we replicate Zakamouline (2017) procedure to find a break date in the U.S. stock market. However, he uses a longer time period of stock price data (1857 to 2015), compared to ours. We extend this research to examine the structural break in the growth rate in the Norwegian stock market, and to find the break date.

We replicate the studies from Maheu and McCurdy (2000) and Gonzalez et al. (2005) to test for return differences between the first six months of a bull (bear) phase and the remaining months of the phase. Their studies are centered on U.S. bull and bear markets. Maheu and McCurdy (2000) apply the Markow-switching model to test for return differences, whereas Gonzalez et al. (2005) use the dating method of Bry and Boschan (1971). We extend their research by testing for return differences in the Norweigan bull and bear markets. We continue their research by testing for differences in returns between the last six months of a bull (bear) phase and the remaining. We want to make an illustration of the shape of an average bull (bear) phase curve, by testing the return differences.

Finally, we want to answer the following question: Can the dynamics of the bull and bear market be partially attributed to investor overreaction? To answer this question we see to the study by Bondt and Thaler (1985) who studies the market efficiency and investigates how people tend to overreact to unexpected events. However, their study is not focused on bull and bear cycles, but on stock market returns. We exploit their idea of overreaction among investors, to test the investor overreaction hypothesis on the bull and bear market amplitudes.

By arranging our data into sub-periods of equal length, we find that the U.S. and Norwegian bull and bear markets are different, in regards to mean return and volatility. In the U.S. we find that the duration of bull (bear) phases tend to increase (decrease) over time. However, in Norway, we observe that the duration of bulls and bears tend to decrease. Despite a decrease in the duration of bull markets, we observe a substantial

increase in the bull-to-bear duration ratio in Norway. These findings suggest more bull dominant stock markets in both the U.S. and in Norway.

We find evidence of a major break in the growth rate, in both the U.S. and in Norway. We find a break date in the U.S. stock market in 1943, whereas the corresponding break date in the Norway occurred 35 years later (1978). We find support for the structural break analysis, where we observe an increase in the bull-to-bear duration ratio, and in the proportion of months in bull markets for both the U.S. and Norway. We find that the dynamics of the stock markets are more similar post-structural break.

The analysis reveals that returns in the first six months of a bull (bear) phase are greater than the remaining. This finding holds for both the U.S. and Norwegian stock market. Furthermore, we find that returns in the last six months of a bull (bear) phase are smaller than the remaining. This result is only supported in the U.S. stock market.

We test the investor overreaction hypothesis in bull and bear market amplitudes and find that the dynamics of the U.S. stock market partially can be explained by overreaction among investors, which suggests that investors are not fully rational. This result is only supported in the U.S. stock market, as we do not find evidence for the overreaction hypothesis in the Norwegian stock market.

The rest of the thesis is organized as follows. Section 2 presents a literature review that covers academic papers related ours. Section 3 provides the data, with a brief overview of the stock markets descriptive statistics, and introduces the structural break analysis. Section 4 considers the method for detecting bull and bear markets and reports the testing methods used. Section 5 summarizes the dating of the suggested turning points, descriptive statistics, and findings from the empirical testing. Section 6 discusses our concluding remarks. The appendix is presented at the end.

2 Literature Review

In this section, we review previous studies that analyze bull and bear markets. By studying the most relevant research on subjects that relate to ours, we establish expectations to our findings. The first section undergoes literature on identifying turning points. Second, we review the relevant literature related to descriptive statistics and features of the bull and bear markets.

2.1 Turning Points

Some of the most leading research on characterizing turning points in business cycles was that of Burns and Mitchell (1947). The two key features from their definition of the business cycle are the co-movement among the individual economic variables and the division of business cycles into separate phases or regimes (Diebold and Rudebusch,1994). A contribution to this field of study was made by Bry and Boschan (1971), with their algorithm for identifying turning points in business cycles using smoothed monthly data. This formal dating method applies quantitative dating rules that mirror the qualitative rules of deciding turning points by the National Bureau of Economic Research (NBER).[1] The dating rules recognize a peak (trough) that is higher (lower) than other points within a 6-month window, from both sides. Furthermore, eliminating phases (peak to trough or trough to peak) and cycles (peak to peak or trough to trough) that do not meet the required length of 5 months for a phase and 15 months for a cycle.

Pagan and Sossounov (2003) criticizes Bry and Boschan (1971) use of smoothed data which removes the "outliers" in the cycle. The perception is that some of the most important movements in the series are found in the "outliers" when working with monthly asset price data, and should not be eliminated (See also Canova (1994) and Canova (1999)). They adopt the formal dating method of Bry and Boschan (1971) and modify it to suit asset price data. The first modification is not to use smoothed data. Second is a censoring rule that ignores the minimum phase length requirement when the return in a month is greater (less) than 20% (-20%). An underlying argument for this rule is the stock market crash in October 1987. This market crash would not be considered a bear market due to the length of the decline being too short (only three months). Pagan and Sossounov (2003) also deviate by increasing the window for identifying turning points from 6 to 8 months. Also, by increasing the cycle length from 15 to 16 months and reducing the minimum phase length from 5 to 4 months.

Gonzalez et al. (2005) also modify the formal dating method by Bry and Boschan (1971). They do not smooth the data and apply the censoring rule that eliminates the

[1]The NBER publicly announce and record business cycle turning point dates for the U.S. economy.

minimum phase length requirement. Gonzalez et al. (2005) do not change the parameters from the formal dating method, as they do not find Pagan and Sossounov (2003) arguments sufficient enough. Original for this study is the alteration to the algorithm to detect non-unique (2 or more months in a row) troughs and peaks. That is because their dataset includes several zero-measure returns in the early 19$^{\text{th}}$ century.

Hamilton (1989) introduce the Markov Switching model, a more complicated method for identifying turning points. Harding and Pagan (2003) study if the Markov Switching model, can, in fact, determine cyclical turning points. They compare the parametric Markov-Switching approach with a non-parametric method associated with the NBER. They conclude that the non-parametric methods, such as the dating method by Bry and Boschan (1971), are more straightforward and transparent than parametric approaches.

Lunde and Timmermann (2004) proposes another dating algorithm. Their approach detects bull and bear markets in terms of a filtering rule that tracks movements between local peaks and troughs. They suggest that a certain percent decrease or increase in stock prices is evident, to qualify for a distinct bull or bear market.

2.2 Descriptive Statistics in Bull and Bear Markets

The bull and bear market is of primary interest from both an academic point of view, as it is from a practical point of view. According to Pagan and Sossounov (2003), bull and bear is a common way of describing the market cycles in equity prices. Edwards, Biscarri, and De Gracia (2003) state that previous research on bull and bear, have gained a deeper understanding of how stock markets behave. Grobys (2012) highlights that changes in stock market returns, over time, leads to new implications regarding the asset allocation problem. From an investors perspective, it is of great interest to understand how the market cycles behave in regards to returns, volatilities, and durations (Edwards et al.,2003).

Pagan and Sossounov (2003) examines the descriptive statistics of bull and bear markets, using monthly data from the S&P 500 in the period January 1835 to May 1997. Their results show that the duration of bull markets have increased over time, while the duration of bear markets have declined. Also, an increase in returns of the average bull phase is detected while the returns of the average bear phase have decreased. Gonzalez et al. (2005) expand the research done by Pagan and Sossounov (2003), by conducting a similar analysis, using 200 years of stock market data for the U.S. They find that the duration of bull increases, whereas the duration of bears decreases over the entire sample period. Gonzalez et al. (2005) examine the return differences between the 19$^{\text{th}}$ and 20$^{\text{th}}$ century. They find that the bull and bear market phenomenon effect increase

over time, with higher mean returns in bull markets, and higher negative mean returns in bear markets.[2]

The study by Edwards et al. (2003) apply the dating algorithm proposed by Pagan and Sossounov (2003), to examine the bull and bear markets in Latin American countries, pre- and post-financial liberalization. They find that the bull and bear markets are more stable after the liberalization process, with lower volatilities and amplitudes, and more similar to those of the U.S. and Germany. Edwards et al. (2003) also study differences in bull and bear markets, between emerging countries and more advanced nations. They find that bull and bear cycles in emerging markets consist of larger amplitudes and volatilities, but shorter duration, compared to those of the U.S. and Germany.

Grobys (2012) apply a 2-state-Markov-switching model to figure out the market regimes in the U.S. bull and bear market. They perform a sample split analysis, with two sub-samples of equal length and test the hypothesis that the parameters in bull and bear markets have changed over time. They find evidence for a structural break in expected returns associated with bull market cycles. However, they do not find evidence of a structural break within bear market cycles.

Candelon, Piplack, and Straetmans (2008), use the Bry and Boschan (1971) dating algorithm, to analyses synchronisations and co-movements of bull and bear markets in five East-Asian countries. They apply a technique proposed by Harding and Pagan (2006), to measure that the cycles are either unsynchronized or perfectly synchronised. They find a significant increase in co-movements across these countries in the 1990s.

Maheu and McCurdy (2000) apply a Markov-switching model and proposes a study on bull markets and capital gains, where they find the first months to have significantly higher return gains than the remaining months of the phase. The same study was replicated by Gonzalez et al. (2005), who concluded that the first six months of a bull phase exhibits significantly higher return gains compared to the remaining months in that phase.

2.3 Behavioural Finance

Bondt and Thaler (1985) studies the market efficiency and investigates how people tend to overreact to unexpected and dramatic events. They study the effect of market behaviour and the psychology of individual decision making. They characterise both these classes as evidence of overreaction. They investigate if such behaviour influences the

[2]They also studied the interaction between market phases and trading volume. The results of this study show that periods with falling volume whether a bear or bull market exists, have higher return volatility. They find that the largest differences in mean returns occur in bull markets with rising volume and bear markets with falling volume.

stock market. Their empirical results indicate that portfolios of earlier losers are found to outperform former winners by about 25%, three years after portfolio formation. They conclude that they have found a substantial weak form of market inefficiency because investors tend to overreact to dramatic news events.

Atkins and Dyl (1990) examine the behaviour of common stock prices after larger changes in prices, that occurs during single day trading. They find evidence that the stock market appears to have overreacted compared to the bid-ask spread for individual stocks.

Welch (2000) introduces a study based on short term bull and bear periods (60 days) in the stock market, and how analysts adjust their forecast based on these trends. The analy- sis suggests that investor optimism indicators and bull markets are intertwined, making bull markets more fragile because of the often-misplaced optimism by analysts.

3 Data

This section is a presentation of the data we use in our empirical analysis of this thesis. First, we show details regarding the datasets and their composition. Second, we perform a robustness check with a sample split analysis and compare descriptive statistics for capital returns. Third, we present a structural break analysis and the break dates for the U.S. and Norwegian stock market.

3.1 Data Composition

The datasets comprise indices used in relevant studies and indices that include large capital companies. To ensure a good representation of the stock market cycles, we use the longest possible time series of stock index data (Gonzalez et al.,2005). The thesis uses monthly market data for the U.S. and Norway. The main sample period where the U.S. and Norwegian market overlap, is from January 1914 to December 2016. That gives 1235 observations, which we consider sufficient for an efficient analysis.[3] Some studies have used daily stock prices to account for the bull and bear markets (see Lunde and Timmermann (2004) and Claessens, Kose, and Terrones (2009)). However, Gonzalez et al. (2005) argued that the use of low-frequency data would better capture broad market movements. Therefore, we use a monthly index in our datasets.

[3]See the research of Yan, Powell, Shi, and Xu (2007). They have conducted similar research on the Chinese market with fewer observations.

Table 1

Data Composition

This table summarizes the composition of our data sets. The U.S. data consist of capital returns from 1802 to 1925 (Schwert,1990) and stock price indices from 1926 to 2016 (Amit Goyal and Yahoo Finance). The Norwegian data consist of stock price indices from 1914 to 2016 (Norges Bank and Yahoo Finance). Columns 2 and 3 show the time lapse and source of the data source. Column 4 reports what factors the source is composed off.

Market	Time lapse	Source	Composition
U.S.	Jan 1802 - Dec 1885	Schwert (1990)	Large capital companies
U.S.	Jan 1886 - Dec 1925	Schwert (1990)	Dow Jones portfolio
U.S.	Jan 1926 - Dec 1956	Amit Goyal	S&P 90 U.S. stocks
U.S.	Jan 1957 - Dec 2015	Amit Goyal	S&P 500 U.S. stocks
U.S.	Jan 2016 - Dec 2016	Yahoo Finance	S&P 500 U.S. stocks
Norway	Jan 1914 - Aug 2001	Norges Bank	Large capital companies
Norway	Sep 2001 - Dec 2016	Yahoo Finance	OSEBX

We use capital returns from 1802 to 1925 (Schwert,1990) and stock price indices from 1926 to 2016 (Amit Goyal, and Yahoo Finance) for a reasonable approximation of the U.S. market. The capital gains from the Schwert (1990) index is composed mainly of banking, railroads and insurance companies in the period before 1885, while the Dow Jones portfolio creates the latter period.[4] The index is considered less reliable according to Zakamouline (2017). However, we find the index reliable due to references and usage in previous relevant studies on the subject (see Pagan and Sossounov (2003), Lunde and Timmermann (2004) and Gonzalez et al. (2005)). Data obtained from Amit Goyal[5] and Yahoo Finance[6] consist of the Standard and Poor's (S&P) index. From 1926 to 1956 the first S&P 90 stocks and from 1966 to 2015 the S&P 500 stocks (Amit Goyal). [7] The remaining period from 2015 to 2016 is the S&P 500 obtained from Yahoo Finance. The S&P 500 index serves as a good benchmark for the stock market (Wilson and Jones,2002) and represents nearly 80% of the total stock market value in the U.S. (Lynch and Mendenhall,1996).

To generate a total index for the entire sample period, we use the capital returns from the Schwert index and implement these returns to the stock price index by Amit Goyal. We reverse the price formula to compose the entire index.

[4]The Schwert index range from 1802 to 1987. See Schwert G.W. 1990 for more information.
[5]The data obtained from Amit goyal is downloaded from http://www.hec.unil.ch/agoyal/.
[6]S&P 500 Quote: (GSPC).
[7]See Wilson and Jones (2002) for more details regarding the S&P 90 and S&P 500.

$$P_t = P_{t-1}(1 + R_t) \tag{1}$$

such that,

$$P_{t-1} = \frac{P_t}{(1 + R_t)} \tag{2}$$

where P_t represents the earliest price level from Amit Goyal, and P_{t-1} represents the prior price index level. R_t is the capital return at time t from the Schwert (1990) index.

The Norwegian data consist of stock price indices from 1914 to 2016 (Norges Bank and Yahoo Finance). The stock price indices from Norges Bank range from January 1914 to August 2001.[8] The index has several smaller indices that include manufacturing, banking, insurance, whaling, shipping and various companies. The remaining period consists of the OSEBX (Oslo Stock Exchange Benchmark Index), obtained from Yahoo Finance. [9] The index includes a representative selection of stocks traded on Oslo Stock Exchange and serves as a reasonable market proxy.

To generate a total index for the entire sample period, we use the capital returns from OSEBX and implement these returns to the stock price index by Norges Bank. Capital returns (R_t) are calculated as:

$$R_t = \frac{P_t}{P_{t-1}} - 1 \tag{3}$$

And the price index (P_t) from August 2001 is calculated as:

$$P_t = P_{t-1}(1 + R_t) \tag{4}$$

3.2 Robustness Test

To submit the results from the main sample period as reliable, we check if the stock market dynamics, both in the distant and near past give the same result. According to Ruiz-Arranz and Giuliano (2005), a simple robustness test consists of splitting the total sample into sub-periods, and compare these periods. We divide the total sample period into two equal sub-periods, to check the robustness of the results. The first sub-period range from 1914 to 1965 whereas the second range from 1966 to 2016.

[8]Downloaded from http://www.norges-bank.no/en/Statistics/Historical-monetary-statistics/Stock-price-indices/.

[9]OSE BENCH IDX GI Quote: (OSEBX.OL).

To test the return and volatility differences between Norway and the U.S. we create the null hypothesis

$$H_0 : \mu_{NOR} = \mu_{US} \text{ and } H_0 : \sigma_{NOR} = \sigma_{US},$$

for the total sample period and the two sub-periods. Table 2 reports the hypothesis tests. The hypothesis of equality in return volatility suggests that the markets are different, at the 1% significance level. However, we can not reject the hypothesis of equality in return between Norway and the U.S.

Table 2

Hypothesis test

The table reports the hypothesis tests on equality in mean return and standard deviation between Norway and the U.S. Using Welch two-sample t-test to compare mean returns and the F-test to compare variances. H_0^1 reports the main sample period, H_0^2 reports the first sub-period and H_0^3 reports the second sub-period

Hypoyhesis	p-value	Hypothesis	p-value
$H_0^1 : \mu_{NOR} = \mu_{US}$	0.6	$H_0^1 : \sigma_{NOR} = \sigma_{US}$	0.0
$H_0^2 : \mu_{1NOR} = \mu_{1US}$	0.1	$H_0^2 : \sigma_{1NOR} = \sigma_{1US}$	0.0
$H_0^3 : \mu_{2NOR} = \mu_{2US}$	0.5	$H_0^3 : \sigma_{2NOR} = \sigma_{2US}$	0.0

Table 3 reports the descriptive statistics for the whole sample period and the sub-periods, while Figure 1 displays a graphical picture of the periods. These results suggest that the average returns and volatilities are indeed different for the two sub-periods tested, between the two markets. We find the largest differences in return and standard deviation during the first sub-period (H_0^2 with a p-value = 0.1).

Table 3

Descriptive Statistics for Capital Returns

This table reports statistics for the U.S. and Norway. Panel A shows the main sample period from 1914-2016, whereas Panel B and C display the first (1914-1965) and second (1966-2016) sub-period. Columns 2 - 7 display the mean, standard deviation, kurtosis, skewness, minimum and maximum return.

	Mean	Standard deviation	Kurtosis	Skewness	Min	Max
Panel A: 1914 - 2016						
U.S.	0.60	5.29	9.32	0.27	-29.94	42.22
Norway	0.49	4.60	3.98	-0.32	-29.35	17.62
Panel B: 1914 - 1965						
U.S.	0.58	6.10	9.79	0.50	-29.94	42.22
Norway	0.17	3.30	4.64	0.54	-14.38	17.61
Panel C: 1966 - 2016						
U.S.	0.62	4.30	1.74	-0.41	-21.76	16.31
Norway	0.82	5.60	2.62	-0.59	-29.35	17.07

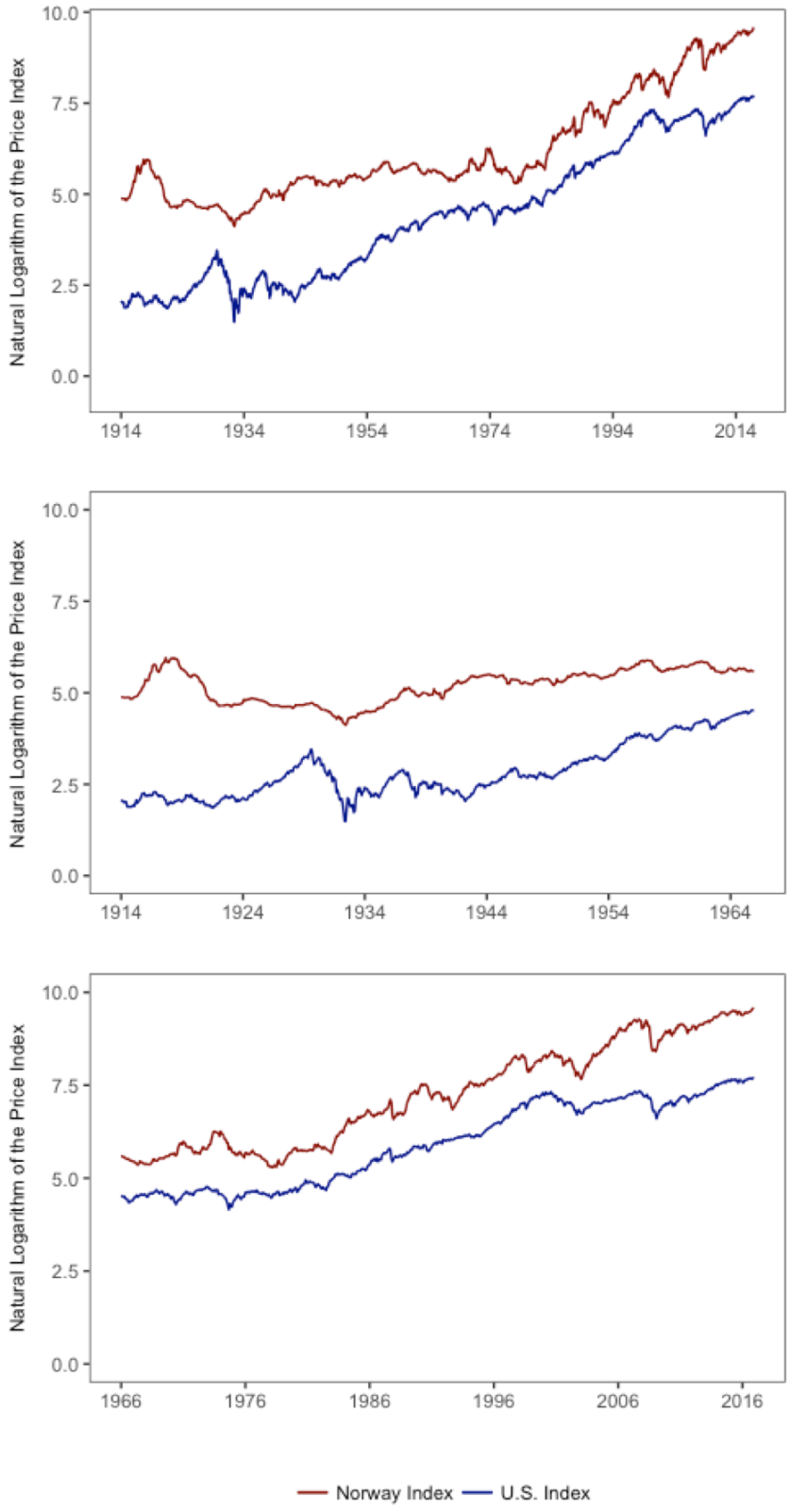


Figure 1: Natural logarithm on the price index for the U.S. and Norway
It is notable that during WWI the U.S. stock market was closed for the period August to November 1914 and from August to September same year for Norway. The equity prices in this time are set constant as of July 1914.

3.3 Structural Breaks in the Stock Market

Over the last century, there was a remarkable increase in stock market returns. The Norwegian stock market experienced a later expansion, compared to more established markets like the U.S. The Norwegian market has grown quite rapidly throughout the years after the oil industry flourished in the late 1960s. We perform a structural break analysis with a twofold goal. First, to verify that there is a larger break in the growth rate for the U.S. and Norwegian market. Second, to find the date when the U.S. and the Norwegian stock market started expanding.

Inspired by (Zeileis, Kleiber, Krämer, and Hornik,2003), we test whether the markets follow a linear model, where the capital return (r_t) at time t for each market is normally distributed with a constant mean return (μ) and variance (σ^2). More formally as $r_t \sim \mathcal{N}(\mu, \sigma^2)$. We consider the following linear model, referring to the logarithmic price index, which represents our null hypothesis.

$$log(I_t) = log(I_0) + \sum_{i=0}^{t} r_i = log(I_0) + \mu t + \epsilon_t, \tag{5}$$

I_0 is the price index level at the start of the time-period, and ϵ_t is normally distributed with zero mean, such that $\epsilon_t \sim \mathcal{N}(0, \sigma^2 t)$. The alternative hypothesis, in this case, is the opposed, that the capital return is not constant, but changes. The sequence of errors (ϵ_t) does not satisfy the conditions for the standard assumptions because it exhibits heteroscedasticity and autocorrelation (Bai and Perron,1998).

To test the null hypothesis, we create a simplified alternative hypothesis, in the same manner as in Zakamouline (2017), where the mean return at time t^* changes from μ to $\mu + \delta$, indicating a structural break in the growth rate.[10] Under this alternative, we consider the following segmented model of the logarithmic price index

$$log(I_t) = log(I_0) + \mu t + \delta(t - t^*)^+ + \epsilon_t, \tag{6}$$

where $(t-t^*)^+$ designates the positive part of the difference in $(t-t^*)$. The true difference between the linear model and the segmented model exists in $\delta(t-t^*)^+$, meaning the null hypothesis $H_0 : \delta = 0$, while the alternative hypothesis, $H_A : \delta \neq 0$. Table 4 reports the results of the estimated models and Figure 2 presents the logarithmic price indices versus the fitted segmented models.

The estimated structural break dates are February 1943 for the U.S. stock market and June 1978 for the Norwegian stock market, for the time period January 1914 to

[10]The breakpoint t^* is found using the methodology presented in Muggeo (2003), and used by Zakamouline (2017).

December 2016. The p-values from Table 4, indicate that we can reject the null hypothesis of constant mean return in the logarithmic price index for both markets, at the 1% significance level ($\delta \neq 0$, but $\delta \approx$ 4.58e-03 (7.29e-03) for the U.S. (Norway)). The segmented model reports a higher R-squared than the linear model (97.4% versus 94.6% for the U.S. and 95.1% versus 78.6% for Norway), and a lower residual standard error (29.5% versus 42.1% for the U.S. and 32% versus 67% for Norway).

Table 4: Linear Model Versus the Segmented Model

The table reports results of the estimated linear model and the segmented model for the U.S. and the Norwegian stock market indices for the time-period 1914 to 2016. Column 1 shows the regression results from the linear model, whereas Column 2 shows the regression results from the segmented model. Panel A refers to the U.S. market, and Panel B refers to the Norwegian market. The brackets report the p-values for the constant and the coefficients.

	Linear model	Segmented model
Panel (A): The U.S. stock market		
Constant log (I_0)	3.37e-01	1.1637
	(0.00)	(0.00)
Coefficient μ	4.95e-03	1.27e-03
	(0.00)	(0.00)
Coefficient δ		4.58e-03
		(0.00)
Adj. R-squared	0.946	0.974
Residual std. error	0.421	0.295
Panel (B): The Norwegian stock market		
Constant log (I0)	-8.92e-01	-1.08e-01
	(0.00)	(0.00)
Coefficient μ	3.59e-03	1.32e-03
	(0.00)	(0.00)
Coefficient δ		7.29e-03
		(0.00)
Adj. R-squared	0.786	0.951
Residual std. error	0.669	0.320

The null hypothesis of constant mean return, under the linear model, shows a monthly mean return of approximately 0.5% (0.36%) for the U.S. (Norway). However, we reject this hypothesis, as we find a major break in the price index level.

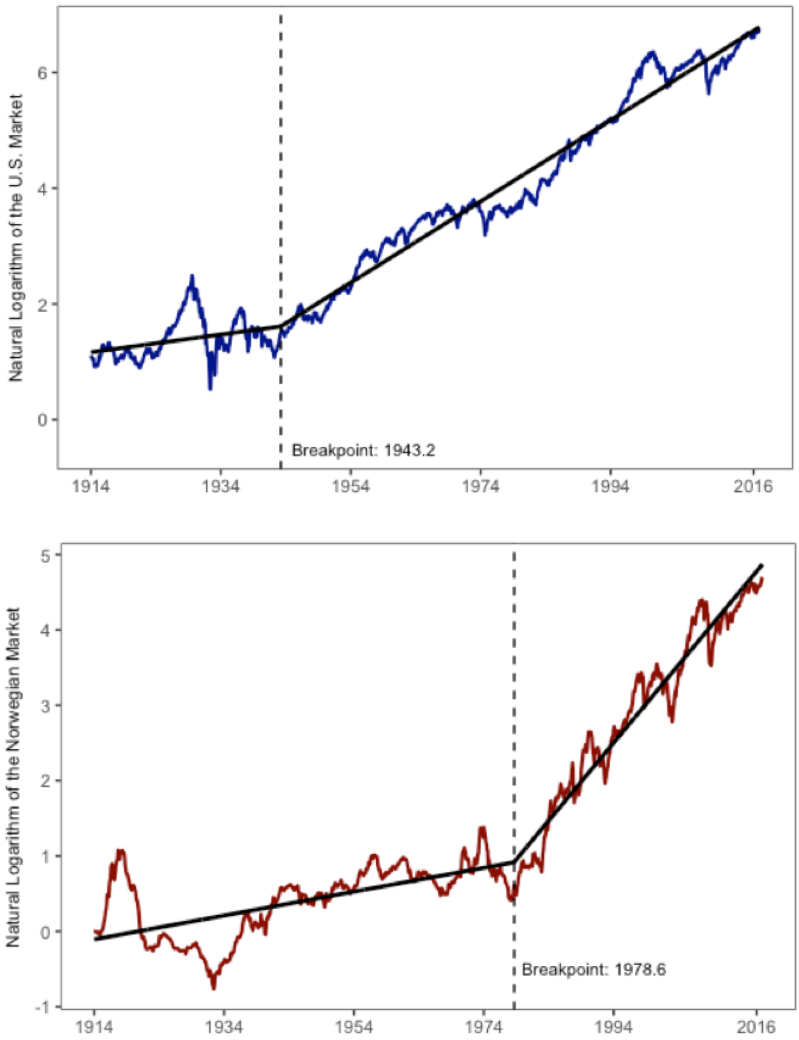


Figure 2: The logarithmic price indices for the U.S. and Norway versus the fitted segmented model.
The figure plots the price indices for the U.S (blue line) and Norway (red line) for the period 1914 to 2016, with the fitted segmented model (black line) to indicate the date of the breakpoint. The fitted segmented model is given by $log(I_t) = log(I_0) + \mu_t + \delta(t - t^*)^+ + \epsilon_t$, where is the capital return before the breakpoint and $\mu + \delta$ represents the capital return after the breakpoint. t^* is the breakpoint date.

By analyzing the pre-and post-structural break periods, for the U.S. and the Norwegian stock market, we find some interesting statistics. For the U.S. stock market, we observe that the average return before February 1943 is 0.37%, with a standard deviation of 7.46%. The returns display leptokurtosis and are positively skewed. For the period after the breakpoint date in the U.S., there is an increase in average return and a decrease in standard deviation. The returns do not display leptokurtosis any longer, while the returns are negatively skewed.

The Norwegian stock market spent most time pre-structural break. Average return for the Norwegian stock market, before June 1978, is 0.12%, whereas the standard deviation is 3.64%. Similar to the U.S., the returns display leptokurtosis and are positively skewed. For the period after 1978, we find that the average monthly return increases by approximately 1%. This finding verifies the a major break in the growth rate for the Norwegian stock market.

Table 5

Descriptive Statistics for Capital Returns

This table reports statistics for the U.S. and Norway. Panel A shows the period from 1914 to the structural break dates, whereas Panel B display the period from the structural break (SB) dates to 2016. Columns 2 - 7 display the mean, standard deviation, kurtosis, skewness, minimum and maximum return.

	Mean	Standard deviation	Kurtosis	Skewness	Min	Max
Panel B: 1914 - SB						
U.S. 1914 - 1943	0.37	7.46	7.03	0.59	-29.94	42.22
Norway 1914 - 1978	0.12	3.64	4.01	0.61	-16.16	17.61
Panel C: SB - 2016						
U.S. 1943 - 2016	0.68	4.13	1.58	-0.42	-21.76	16.30
Norway 1978 - 2016	1.11	5.83	2.87	-0.87	29.35	17.07

4 Methodology

This section presents the methodology for detecting bull and bear markets and the empirical testing. First, we introduce the theoretical framework of the model and different modifications for identifying turning points. Second, we describe how to calculate the statistics for bull and bear phases. Third, we discuss the empirical testing of the statistics for bull and bear phases.

4.1 Turning Point Detection

An algorithm for identifying turning points in business cycles was developed by Bry and Boschan (1971).[11] It seeks to recognize patterns in monthly data which are smoothed, using a sequence of rules. First, the algorithm identifies the location of potential turning points. It finds the local peak (7) at the time t by detecting the highest point in a six-month window on both sides of the point, whereas it identifies the local trough (8) at time t by detecting the lowest point.

$$max\Big(P_{t-6}, ..., P_{t-1}\Big) < P_t > max\Big(P_{t+1}, ..., P_{t+6}\Big) \tag{7}$$

$$min\Big(P_{t-6}, ..., P_{t-1}\Big) > P_t < min\Big(P_{t+1}, ..., P_{t+6}\Big) \tag{8}$$

P_t is the price index at time t. P_{t-6} and P_{t+6} are the price index 6 months before and after the price index at time t. Second, the algorithm measures the duration between turning points and use rules to restrict the length of phases and cycles. A phase (peak to trough or trough to peak) must span at least 5 months, whereas a complete cycle (peak to peak or trough to trough) must span at least 15 months.

We replicate the modifications done in Pagan and Sossounov (2003), to adapt the algorithm to stock market data. The first adjustment is not to smooth the data, as it could remove important findings by eliminating outliers. The second alteration is a censoring rule that ignores the minimum length of a phase requirement when the return in a month is greater than 20% or less than -20%. The marked stock crash in October 1987 is a known historical event that applies to this rule because it lasted only for three months. They also change the original parameters in the algorithm. These changes are adjusting the size of the window from 6 to 8 months, the phase length from 5 to 4 months, and the cycle from 15 to 16 months. However, as of Gonzalez et al. (2005), we do not find their argument for changing the parameters sufficient enough. Also, taking

[11] According to Harding and Pagan (2002) the algorithm gives a good reproduction of the chronology determined by the NBER which consist of a comittee who determines bull and bear markets in the U.S.

into consideration that we analyze two different markets, we find it more convenient to keep the original parameters. Equation 9 displays the parameters we use,

$$[window = 6, censor = 6, phase = 5, cycle = 15, \theta = 20] \tag{9}$$

where the window, censor, phase, and cycle are the monthly parameters, and θ is the percentage threshold for the censoring rule.

4.2 Descriptive Statistics for Bull and Bear Phases

We summarize descriptive statistics for the phases between the detected turning points. There are four measures we find relevant: average duration, average amplitude, average cumulated change and the proportion of severe bull and bear phases.

To separate the bull and bear phases, we define S_t as a dummy variable taking the value 1 if a bull market exists and zero if a bear market exists, at time t. Similarly, B_t defines the dummy variable taking the value 1 if a bear market exists and zero if a bull market exists. Making the total time spent in bull markets $\Sigma_{t=1}^{T} S_t$, and the total time spent in bear markets $\Sigma_{t=1}^{T} B_t$. We define the total numbers of peaks as N_{bull} = Total number of bull phases, and the total number of troughs as N_{bear} = Total number of bear phases.

Duration ($\hat{D}$): The average duration is measured in months of each phase, and calculated as:

$$\hat{D}_{Bull} = \frac{1}{N_{bull}} \sum_{t=1}^{T} S_t, \hat{D}_{Bear} = \frac{1}{N_{bear}} \sum_{t=1}^{T} B_t \tag{10}$$

Amplitude ($\hat{A}$): The average amplitude of each phase is measured in percent, and refers to the total increase (decrease) from the trough (peak) to the peak (trough) in a bull (bear) market. R_t represents the return between a trough and a peak for a bull market, and between a peak and a trough for a bear market. R_t is calculated as $\frac{P_{t,2}}{P_{t,1}} - 1$, where $P_{t,2}$ is the price level at the turning point that ends the phase, and $P_{t,1}$ is the price level at the turning point that starts the phase. The average amplitude is calculated as:

$$\hat{A}_{Bull} = \frac{1}{N_{bull}} \sum_{t=1}^{T} S_t R_t, \hat{A}_{Bear} = \frac{1}{N_{bear}} \sum_{t=1}^{T} B_t R_t \tag{11}$$

Cumulated change ($\hat{C}$): The average cumulative return of the corresponding bull or bear phase is measured as the change in the natural logarithm over the phase. To obtain

the cumulated change over a bull market we define

$$Z_t = S_t Z_{t-1} + S_t \Delta lnP_t \tag{12}$$

where ΔlnP_t is the change in the natural logarithm over the phase. Such that Z_t is the running sum of ΔlnP_t if $S_t = 1$ (To obtain the cumulated change over a bear market we change S_t with B_t).

The average cumulative change in a bull market is then calculated as:

$$\hat{C}_{Bull} = \frac{1}{N_{bull}} \sum_{t=1}^{T} Z_t, \hat{C}_{Bear} = \frac{1}{N_{bear}} \sum_{t=1}^{T} Z_t \tag{13}$$

Proportion of severe bull and bear phases (B^+, B^-): This measure indicates the proportion of bull (bear) markets that exceeds 20% increase (decrease) for a given phase. If the entire sample consists of bull markets greater than 20%, the B^+ indicator would be equal to 1.

$$B^+ = \frac{1}{N_{bull}} \sum_{t=1}^{T} I[S_t(1 - S_{t+1} Z_t^{bull}) > 0.2] \tag{14}$$

$$B^- = \frac{1}{N_{bear}} \sum_{t=1}^{T} I[B_t(1 - B_{t+1} Z_t^{bear}) < -0.2] \tag{15}$$

4.3 Empirical Testing

4.3.1 Hypothesis Test

Methods for testing bull and bear markets descriptive statistics, usually involve employing phase returns to a hypothesis tests at a suitable significance level.

Grobys (2012) apply a 2-State-Markov-Switching model to figure out the market regimes in the U.S. bull and bear market. He performs a sample split analysis, with two sub-samples of equal length. He tests the hypothesis that the parameters in bull and bear markets have not changed over time. We apply this sample split analysis on the Norwegian and the U.S. bull and bear markets, for sub-periods of equal length. Equations 16, 17 and 18 presents the hypothesis tests we employ in this thesis.

Equation 16 test for significant difference in mean returns between the Norwegian ($\mu_{bullNOR}$) and the U.S. (μ_{bullUS}) bull markets.[12] Equation 17 represents a test for significant difference in standard deviation between the Norwegian ($\sigma_{bullNOR}$) and the U.S. (σ_{bullUS}) bull markets[13]. Equation 18 tests for significant difference in returns during the first (last) six months of the phase versus the remaining.

$$H_0^1 : \mu_{bullNOR} = \mu_{bullUS} \tag{16}$$

$$H_0^2 : \sigma_{bullNOR} = \sigma_{bullUS} \tag{17}$$

$$H_0^3 : \mu_{first6} = \mu_{remaining} \tag{18}$$

The μ_{first6} (μ_{last6}) represents the return in the first (last) six months of a given bull or bear phase, and $\mu_{remaining}$ represents the mean for the remaining months of the same phase.

We use a broad aspect of the Welch's t-test on the equality of mean returns between the Norwegian and the U.S. market. We also use it for testing for the return differences between returns during the first (last) six months of the phase and the remaining. Welch's t-test is an adaption of the Student's t-test, and Ruxton (2006) considers it to be more reliable when the two samples have unequal variances or unequal sample sizes. The F-test are implemented to analyze the variances between the two countries and is a measure of equality in variances (Lix, Keselman, and Keselman,1996). Equations 19 and 20 show the calculation of the Welch's t-test and the F-test.

$$t = \frac{\bar{\mu_1} - \bar{\mu_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \tag{19}$$

$$F = \frac{\sigma_1^2}{\sigma_2^2} \tag{20}$$

Where μ_1 (μ_2) and σ_1^2 (σ_2^2) represent the mean return and the variance in the Norwegian (U.S.) stock market.

[12]We perform the same hypothesis test on the equality of mean return for bear markets, and for the two sub-periods.

[13]The hypothesis test on the equality of standard deviation is also tested for bear markets, and for the two sub-periods.

4.3.2 Regression Analysis

Other methods for testing and evaluating the bull and bear market entail employing phase returns to a time-series regressions analysis. However, time-series data of the stock market usually lack the assumption of normal distribution, because of the high level of excess kurtosis (Schmidt,2010). Gonzalez et al. (2005) use regression to test return differences between the first six months of a phase, versus the remaining. [14] We replicate their regression on the return differences between the first six months of a phase and the remaining. We expand their research by also testing the last six months against the remaining. Additionally, we construct a regression analysis on the dependence between bull and bear market amplitudes, to test the overreaction hypothesis. This test is inspired by Bondt and Thaler (1985), to check if investors overreact to larger changes in returns.

$$Return_t = \alpha + \beta D_{Ft} + \epsilon_t \tag{21}$$

$$Return_t = \alpha + \beta D_{Lt} + \epsilon_t \tag{22}$$

$$AmpBear_t = \alpha + \beta AmpBull_{t-1} + \epsilon_t \tag{23}$$

Equations (21) and (22) represent the regression on returns during the first (last) six months of the associated bull and bear phase. The dummy, D_F (D_L), takes the value 1 if in the first (last) six months, and zero otherwise. The constant (α) represents the returns in the remaining months. Equation (23) represents the overreaction hypothesis and is created using vectors of bear phase amplitudes, and bull phase amplitudes from the previous phase.

[14] They also apply regression to test the dependence of bull and bear markets with rising/falling trading volume on the NYSE. Agmon (1973) use regression to analyze the relationship in equity markets in the U.S. Japan, Germany, and the U.K. to look for co-movements.

5 Empirical Results

In this section, we present the identified bull and bear markets and then analyze descriptive statistics for the selected time periods. Furthermore, we examine average returns in bull and bear for the 19^{th} and 20^{th} century. Also, we test for return and volatility differences in the bull and bear markets, between Norway and the U.S. Additionally, we perform tests on return differences in the first (last) six months versus the remaining. Finally, we test if investors are rational or not entirely rational with the overreaction hypothesis.

5.1 Bull and Bear Market Phases

In the process of analyzing the U.S. and the Norwegian bull and bear phases, we highlight some historical events from our findings in Tables 6 and 7. We find a U.S. bear market from September 1929 to July 1932 (35 months), with an amplitude of 85%. This period refers to "The Great Depression". The equivalent bear market in Norway lasted from October 1929 to July 1932 (34 months), with an amplitude of -46%. One of the U.S. longest bull markets from our findings starts some years before The Great Depression. That period lasts from August 1923 to September 1929 (74 months) with an amplitude of astonishingly 294%. We know this period as the "Roaring Twenties."

Our first vital bull market for Norway lasted from July 1932 until September 1937 (62 months) with a 169% amplitude. The longest recorded bull market from our finding for the U.S. started in July 1994 and ended in September 2000 (75 months) with an amplitude of 231%. In history, this is called "The Dotcom Bubble." The equivalent period in Norway consists of two bull markets. The first starts in November 1994 and ends in May 1998. The last starts in November 1998 and ends in October 2000. The two bull markets have amplitudes of 132%, and 77% respectively, while during the bear phase between have an amplitude of -37%. The next and most recent bear market in the U.S. occur in November 2007 and ends in Mars 2009 (17 months) with an -50% amplitude. It is known as "The Global Financial Crisis." In Norway, the length of the financial crisis was shorter, from May 2008 to February 2009 (9 months) but more severe with an -57% amplitude.

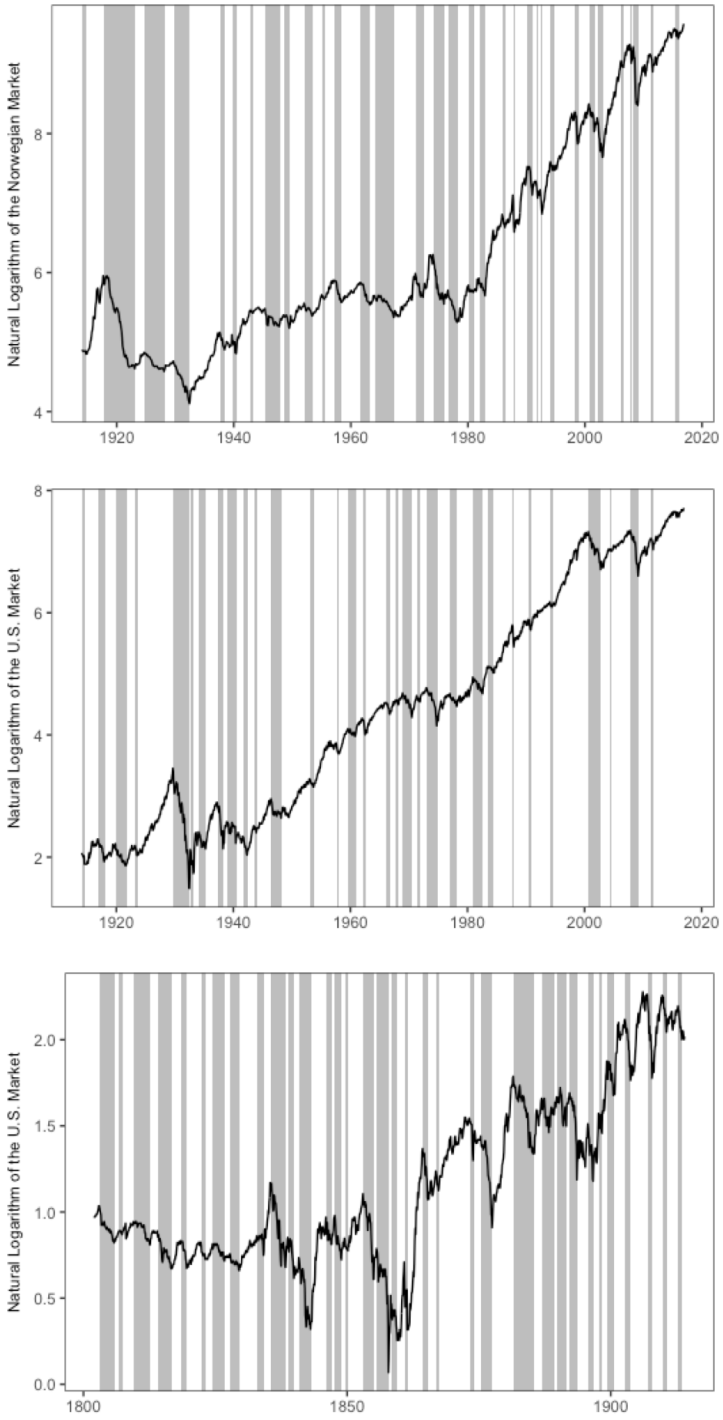


Figure 3: Bull and bear markets on the logarithmic price indices for the U.S and the Norwegian stock markets.
The figure plots the price index for the U.S. and Norway. The shaded areas represent bear markets. We divide the graphical display of the U.S. data, to make it is easier to compare it to the Norwegian data visually. The first figure shows the Norwegian stock market in the time-period 1914-2016. The second and the third figure show the U.S. stock market in the time-period 1914-2016 and 1802-2016, respectively.

Table 6

Bull and Bear Markets in the U.S.

The table reports all bull and bear markets for the entire sample period for the U.S. (1802 to 2016). Column 1 displays the peak to trough dates (bear markets), while Column 4 displays the trough to peak dates (bull markets). Columns 2, 3 and 5, 6 reports the monthly mean phase returns (μ) and the amplitudes (Amp) of the given phases. Note that a bull (bear) phase starts at the beginning of the month, following the trough (peak) date. The end date in a bull (bear) phase is the start date of the next bear (bull) phase.

	Bear markets			Bull markets	
Peak to trough dates	μ (%)	Amp (%)	Trough to peak dates	μ (%)	Amp (%)
			1802 Jan-1802 Dec	0.65	7.21
1802 Dec-1805 Nov	-0.51	-19.23	1805 Nov-1806 Oct	0.53	5.88
1806 Oct-1807 May	-0.16	-2.22	1807 May-1809 Jul	0.21	6.74
1809 Jul-1812 Aug	-0.31	-11.70	1812 Aug-1814 Jan	0.28	8.43
1814 Jan-1816 Sep	-0.52	-16.87	1816 Sep-1818 Jul	0.74	17.64
1818 Jul-1819 Aug	-0.90	-13.93	1819 Aug-1822 Apr	0.35	13.63
1822 Apr-1823 Feb	-0.66	-7.69	1823 Feb-1824 Jul	0.30	8.24
1824 Jul-1826 Oct	-0.18	-6.86	1826 Oct-1827 Oct	0.17	2.06
1827 Oct-1829 Jul	-0.43	-9.09	1829 Jul-1832 Dec	0.51	22.22
1832 Dec 1834 Mar	-0.53	-9.84	1834 Mar-1835 Jun	3.14	49.09
1835 Jun-1838 May	-0.97	-38.20	1838 May-1838 Oct	1.11	12.23
1838 Oct-1839 Dec	-0.99	-16.22	1839 Dec 1840 Nov	0.77	9.78
1840 Nov-1843 Feb	-1.11	-33.22	1843 Feb-1846 Jan	1.88	83.98
1846 Jan-1847 Jan	-0.47	-5.74	1847 Jan-1847 Sep	1.96	18.29
1847 Sep-1848 Dec	-1.04	-21.05	1848 Dec 1849 Jul	0.71	6.25
1849 Jul-1850 Mar	-0.29	-5.95	1850 Mar-1853 Jan	0.81	34.14
1853 Jan-1855 Jan	-1.49	-36.19	1855 Jan-1855 Aug	2.53	19.40
1855 Aug-1857 Nov	-1.71	-50.63	1857 Nov-1858 Apr	6.15	45.23
1858 Apr-1859 Jul	-0.96	-14.54	1859 Jul-1860 Nov	2.48	57.44
1860 Nov-1861 Jun	-3.43	-24.24	1861 Jun-1864 May	4.89	185.90
1864 May-1865 May	-1.69	-22.27	1865 May-1866 Nov	0.75	15.51
1866 Nov-1867 May	-1.37	-9.32	1867 May-1873 Mar	0.69	50.42
1873 Mar-1873 Dec	-1.46	-20.92	1873 Dec 1875 May	0.07	5.05
1875 May-1877 Jul	-1.38	-38.88	1877 Jul-1881 Jul	2.53	131.00
1881 Jul-1885 Jun	-0.71	-33.92	1885 Jun-1886 Dec	1.87	37.80
1886 Dec 1889 Apr	-0.13	-6.68	1889 Apr-1889 Oct	0.90	7.42
1889 Oct-1891 Aug	-0.13	-14.00	1891 Aug-1892 Mar	0.58	7.28
1892 Mar-1893 Aug	-1.81	-37.79	1893 Aug-1895 Sep	0.91	25.41
1895 Sep-1896 Sep	-1.61	-26.98	1896 Sep-1897 Sep	2.41	34.61
1897 Sep-1898 May	-1.36	-7.25	1898 May-1899 May	1.68	33.80
1899 May-1900 Jul	-0.48	-8.94	1900 Jul-1902 Sep	1.87	51.76
1902 Sep-1903 Oct	-2.06	-28.71	1903 Oct-1906 Dec	1.44	61.05
1906 Dec 1907 Nov	-3.09	-36.35	1907 Nov-1909 Oct	2.35	57.18
1909 Oct-1910 Aug	-1.52	-17.97	1910 Aug-1912 Oct	0.35	12.83
1912 Oct-1914 Aug	-1.09	-24.33	1914 Aug-1916 Nov	1.82	50.56
1916 Nov-1917 Dec	-2.12	-30.57	1917 Dec 1919 Nov	0.70	29.25
1919 Nov-1921 Sep	-0.85	-22.40	1921 Sep-1923 Mar	1.69	33.19
1923 Mar-1923 Aug	-1.67	-13.61	**1923 Aug-1929 Sep**	**3.72**	**294.84**
1929 Sep-1932 Jul	**-2.31**	**-85.31**	1932 Jul-1932 Sep	15.71	37.54
1932 Sep-1933 Mar	-4.57	-29.95	1933 Mar-1934 Feb	7.47	90.94
1934 Feb-1935 Apr	-0.97	-21.28	1935 Apr-1937 Mar	3.99	94.93
1937 Mar-1938 Apr	-3.48	-52.56	1938 Apr-1939 Jan	2.92	36.18
1939 Jan-1940 Jun	-1.09	-24.63	1940 Jun-1941 Aug	0.23	4.10
1941 Aug-1942 May	-2.29	-25.63	1942 May-1943 Jul	3.05	51.53
1943 Jul-1943 Dec	-0.02	-5.65	1943 Dec 1946 Jun	1.90	64.35

Table 6 (Continued)

	Bear markets			Bull markets	
Peak to trough dates	μ (%)	Amp (%)	Trough to peak dates	μ (%)	Amp (%)
1946 Jun-1948 Mar	-0.85	-24.03	1948 Mar-1953 Jan	1.27	76.19
1953 Jan-1953 Sep	-1.42	-11.59	1953 Sep-1957 Aug	1.96	105.18
1957 Aug-1958	-1.53	-11.56	1958 Jan-1959 Aug	2.23	45.10
1959 Aug-1960 Nov	-0.45	-10.41	1960 Nov-1962 Jan	1.69	28.82
1962 Jan-1962 Jul	-2.55	-20.46	1962 Jul-1966 Feb	1.30	59.50
1966 Feb-1966 Oct	-1.50	-16.07	1966 Oct-1967 Oct	1.40	20.58
1967 Oct-1968 Mar	-0.78	-4.83	1968 Mar-1968 Dec	1.65	20.14
1968 Dec 1970 Jul	-1.29	-29.98	1970 Jul-1971 May	2.73	33.18
1971 May-1971 Dec	-1.39	-5.66	1971 Dec 1973 Jan	1.03	15.63
1973 Jan-1974 Oct	-1.71	-45.23	1974 Oct-1977 Jan	1.39	45.41
1977 Jan-1978 Mar	-0.89	-14.69	1978 Mar-1980 Dec	1.56	57.51
1980 Dec 1982 Aug	-0.59	-21.11	1982 Aug-1983 Jul	3.24	40.66
1983 Jul-1984 Jun	-0.52	-7.38	1984 Jun-1987 Sep	2.78	115.30
1987 Sep-1987 Dec	-7.66	-28.44	1987 Dec 1990 Jun	1.48	46.19
1990 Jun-1990 Nov	-1.96	-15.08	1990 Nov-1994 Feb	1.14	49.46
1994 Feb-1994 Jul	-0.38	-4.89	**1994 Jul-2000 Sep**	**2.84**	**231.19**
2000 Sep 2002 Oct	-1.51	-43.24	2002 Oct-2004 Mar	1.58	29.26
2004 Mar 2004 Aug	-0.38	-2.17	2004 Aug-2007 Nov	0.86	40.31
2007 Nov 2009 Mar	**-2.85**	**-50.36**	2009 Mar-2011 May	2.60	70.90
2011 May 2011 Oct	-1.34	-15.89	2011 Oct-2016 Dec	1.25	78.63

Table 7

Bull and Bear Markets in Norway

The table reports all bull and bear markets for the entire sample period for Norway (1914 to 2016). Column 1 displays the peak to trough dates (bear markets), while Column 4 displays the trough to peak dates (bull markets). Columns 2, 3 and 5, 6 reports the monthly mean phase returns (μ) and the amplitudes (Amp) of the given phases. Note that a bull (bear) phase starts at the beginning of the month, following the trough (peak) date. The end date in a bull (bear) phase is the start date of the next bear (bull) phase.

	Bear markets			Bull markets	
Peak to trough dates	μ (%)	Amp (%)	Trough to peak dates	μ (%)	Amp (%)
1914 Jan-1914 Nov	-0.45	-4.97	1914 Nov-1917 Oct	5.03	207.26
1917 Oct-1923 Mar	-1.05	-73.72	1923 Mar-1924 Oct	1.00	26.28
1924 Oct-1928 Mar	-0.51	-23.93	1928 Mar-1929 Oct	0.57	15.98
1929 Oct-1932 Jul	**-1.28**	**-45.72**	**1932 Jul-1937 Sep**	**2.64**	**169.32**
1937 Sep-1938 Jul	-1.82	-22.10	1938 Jul-1939 Oct	0.70	23.97
1939 Oct-1940 Jul	-1.10	-23.73	1940 Jul-1942 Dec	2.28	86.88
1942 Dec-1943 May	-0.06	-4.33	1943 May-1945 Jun	0.27	6.90
1945 Jun-1947 Nov	-0.49	-22.73	1947 Nov-1948 Sep	1.02	18.08
1948 Sep-1949 Aug	-0.97	-17.28	1949 Aug-1952 Feb	1.11	43.04
1952 Feb-1953 Jul	-0.71	-16.81	1953 Jul-1955 Feb	1.41	35.64
1955 Feb-1955 Aug	-0.07	-2.84	1955 Aug-1957 Apr	1.32	31.25
1957 Apr-1958 Jun	-1.87	-27.30	1958 Jun-1961 Sep	0.83	33.19
1961 Sep-1963 May	-1.20	-27.54	1963 May-1964 Feb	0.90	14.03
1964 Feb-1967 Jun	-0.61	-26.99	1967 Jun-1971 Feb	1.76	88.43
1971 Feb-1972 Jun	-1.19	-28.89	1972 Jun-1974 Feb	3.00	84.37

Table 7 (Continued)

	Bear markets			Bull markets	
Peak to trough dates	μ (%)	Amp (%)	Trough to peak dates	μ (%)	Amp (%)
1974 Feb-1976 Jan	-1.78	-50.85	1976 Jan-1976 Sep	2.62	21.84
1976 Sep-1978 Apr	-1.63	-36.79	1978 Apr-1980 Mar	2.27	70.15
1980 Mar-1981 Jan	0.09	-7.90	1981 Feb-1981 Dec	1.11	20.01
1981 Dec-1983 Jan	-0.72	-15.20	1983 Feb-1985 Dec	5.31	195.30
1985 Dec-1986 Jun	-1.56	-16.92	1986 Jun-1987 Oct	2.30	59.20
1987 Oct-1988 Jan	-10.46	-41.25	1988 Jan-1990 Apr	4.83	156.46
1990 Apr-1991 Feb	-2.45	-33.46	1991 Feb-1991 Sep	1.37	21.93
1991 Sep-1992 Jan	-2.87	-21.75	1992 Jan-1992 Jun	2.57	12.71
1992 Jun-1992 Oct	-5.08	-29.37	1992 Oct-1994 Mar	5.51	111.88
1994 Mar-1994 Nov	-1.08	-11.66	**1994 Nov-1998 May**	**3.04**	**131.97**
1998 May-1998 Nov	-5.01	-36.88	**1998 Nov-2000 Oct**	**2.38**	**77.52**
2000 Oct-2001 Sep	-2.51	-32.74	2001 Sep-2002 Mar	2.22	21.74
2002 Mar-2003 Feb	-3.47	-43.24	2003 Feb-2006 Apr	6.93	300.49
2006 Apr-2006 Sep	-1.83	-9.00	2006 Sep-2007 Oct	1.73	38.80
2007 Oct-2008 Jan	-4.35	-23.39	2008 Jan-2008 May	2.11	26.25
2008 May-2009 Feb	**-5.56**	**-56.83**	2009 Feb-2011 Apr	3.60	108.60
2011 Apr-2011 Sep	-2.52	-22.21	2011 Sep-2015 May	1.43	85.39
2015 May-2016 Jan	-1.10	-13.13	2016 Jan-2016 Dec	1.89	23.57

5.2 Descriptive Statistics of Bull and Bear Phases

We initiate our analysis on the descriptive statistics of bull and bear phases, by first examining the sub-periods of equal length. Second, we analyze the bull and bear phases before and after the structural break in the growth rate. Third, we examine the average returns in bull and bear markets from the 19$^{\text{th}}$ and 20$^{\text{th}}$ century for the U.S. and the 20$^{\text{th}}$ century for Norway.

5.2.1 Equal Sub-Periods

Table 8 present the descriptive statistics for the U.S. bull and bear phases for the entire sample, the main sample and the equal sub-periods. Over the two sub-periods (1914 to 1965 and 1966 to 2016), the average duration of bear phases declines from about 14 months to 11 months, while the average duration of bull phases grows from about 27 months to 30 months. The bull-to-bear duration ratio increases from 1.98 in the first sub-period, to 2.61 in the second, showing that the dominance of bull markets becomes greater.[15] The findings that U.S. bull markets tend to be longer and U.S. bear markets tend to be shorter, is already stated in the finance literature printed on this subject.[16] Our findings reveal an increase in several of the descriptive statistics from the whole sample period to the main sample period for the U.S. Extreme events during the 20$^{\text{th}}$ and 21$^{\text{st}}$ century like The Great Depression and The Dotcom Bubble may partially explain this increase. On average, for the main sample period, the U.S. stock price index decreases by 23% during bear periods and increases by 64% during bull periods. Over the two equal sub-periods, our results imply that the average amplitude and cumulative return tend to decrease for bull and bear markets (see Panels C and D).

To give an indication of the strength and weakness of the significance in bull and bear markets, the proportion of severe bull and bear markets, perform as a good measure. This measure implies how big proportion of bull markets that exceeds a 20% rise, and how big proportion of bear markets that exceeds a 20% fall. For the main sample period, in the U.S., the proportion of bull phases that exceeded a 20% rise was 87%, and the proportion of bear phases that exceeded a 20% fall was 50%. This observation gives a clear vision of how much stronger bull phases are, compared to bear phases. An interesting result arises from the two sub-periods, where the U.S. experienced a drop in the proportion of severe bull and bear markets at about the same ratio.

[15] The average duration of bull markets divided with the average duration of bear markets.
[16] Empirical results from Gonzalez et al. (2005) and Pagan and Sossounov (2003)

Table 8

Summary Measures of Bull and Bear Markets in the U.S.

The table reports the summary statistics for the U.S. obtained from the formulas presented in Section 4.2 on the average duration ($\hat{D}$), amplitude ($\hat{A}$), cumulated return ($\hat{C}$), return (μ), standard deviation (σ) and the proportion of severe bull and bear phases (B). Whereas the amplitudes, returns and standard deviation are percentage changes, and durations are in months. The average cumulated changes are measured in the natural logarithm of the index for each peak (trough) date. The proportion of severe bull and bear phases are measured by the share of phase returns exceeding 20%. Panels A to D provide the results from the whole sample period, the main sample period, and the first and second sub-period.

	$\hat{D}$	$\hat{A}$	$\hat{C}$	μ	σ	B
Panel A: 1802-2016						
BULL	24.65	48.33	0.32	1.74	4.00	0.66
BEAR	15.84	-21.44	-0.22	-1.81	4.49	0.47
Panel B: 1914-2016						
BULL	28.36	64.4	0.42	1.93	4.50	0.87
BEAR	12.55	-23.16	-0.24	-2.63	5.64	0.50
Panel C: 1914-1965						
BULL	26.96	68.89	0.44	2.12	5.12	0.93
BEAR	13.62	-25.36	-0.29	-2.86	6.62	0.56
Panel D: 1966-2016						
BULL	29.84	59.62	0.40	1.75	3.80	0.80
BEAR	11.42	-20.64	-0.19	-2.35	4.27	0.42

Table 9 reports the descriptive statistics for the Norwegian bull and bear phases, with statistics for the equal sub-periods. Over the two sub-periods for the Norwegian market, the average duration of bears dropped from about 21 months to 11 months, while the average duration of bulls dropped from about 26 months to 21 months. This finding does not support the empirical fact, about the change in duration over time, as in the U.S., but suggests that the Norwegian bull markets behave differently in length. However, the bull-bear ratio increases from 1.23 to 1.95, which is similar to that of the U.S., indicating more dominant bull markets, despite the decrease in average duration.

Our findings on the Norwegian bull and bear markets, over the two sub-periods, implies an increase in amplitude, mean return, standard deviation and the proportion of severe bull and bear phases. The average Norwegian stock price index, in the main sample period, decreases by 20% during bear phases and increases by 58% during bull phases, which are similar to the movements in the U.S. However, the findings from the sub-periods are different with the findings from the U.S. bull and bear markets, which again suggests that the behaviour of Norwegian bull and bear markets differ from the U.S.

Our results on the proportion of severe bull and bear phases in the Norwegian stock market, for the main sample period, suggest that 78% of all bull phases exceed an increase

of 20%, while 66% of all bear phases exceed a decrease of 20%. The proportion in bull phases increases from 70% to 85%, whereas the proportion of bear phases increases from 64% to 68% during the sub-periods. This result is also different from the U.S. market, as the proportion dropped in bull and bear phases, over the second sub-period.

Table 9

Summary Measures of Bull and Bear Markets in Norway.

The table reports the summary statistics for the Norwegian stock market, obtained from the formulas presented in Section 4.2 on the average duration ($\hat{D}$), amplitude ($\hat{A}$), cumulated return ($\hat{C}$), return (μ), standard deviation (σ) and the proportion of severe bull and bear phases (B). Whereas the amplitudes, returns and standard deviation are percentage changes, and durations are in months. The average cumulated changes are measured in the natural logarithm of the index for each peak (trough) date. The proportion of severe bull and bear phases are measured by the share of phase returns exceeding 20%. Panels A to C provide the results from the main sample period, and the first and second sub-period.

	$\hat{D}$	$\hat{A}$	$\hat{C}$	μ	σ	B
Panel A: 1914-2016						
BULL	23.09	58.50	0.39	2.22	4.06	0.78
BEAR	14.88	-20.24	-0.25	-2.20	4.07	0.66
Panel B: 1914-1965						
BULL	25.86	45.44	0.32	1.56	3.16	0.70
BEAR	21.04	-19.69	-0.26	-1.41	2.74	0.64
Panel C: 1966-2016						
BULL	21.29	66.58	0.44	2.74	4.59	0.85
BEAR	10.87	-20.58	-0.25	-3.44	5.31	0.68

5.2.2 Pre-and Post-Structural Break

For the entire sample period, it becomes evident from Panel A in Table 10 that bull markets last longer than bear markets with an average length of 25 months compared to 16 months. Our findings report 1579 months in bull markets and 1000 months in bear markets during this period (61% in bull phase). The average return in bull markets is 1.74%, whereas -1.81% in bear markets. The return volatility is significantly different between the bull and bear states (p-value = 0.02), a finding which implies that bear markets are more likely to be of high volatility states than bull markets.[17] These results are inconsistent with Gonzalez et al. (2005) who argued that bear markets are unlikely to be of exclusively high volatility states. An interesting result is that bull markets report kurtosis of almost three times the kurtosis of bear markets.

[17]Levene's test for homogeneity of variance indicates significant difference between bull and bear market return volatility at the 5% significance level (F-statistics = 5.32). Levene's test is used rather than the F test because of the high level of kurtosis-differences between bulls and bears (from the F-test; F-statistics = 1.6).

Panel B reports the main period 1914 to 2016. Bull markets tend to last longer, while bear markets tend to be shorter, as the recorded months in bull markets is 70% in this period. The bear states appear to be shorter, but the average negative return increases from -1.83% to -2.63%, indicating shorter, but stronger bear markets. The return volatility in bull and bear markets increase, whereas the kurtosis of monthly return in bull markets increase, and decrease for the corresponding bear markets.

Panels C and D report the pre-and post-structural break period (before and after February 1943). We observe an increase (decrease) in the average length of a bull (bear) market. The average length of a bull (bear) market is about 22 (15) months, pre-structural break, while in the post-structural break period, the length of a bull (bear) market decreases to about 32 (11) months. The increase of months in bull market phases during this period (from about 62% to 74%), as well as an increase in the bull-bear ratio (from 1.44 to 2.86), indicates an upward shifting market trend.

Table 10

Descriptive Statistics of Bull and Bear Markets in the U.S.

The table provides the summary descriptive statistics for the bull and bear markets in the U.S. Durations ($\hat{D}$) are in months, max/min cumulative returns (C), monthly returns (μ) and standard deviations (σ) are in percent. SB is the structural break date in February 1943. Panel A and B present the whole sample period and the main sample period. Panel C reports the pre-structural break period, whereas Panel D reports the post-structural break period. *The overlapping maximum (minimum) cumulative return occurred in Aug 1923 (Sep 1929).

	$\hat{D}$	Max C	Min C	μ	σ	Kurt.	Skew.	% bulls
Panel A: 1802-2016								
BULL	24.65	29.84*		1.74	4	15.68	1.88	61.23
BEAR	15.84		-85.31*	-1.81	4.49	5.57	-1.21	
Panel B: 1914-2016								
BULL	28.36	294.84*		1.93	4.5	16.47	2	70.69
BEAR	12.55		-85.31*	-2.63	5.64	3.41	-0.92	
Panel C: 1914-SB								
BULL	21.73	294.84*		2.65	6.4	13.75	2.66	61.9
BEAR	14.97		-85.31*	-3.34	7.58	1.42	-0.64	
Panel D: SB-2016								
BULL	31.51	231.19		1.7	3.65	1.14	-0.09	73.78
BEAR	11.05		-50.36	-2.15	4.1	2	-0.73	

Table 11 reports the descriptive statistics for the Norwegian bull and bear phases. The main sample period in Panel A reports that the average length of a bull market, is 23 months, whereas a bear market is close to 15 months. We observe 752 months within bull markets and 483 months in bear markets for this period (about 61% in bull states). An insignificant difference in return volatility is present for the bull and bear states (4.06 and 4.07)[18].

We observe that the kurtosis of monthly returns for Norwegian bear markets is significantly larger than of Norwegian bull markets, which is the opposite as the observed results from the U.S. This is an indication of more common medium to large deviations from the mean value in bear markets than of bull markets (Schmidt,2010).

Panel B and C report the descriptive statistics from the pre- and post-structural break periods (before and after June 1978). The average length of a bull (bear) market is about 25 (22) months, pre-structural break, while in the post-structural break period, the length of a bull (bear) market decreases to about 21 (7) months. Despite the decrease in bulls, the bull-to-bear duration ratio increases from 1.1 to 2.8, indicating more dominant bull markets in the post-structural break period. We observe an increase in positive and negative returns, in bull and bear markets, in the post-structural break period. This is an interesting finding because the good market states appear to have grown better, despite the bad states have grown worse. The proportion of months in bull markets increases from about 52% to 75%, giving support for the structural break analysis, of an upward shifting trend in the Norwegian stock market.

Table 11

Characteristics of Bull and Bear Markets Norway

The table provides the summary characteristics for the bull and bear markets in Norway. Durations ($\hat{D}$) are in months, max/min cumulative returns (C), monthly returns (μ) and standard deviations (σ) are in percent. SB is the structural break date in June 1978. Panel A presents the main sample period. Panel B reports the pre-structural break period, whereas Panel C reports the post-structural break period. *The maximum (minimum) cumulative return occurred in February 2003 (October 1917).

	$\hat{D}$	Max C	Min C	μ	σ	Kurt.	Skew.	% bulls
Panel A: 1914-2016								
BULL	23.09	300.49		2.22	4.06	1.39	0.58	60.89
BEAR	14.88		-73.72	-2.2	4.07	8.36	-1.92	
Panel B: 1914-SB								
BULL	25.58	207.26		1.66	3.53	4.15	1.31	52.13
BEAR	21.93		-73.72	-1.07	2.95	3.46	-0.76	
Panel C: SB-2016								
BULL	20.74	300.49		2.89	4.53	0.27	0.01	74.84
BEAR	7.39		-56.83	-4.19	6.05	3.24	-1.37	

[18]Levene's test F-statistics = 3.62 (from the F-test; F-statistics = 1).

5.2.3 Average Return in Bull and Bear Phases

An interesting observation is a change in the average returns in bull and bear markets over the 19th and 20th century in the U.S. The average U.S. bull market return increased from 1.47% to 2.05%, while the average U.S. bear market return dropped from -1.25% to -2.57%. In comparison, the Norwegian bull market monthly return in the 20th century are 2.10%, and -1.92% in bear markets.

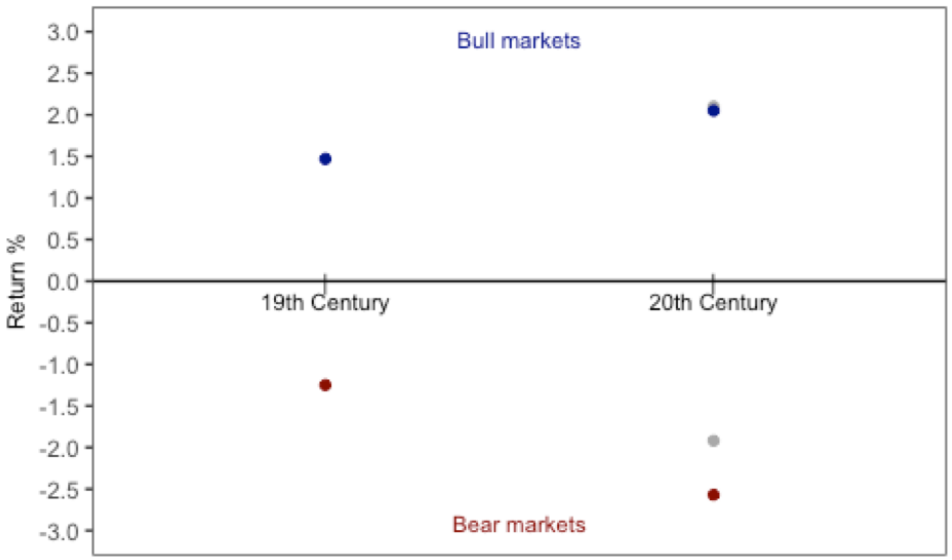


Figure 4: The average return in bull and bear markets each century.
Red circles indicate bear markets in the U.S. and blue circles indicate bull markets in the U.S. The grey circles represent bull and bear markets for Norway, as we only have data for the 20th century.

Table 12 introduces a test on the return differences among the 19th and 20th-century bull and bear states; the differences are statistically significant at the 5% level. The return variations tend to be spread out over time, while both bull and bear phases seemed to be more severe in the 20th century. This observation is consistent with Gonzalez et al. (2005). These observations suggest that the bull and bear phenomenon has become more important in recent times. The overall conclusion is that the good market phases have become better, although the bad states have become worse. Table 12 present these findings together with returns from the Norwegian bull and bear markets over the 20th century. Figure 4 displays graphically the return differences during the 19th and 20th-century bull and bear markets for the U.S. and the 20th-century bull and bear markets for Norway.

Table 12

Average Return in Bull and Bear Markets

The table reports the summary statistics for bull and bear market mean returns over the 19th and 20th century. The U.S. and the Norwegian market are comparable for the 20th century returns. The table introduces a t-test on the return differences among the 19th and 20th century bull and bear markets. *Significant at the 5% level.

	19th century	20th century	t-statistics
U.S. market			
μBull	1.47	2.05	-2.74*
μBear	-1.25	-2.57	3.58*
Norwegian market			
μBull		2.10	
μBear		-1.92	

5.3 Variation in Return and Standard Deviation

Table 13 reports the results of the hypothesis tests on the equality of means and standard deviation between Norway and the U.S. The results from the hypothesis on equality in standard deviation, suggest that we have strong statistical evidence that the volatilities between Norway and the U.S. differ for both the main period and the sub-periods, in the bull and bear market (p-value = 0, for H_0^1 to H_0^6).

For the similarity between the U.S. and Norwegian bull and bear phases, the reported results vary. The hypothesis of equality in the main sample bull period and the main sample bear period, cannot be rejected (p-value = 0.2, for H_0^1 and H_0^2). This is an indication of a positive relationship between the Norwegian and the U.S. bull and bear periods. However, at a 10% significant level, we find strong statistical evidence against equality for all bull and bear markets in the corresponding sub-periods (H_0^3 to H_0^6). This is an interesting observation because the results clearly imply a relation between the main sample periods for the bull and bear markets. This can partially be explained by the previous section, where bigger fluctuations are evident between Norway and the U.S. for the two sub-periods in the bull and bear market phases.

Overall there is statistical evidence of equality between the Norwegian and the U.S. bull and bear market. When testing the robustness of our results, the equality in mean returns appears to withdraw, when comparing mean returns over the two sub-periods. More variation is observed during the sub-periods, which implies that similarities are more frequent in the long-term than in the short- term comparison window. The strongest statistical evidence against equality is observed during the second sub-period for bull markets, and during the first sub-period for bear markets (p-value=0, for H_0^3 and H_0^6).

Table 13

Hypothesis Test on equality of Mean Return and Standard Deviation

The table provides return and standard deviation differences between Norway and the U.S. by testing different hypothesis on equality in mean returns (μ) and standard deviation (σ). Columns 1 and 2 represents the hypothesis tests based on the two-sample t-test by Welch, for mean return differences. Columns 3 and 4 represents the hypothesis tests based on the F-test, to compare variances of unequal length. 1bull(bear) and 2bull(bear) represents the bull (bear) markets in the two sub-periods from 1914-1965 and 1966-2016.

Hypoyhesis	p-value	Hypothesis	p-value
$H_0^1 : \mu_{bullNOR} = \mu_{bullUS}$	0.20	$H_0^1 : \sigma_{bullNOR} = \sigma_{bullUS}$	0.00
$H_0^2 : \mu_{bearNOR} = \mu_{bearUS}$	0.20	$H_0^2 : \sigma_{bearNOR} = \sigma_{bearUS}$	0.00
$H_0^3 : \mu_{1bearNOR} = \mu_{1bearUS}$	0.00	$H_0^3 : \sigma_{1bearNOR} = \sigma_{1bearUS}$	0.00
$H_0^4 : \mu_{2bearNOR} = \mu_{2bearUS}$	0.03	$H_0^4 : \sigma_{2bearNOR} = \sigma_{2bearUS}$	0.00
$H_0^5 : \mu_{1bullNOR} = \mu_{1bullUS}$	0.06	$H_0^5 : \sigma_{1bullNOR} = \sigma_{1bullUS}$	0.00
$H_0^6 : \mu_{2bullNOR} = \mu_{2bullUS}$	0.00	$H_0^6 : \sigma_{2bullNOR} = \sigma_{2bullUS}$	0.00

5.4 Return Differences in Bull and Bear Phases

The Bry and Boschan method for identifying turning points requires six months of subsequent returns, hence, turning points cannot be detected right away. This lag adds some implications to investors interested in selling out at a peak or buying long at a trough. The first six months are therefore extremely important in any bull or bear phase. This can be tested by opposing the returns from the first six months of each phase, with the returns for the remaining months of the same phase. The last six months is equally important in this matter. For instance, if the majority capital gains occur during the last six months of a bull (bear) phase, investors can buy (sell) after the turning point have been recognized, without missing out on the significantly high (low) returns.

The test results for the occurrence of majority capital gains are reported in Tables 15 and 17, by the regressions

$$Return_t = \alpha + \beta D_{Ft} + \epsilon_t \tag{24}$$

$$Return_t = \alpha + \beta D_{Lt} + \epsilon_t \tag{25}$$

where D_F is the dummy variable taking the value 1, if the return is in the first six months of a phase, otherwise it is zero. D_L is the dummy taking value 1, if the return is in the last six months, otherwise zero. The constant represents the mean return in the remaining months of the phase.

The test results from the return differences are reported in Tables 14 and 16, by the

null hypothesis

$$H_0^1 : \mu_{First6} = \mu_{Remaining} \tag{26}$$

$$H_0^2 : \mu_{Last6} = \mu_{Remaining} \tag{27}$$

where μ_{First6} (μ_{Last6}) is the returns in the first (last) six months of the phase, whereas $\mu_{Remaining}$ is the returns in the remaining.

5.4.1 Returns in the first six months

The results presented in Table 15 indicates that the average return during the first six months exhibits a significant bulk of the mean phase return for the U.S. market phases (excluding the bear phases during 1802 to 1914, with a lack of significance). This indication is verified by the results from Table 14, which suggests that the mean returns between the first six and remaining months are greater, than the returns for the remaining months (significant at the 5% level). This finding is consistent with Gonzalez et al. (2005) and Maheu and McCurdy (2000).

The results for the Norwegian market are similar to that of the U.S. market. Table 14 suggests that the return differences are statistical significant (at the 5% level) and that the returns for the first six months are greater than the returns for the remaining, for both bull and bear phases. The stronger relationship suggested by bear markets is based on the mean return differences, where the average return for the first six is twice the return for remaining months.

Table 14

Hypothesis Test on First Six Months against Remaining Months of the Phase
The table presents the t-statistics on the differences in returns between the first six and the remaining months. The t-statistics is calculated over the period 1914 to 2016 for (A) Norway and (B) the U.S. Column 1 reports the t-statistics, whereas Columns 2 and 3 report the mean returns during the first six months and the remaining months, in percent. The p-values are reported in brackets.

	t-Statistics	Mean ret. first six	Mean ret. remaining
(A) Norway			
Bull markets on first six	2.131	2.78	1.95
	(0.04)		
Bear markets on first six	-2.283	-3.29	-1.66
	(0.03)		
(B) U.S.			
Bull markets on first six	2.164	4.86	2.16
	(0.04)		
Bear markets on first six	-2.105	-2.72	-1.61
	(0.04)		

Table 15

Regression Results for Returns in the First Six Months of Bull and Bear Phases
This table reports the relevant statistics obtained by running time-series regressions on the mean return and the returns during the first six months of the phase. Column 1 (4) reports the coefficients, whereas Columns 2 (5) and 3 (6) report the standard errors and t-statistics in bull (bear) phases. Row (A) to (D) shows the results from the Norwegian and for the U.S. market for different time periods. Numbers assigned stars: ***, **, and * indicate significance at the 0%, 1%, and 5% levels, respectively.

	Bull markets			Bear markets		
	Coefficient	S.E.	t-statistics	Coefficient	S.E.	t-statistics
(A) Norwegian market 1914-2016						
Constant	0.011***	0.002	4.01	-0.008*	0.003	-2.274
First six months	0.446***	0.086	5.21	-0.79***	0.071	-11.055
F-value	27.15***			122.2***		
Adj. R-squared	0.45			0.79		
(B) U.S. market 1802-2016						
Constant	-0.001	0.006	-0.203	-0.008**	0.003	-2.990
First six months	0.918***	0.104	8.853	-0.741***	0.11	-6.723
F-value	78.37***			45.19***		
Adj. R-squared	0.54			0.41		
(C) U.S. market 1802-1914						
Constant	0.001	0.002	0.423	-0.013*	0.005	-2.59
First six months	0.826***	0.087	9.512	-0.418	0.332	-1.261
F-value	90.47***			1.59		
Adj. R-squared	0.73			0.02		
(D) U.S. market 1914-2016						
Constant	-0.002	0.013	-0.158	-0.005	0.003	-1.378
First six months	0.927***	0.16	5.786	-0.846***	0.104	-8.137
F-value	33.48***			66.2***		
Adj. R-squared	0.52			0.68		

5.4.2 Returns in the last six months

The results from Table 17, suggests that the last six months has very little explanatory power over the mean phase return for the U.S. (R-squared = 0). The last six months does not show a significant size of the U.S. mean phase returns, for any time-period, in the bull or bear market. Table 16 indicates that there is a significant difference, at the 5% significance level, between the last six and remaining months of the U.S. bear phases. However, the returns during the last six months are less than the remaining (-1.15% against -3.55%). We find no significance for the U.S. bull phases.

The findings for the Norwegian phases, suggest that the sample explanatory power in bear phases explains more than twice the variation in returns compared to bull phases (R-Squared = 0.83 against R-Squared = 0.32). Table 16 indicates that the returns in the last six months, of the bear phases, are significantly different, at the 5% level, compared to the remaining months of the phase. The returns in the last six months of the bear phase is greater than the remaining (-3.12% against -1.52%). We find no significance for the bull phases.

Table 16

Hypothesis Test on Last Six Months against the Remaining Months of the Phase
The table presents the t-statistics on the differences in returns between the last six and the remaining months. The t-statistics is calculated over the period 1914 to 2016 for (A) Norway and (B) the U.S. Column 1 reports the t-statistics, whereas Columns 2 and 3 report the mean returns during the first six months and the remaining months, in percent. The p-values are reported in brackets.

	t-Statistics	Mean ret. last six	Mean ret. remaining
(A) Norway			
Bull markets on last six	0.360	2.44	2.28
	(0.72)		
Bear markets on last six	-2.219	-3.12	-1.52
	(0.03)		
(B) U.S.			
Bull markets on last six	-1.628	1.80	3.77
	(0.11)		
Bear markets on last six	4.570	-1.15	-3.55
	(0.01)		

Table 17

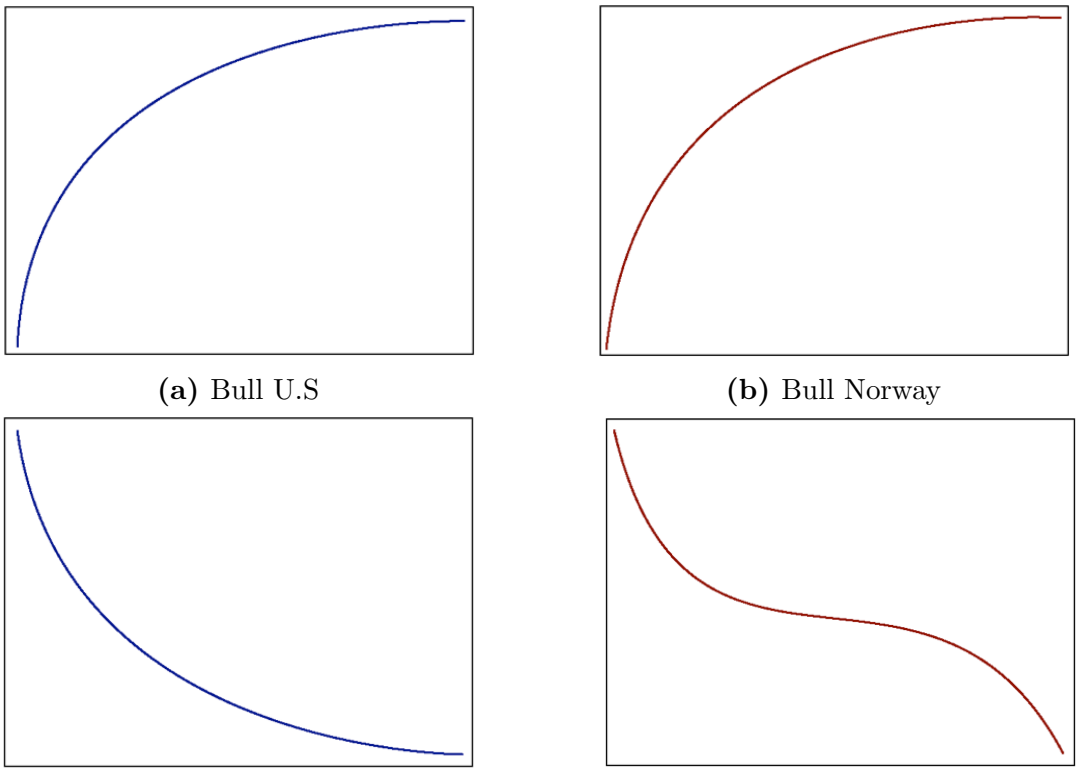
Regression Results for Returns in the Last Six Months of Bull and Bear Phases
This table reports the relevant statistics obtained by running time-series regressions on the mean return and the returns during the last six months of the phase. Column 1 (4) reports the coefficients, whereas Columns 2 (5) and 3 (6) report the standard errors and t-statistics in bull (bear). Row (A) to (D) shows the results from the Norwegian and for the U.S. market for different time periods. Numbers assigned stars: ***, **, and * indicate significance at the 0%, 1%, and 5% levels, respectively.

	Bull markets			Bear markets		
	Coefficient	S.E.	t-statistics	Coefficient	S.E.	t-statistics
(A) Norwegian market 1914-2016						
Constant	0.013***	0.003	4.283	-0.008*	0.003	-2.731
Last six months	0.425***	0.106	3.998	-0.821***	0.064	-12.68
F-value	15.98***			160.75***		
Adj. R-squared	0.32			0.83		
(B) U.S. market 1802-2016						
Constant	0.032**	0.01	3.065	-0.022***	0.004	-6.3
Last six months	-0.058	0.355	-0.163	-0.05	0.158	-0.317
F-value	0.03			0.1		
Adj. R-squared	0			0		
(C) U.S. market 1802-1914						
Constant	0.016***	0.004	4.3	-0.014**	0.005	-2.9
Last six months	0.121	0.106	1.139	-0.231	0.181	-1.281
F-value	1.3			1.64		
Adj. R-squared	0			0		
(D) U.S. market 1914-2016						
Constant	0.06	0.0296	2.029	-0.028***	0.005	-5.481
Last six months	0.954	1.42	0.672	-0.016	0.303	-0.054
F-value	0.45			0		
Adj. R-squared	0			0		

5.4.3 The shape of the curve

These findings can partially explain the average shape of the curve between a bull and a bear phase. The findings from a U.S. bull phase, suggests a significantly high return yield in the first six-month, while the return for the remaining months is diminishing. The results indicate no significance for return differences in the last six months. The average shape of a U.S. bull phase is increasing concave, where the return is diminishing over time. The U.S. bear phases follow a similar pattern, where the first six months is significantly higher than the remaining, while we find no significance in return differences in the last six. The average shape of a bear phase is decreasing convex, with diminishing returns over time.

The findings from the Norwegian bull and bear phases indicate significant return differences in the first six months, whereas the average return in the remaining months is less than the first six. We find no significance in the return differences for the last six months, for the Norwegian bull phases. The average shape of a Norwegian bull phase is increasing concave, with diminishing return over time. We find evidence, from the



(a) Bull U.S **(b)** Bull Norway

(c) Bear U.S. **(d)** Bear Norway

Figure 5: Average Bull and Bear Market Curves.
Figure (a) and (b) display the illustration of the average bull market curve. Figure (c) and (d) display the illustration of the average bear market curve.

returns in the last six months, that they are significantly greater, than the remaining months of the phase. The average shape of a bear phase is decreasing convex in the first months, with diminishing returns in the middle, and decreasing convex at the end.

These results suggest that by connecting turning points with market timing, by identifying bull and bear market states, potentially can accommodate investors with useful information about when to enter and exit the market. Considering the fact that the average bull market lasts 28 (23) months in the U.S. (Norway) and that the average bear market lasts 12 (15) months. All stages of bull markets are good, while all stages of bear markets are bad for investors.

5.5 Interaction between Bear and Bull Market Amplitudes

Inspired by Bondt and Thaler (1985), an indication of the investor overreaction hypothesis is incorporated into the analysis to determine if there is an inter-relationship between bear and bull market amplitudes. The bull and bear amplitudes tested are presented in Tables 6 and 7. The interaction between bear phases and bull phases is examined using

vectors of bull and bear amplitudes. The analysis, therefore, examines the variation in bear amplitudes that can be explained by the previous bull amplitude.

The results are presented in Table 18, for the main sample period, and for the two sub-periods on the Norwegian market and the U.S. market. The findings suggest, for both markets in all time-periods, a negative relationship, which makes sense because the bull amplitudes for both markets are significantly greater than the corresponding bear amplitudes. The negative relationship of less than "negative one", implies an increase in prices over time.

Results from the U.S. market suggest, for the main sample period and for the first sub-period, that the previous bull phase has a significant impact on the following bear phase. However, there is a lack of significance in the analysis for the Norwegian market phases, where we only observe significance in the first sub period (at the 10% significance level). An interesting observation for the Norwegian market is that a rather small fraction of the variance is explained (low adjusted R-squared for all time-periods). According to Kroll, Wright, and Heiens (1999), this is a familiar hallmark in stock market returns, and is an indication of a more unstable market.

Table 18

Regression Results on Dependence between Bull and Bear Market Amplitudes
The table presents the relevant statistics obtained by running time-series regressions on the bull and bear amplitudes in our sample. Column 1 reports the intercepts, Column 2 reports the beta-coefficients, and Columns 3 and 4 report the F-values and the adjusted R-suared. Panel A reports the results for the main sample period, whereas Panel B (C) shows results from the first (second) sub-period. The t-statistics are reported in brackets and the alphas in percent. The linear regression formula is specified as $AmpBear_t = \beta(AmpBull)_{t-1} + t$ where $AmpBear$ is the bear amplitude at time t, and $AmpBull$ is the bull amplitude at time $t-1$. Numbers assigned stars: '***','**', '*' and '.' indicate significance at the 0%, 1%, 5% and 10% levels, respectively.

Model	α	$\beta_{AmpBull}$	F-value	Adj. R-squared
Panel A: 1914.1 - 2016.12				
Norwegian market	-25.70***	-1.084	0.054	0.001
	(-6.40)	(-0.23)		
U.S. market	-12.07**	-1.242***	17.4	0.354
	(-3.28)	(-4.18)		
Panel B: 1914.1 - 1965.12				
Norwegian market	-16.72*	-1.149 .	4.22	0.199
	(-2.94)	(-2.06)		
U.S. market	-11.58*	-1.217***	19.2	0.549
	(-2.52)	(-4.38)		
Panel C: 1966.1 - 2016.12				
Norwegian market	-34.34***	-1.07	2.88	0.095
	(-7.07)	(-1.70)		
U.S. market	-14.04*	-1.108	2.03	0.069
	(-2.37)	(-1.42)		

We find evidence of overreaction among investors in the U.S. stock market, in the main sample period. However, this result is not robust, as we do not find evidence of overreaction in both sub-periods. The observed overreaction in the U.S. can partially be explained by higher levels of amplitudes in the U.S. than in Norway (64% against 58% and -23% against -20% in the main sample period).

6 Conclusion

This thesis seeks to detect and analyze bull and bear markets in the U.S. and Norway, using monthly stock index data from 1802 to 2016 for the U.S. and 1914 to 2016 for Norway. We apply the dating algorithm of Pagan and Sossounov (2003) to identify bull and bear cycles in the stock market. We divide our datasets into two sub-periods, to account for the robustness of our results.

We observe that bull markets are longer and bear markets are shorter in the U.S. compared to Norway in the main sample period. Additionally, severe bull markets occur more frequently, and severe bear markets are more uncommon in the U.S compared to Norway. However, the Norwegian market appears to be less volatile for both bull and bear markets in this period. To evaluate if these results are reliable, we perform a simple robustness test by splitting the period into two sub-periods of equal length. Bull markets are longer, and bear markets are shorter in the U.S. compared to Norway during the first and the second sub-period, suggesting that these findings are robust. However, the U.S. bull and bear markets are less volatile than the Norwegian market in the second sub-period. Furthermore, severe bull markets occur more frequently in the second sub-period for Norway than the U.S. implying that the market dynamics is changing over time.

We find evidence of a structural break in the growth rate, implying a shift in the market. The break dates are February 1943 for the U.S. and June 1978 for Norway. The bull market dominance in the post-structural break period is almost identical for the U.S. and Norway. We also see that the bull to bear duration ratio are fairly the same, which could point out that the markets are more similar after the breakpoints. Still, the post-structural break period for the U.S is 35 years longer than that of Norway.

We fail to reject the hypothesis of equality in mean return and standard deviation, between the U.S. and Norwegian bull (bear) markets over the main sample period. When testing the robustness of these results, we find that the bull (bear) markets are different regarding mean return and standard deviation. We find that similarities are more frequent in the long-term (main sample) than in the short-term (sub-sample) window.

We examine the return differences in bull (bear) markets. We find that returns in the first six months of a phase are significantly greater than the remaining, for bull and bear phases, in Norway and the U.S. We find that returns in the last six months are smaller than the remaining, except for Norwegian bear phases. These findings can illustrate the average shape of the cycle. The U.S. and Norwegian bull phase curve appear to be increasingly concave, whereas the U.S. and Norwegian bear phase curve, seems to be decreasingly convex and decreasingly monotonic.

Finally, we test the investor overreaction hypothesis in bull and bear amplitudes. We find that the dynamics of the U.S. stock market partially can be explained by overreaction among investors, which suggests that investors are not fully rational. However, we do not find evidence of overreaction in Norwegian bull and bear amplitudes. This can partially be explained by smaller observed amplitudes in the Norwegian bull and bear market.

This analysis demonstrates how bull and bear cycles, in two different stock markets, can be identified and characterized, as previous studies have done before us. Our findings regarding the characteristics and dating of the U.S. bull and bear cycles are similar to the study done by Gonzalez et al. (2005).

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7 Appendix

Reflection Note, Andreas Frøystad

Conclusion and findings

Our thesis seeks to detect and analyse the bull and bear markets in the U.S. and Norway, using monthly stock index data from 1802 to 2016 for the U.S. and 1914 to 2016 for Norway. We use a formal dating method proposed by Bry and Boschan (1971) to identify turning points in the stock market cycle. We identify turning points to detect the troughs and peaks, which suggests the bull and bear cycles.

We find evidence of a structural break in the growth rate, meaning there is a shift in the market trend. The breakpoint dates are February 1943 for the U.S. and June 1978 for Norway. We analyse the bull and bear markets in the main sample period, and for these sub-periods, to account for changes in the stock market trends. We find that the bull and bear markets in the post-structural break is more similar in terms of length, compared to pre-structural break and the main sample period. We check the robustness of our results from the main sample period, by a sample split analysis (sub-periods of equal length). We find that similarities, regarding mean return and volatility, are more frequent in the long-term than in the short-term comparison window.

Furthermore, we examine the investor interest aspect of bull and bear markets. We find that returns in the first six months of a phase are significantly greater than the remaining, for bull and bear phases, in Norway and the U.S. We find that returns in the last six months are smaller than the remaining, except the Norwegian bear markets. These findings can partially explain the average shape of the cycle, where the U.S. and Norwegian bull phase curve, appears to be increasingly concave, while the U.S. and Norwegian bear phase curve, seems to be decreasingly convex and decreasingly monotonic.

Finally, we test the investor overreaction hypothesis in bull and bear amplitudes. We find that the dynamics of the U.S. stock market partially can be explained by overreaction among investors, which suggests that investors are not fully rational. However, we do not find evidence of overreaction in Norwegian bull and bear amplitudes, which can partially be explained by smaller observed amplitudes in the Norwegian bull and bear market.

International forces

International trends are the foundation of our analysis, as we investigate the dynamics in international stock markets. Norway, as a smaller economy is influenced by international stock prices and stock markets in bigger economies, like the U.S. However, the Norwegian stock market is highly affected by international forces like oil prices. Oil prices are affected by demand and supply in the market. Norway is an oil nation, built on oil money. The oil crisis, which occurred a few years ago, was a game changer for the Norwegian economy. The reduction in oil prices meant less income to oil companies, causing stock prices to fall. Investors reacted to this by selling oil related stocks. The market effect of this crisis, was an increase in prices of non-oil companies, i.e. airline companies which uses oil as fuel for their airplanes. The U.S. stock market is less volatile to oil price changes, as the biggest companies in the U.S. is more technological (Apple, Microsoft, Amazon etc.) and commodity (Wall Mart) related. However, the U.S. stock market is influenced by other international forces, like the growth rate in China and India. Relevant forced like population growth, and an increase (decrease) in welfare among the population are important aspects for the U.S. stock market. Lets assume that the demand for expensive goods and services drop in China and India. The U.S. is a big supplier of these goods, and the market is over-supplied, causing a decrease in income and lower stock prices. Changes in economic situations are forces that affect all international stock markets.

Innovation

The attention around innovation in the stock market is remarkable. Mainly covering the aspect of artificial intelligence. A gap in the market place today is well performing funds that does not require high premiums. A question today is: Does fund performance depend on skilled fund managers or purely luck? The problem is that an average investor pays a fund managers to invest his money, at the cost of a premium. This matter does not change whether the fund manager outperforms the market, or underperforms the market. This need can be covered by artificial intelligence, with lower premiums. Our thesis is based on stock market return in good market states and in bad market states. The problem with these market states is that investors act accordingly, and might overreact to dramatic news events. This is an indication of an inefficient market and suggests that investors are not fully rational. This is a gap, not covered by existing services. A product that would meet this gap, is an artificial intelligence product that can calculate the true effect of dramatic news events. This would certainly remove outliers in stock prices and lower the levels of amplitudes (cumulative return) in the stock market.

Responsibility

Ethical problems concerning stock markets have been a heated discussion over the last century. Especially regarding stock brokers, and their ability to sell stocks rather than to analyse and find winner stocks. This is an ethical problem, because stock brokers get their premiums if they can trade on behalf of an investor, not regarding the actual profit of the investment. This hurts the local environment among investors. However, this thesis concerns market trends in terms of bull and bear markets. Financial crisis (a substantial bear market) hurts the global environment through lower income among companies and a decrease in welfare for an average investor. The importance of dating bull and bear markets, as we do in this thesis, might assist the average investors knowledge of how to understand these market trends. Another problem that arises is that investors might be subject to loosing borrowed money. This responsibility can be covered by the government on the lending practises. Other regulations issued by the government might affect stock prices and an average investors profit from stock trading, through taxes on stock income and dividend income. Lowering taxes in stock income might influence investors in a positive way.

Reflection Note, Jørgen Solberg Johansen

Conclusion

Our thesis seeks to date bull and bear markets in the U.S. and Norway. Furthermore, analyze these periods in time and compare the results. We used monthly stock index data from 1802 to 2016 for the U.S. and 1914 to 2016 for Norway. Our method for detection these phases is a dating algorithm proposed by Bry and Boschan (1971).

To check for robustness in our results, we conduct a sample split to account for changes in the stock market trends. We find that similarities, regarding mean return and volatility, are more frequent in the long-term than in the short-term comparison window. We also perform a structural break analysis and detect a shift in the market for the U.S. and Norway. We find that bull and bear markets between the U.S. and Norway tend to be similar after the breakpoint date.

We seek to investigate the investor interest aspect of bull and bear phases. Our results show that returns in the first six months of a phase are greater than the remaining months in bull and bear markets for the U.S. and Norway. The Norwegian and the U.S bull phases appear to be increasingly concave. Bear phases in the U.S. markets appear to be decreasingly convex while bear phases in the Norwegian market appear to be decreasingly monotonic.

Finally, we test the investor overreaction hypothesis in bull and bear amplitudes. Our findings suggest that the overreaction among investors can partially explain the dynamics of the U.S. stock market. This suggests that the investors are not fully rational.

International forces

The U.S. stock market in influenced by a number of international forces. i.e. the supply and demand for goods and services produced in the U.S. Relevant forced like population growth, and an increase (decrease) in welfare among the population are important aspects of the U.S. stock market. These forces affect the stock market in terms of purchasing power. Other stock markets affect the U.S. market, like the stock markets in Japan and China. When the U.S. market opens, the Asian markets are closed, because of the time difference. If the Asian markets performed badly, then this decrease is likely to reflect upon the opening hours of the U.S. market. The Norwegian market is also subject to dependant on these stock markets. If there is investor pessimism in the U.S., we will most likely witness this pessimism in Norway. Considering that Norway is an oil nation, the Norwegian stock market is highly dependent on oil prices and the

demand for oil in the economy. If China states that they will move away from using oil as a primary source of fuel, the oil price will drop and affect the Norwegian market in a bad way. If OPEC states that they will increase their supply, and overrun the market on oil, the oil price will drop, and likewise the Norwegian stock market. The bull and bear market is commonly described as market trends. These trends are affected by changes in the economy and different forces that affect the stock market.

Innovation

Our thesis is based on stock market return in good market states and in bad market states, namely called bull and bear markets. The problem with these markets is that investors might overreact to dramatic news events. This is an indication of an inefficient market and suggests that investors are not fully rational. This is a gap, not covered by existing services. A product that would meet this gap, is a product that can calculate the true effect of dramatic news events. This would certainly lower the levels of amplitudes in the stock market. However, the financial market is evolving and is moving in a more standardized way, as a result of new technology. Meaning a more digital market, with less human interference. Analysis computed by computers and computer-driven funds.

Responsibility

Financial crisis (a substantial bear market) hurts the global environment through lower income among companies and a decrease in welfare for an average investor. The importance of dating bull and bear markets, as we do in this thesis, might assist the average investor's knowledge of how to understand these market trends. Another problem that arises is that investors might be subject to loosing borrowed money. This responsibility can be covered by the government on the lending practices. Other regulations issued by the government might affect stock prices and an average investors profit from stock trading, through taxes on stock income and dividend income. Lowering taxes on stock income might influence investors in a positive way. Ethical problems arise from the stock market. Ethical problems like mispriced assets and misplaced optimism by an analyst. This problem leads back to the assumption of skilled fund managers, who gain on other peoples investments. This assumption lacks proof, which might imply that the performance is based on luck.