Emma-Sophie Doksæter
Jonas Aarum Bøckmann

Is there a bubble within ESG stocks on Oslo Stock Exchange?

An empirical analysis of the low risk rated ESG stocks in Norway

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Abstract

The purpose of this master thesis is to examine whether there is a financial bubble within ESG stocks on Oslo Stock Exchange. To research the thesis question, we apply both a quantitative and a qualitative method. The main analysis is performed with a bubble model proposed by Cuthbertson and Nitzsche (2004). The bubble model is based on a valuation model including a bubble term. In the spirit of Anderson and Brooks (2014), the model is further incorporated into a regression specification to perform statistical tests for the presence of a bubble. In addition, we include bubble theory in the form of Shiller's indicator list (2016) to further analyze the ESG segment in the Norwegian stock market. The period studied extends from 2015 to 2020.

We apply the bubble model to a constructed portfolio consisting of the 17 lowest ESG risk rated stocks on Oslo Stock Exchange. In other words, we analyze the most sustainable and green companies in the Norwegian financial market, provided by the database Sustainalytics. An equally weighted portfolio is considered in the main analysis, while a value weighted portfolio is used in a robustness check. The bubble model is approached with both a one- and three-factor model based on research from Fama and French (1993), taking different systematic risk factors into account. We obtain data consisting of monthly observations for returns, dividend yields and market capitalizations from the 17 firms in the portfolio. The data is collected from the Refinitiv database. When approaching Shiller's indicator list, we study empirical evidence based on the market environment in the Norwegian stock market.

The results from the regression for an equally weighted ESG portfolio provide support for the bubble model, both in the one- and three-factor model. This indicates that there is a bubble present in the data. Although, there is some uncertainty related to regression results. Taking Schiller's indicator list into account, the general assessment points in the direction of a bubble. Some of Schiller's criteria are ambiguous, but the overall analysis implies the presence of a bubble in ESG stocks in the Norwegian market. Based on the results from both approaches, we find evidence for our thesis statement being true; there is a bubble within ESG stocks on Oslo Stock Exchange.

Preface

This master thesis was written at Oslo Metropolitan University in the spring of 2021 as the final part of our master's program in business administration (MBA).

The theme about bubbles in financial markets quickly became a natural thesis for us, as we are involved in the stock market ourselves. In addition, we have a genuine interest in the topic of green and sustainable investments, and we find the financial markets and their pricing mechanism fascinating.

There is increasing interest in ESG stocks in general, and the topic of an ESG bubble is an ever-recurring theme in the media. Based on this, we think it is interesting to immerse ourselves in the matter to understand better the factors that affect the stock market. Working on the thesis, we have experienced applying economic theory and taking a deep dive into such a topic. We have also learned an incredible amount when it comes to obtaining data material and processing it. Writing the master thesis has been time-consuming and challenging, but at the same time exciting and educational as the task has progressed. Finally, we would like to thank our supervisor, Associate Professor in Finance, Johann Reindl, for all the guidance and advice along the way.

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Emma-Sophie Doksæter

Jonas Aarum Bøckmann

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1. Introduction

1.1 Background

Green shares make up more than eight percent of the total market value of the shares on Oslo Stock Exchange (OSE) today. This is a doubling compared to 2019, when green shares only made up about four percent. Six years ago, in 2015, these shares only accounted for two percent. The significant increase is driven by new green companies listed (IPOS) along with abnormal growth in stock prices for these specific companies (Oslo Stock Exchange, 2020). The focus on these typical green stocks and the interest around such investments align with the ever-increasing focus on sustainability, climate change, and new regulations and laws regarding pollution. Therefore, there is no doubt that companies that operate in this segment are a part of the future - also in capital markets. However, the question arises whether the prices of these green shares have risen too quickly, thus separated itself from the fundamental or fair value of the stock, in other words, a financial bubble.

People today are more aware of environmental and sustainability perspectives, both in the way they live, and when investing their money and what companies they want to support. A measurement on how sustainable or “green” a company or a stock is, could be expressed through the so-called ESG risk rating, which Morningstar’s Sustainalytics develop. ESG is an abbreviation for Environmental, Social and Governance. The rating addresses the environment in general, such as energy use, waste, pollution, resource and treatment towards nature and animals, along with the relationship towards investors, employees, local community, and economic transparency. A low risk rating score means that the company takes these aspects into account and is successful in doing so. To a greater extent than before, investors today use ESG scores as an essential screening criteria when deciding which stocks to invest in. In turn, this leads to a higher demand for companies with a low ESG risk score, and since there are only as many green shares outstanding, it has resulted in a relatively high valuation in these stocks. The focus on the ESG label has brought up a discussion in the media and among investors whether the increasing demand, and thereby high prices, is sustainable.

The high pricing in ESG stocks has introduced an ongoing debate on whether it will result in an imploded financial bubble or not. Historically, an abnormal increase in value in a short amount of time has led to a bursting bubble, e.g., the dot-com bubble in 2000. However, investors and analysts are split when it comes to the speculations around a potential ESG bubble. On one side, we have those who reject an ESG-bubble, for instance, DNB-asset manager Øyvind Fjeld. He believes that the green trend ruling the capital markets today is just in an early stage, and that today's pricing does not reflect a bubble. He argues that there is instead a high valuation that is justified through the implementation of the EU's new green deal and other growth drivers in this green sector (Finansavisen, 2020). On the other hand, we have Professor Ola Grytten in economic history at NHH. He believes that the overpricing could cause a significant correction in the near future, a bursting bubble. Therefore, he argues that the financial aspects around ESG stocks and the following pricing have turned into a trend that has no root in fundamentals (NRK, 2020). The speculations around it being a bubble or a stable new trend, therefore, remains undisclosed. This is what lays the foundation for our thesis statement:

"Is there a bubble within ESG stocks on Oslo Stock Exchange?"

1.2 Limitations

The thesis aims to investigate if there is a potential bubble within ESG stocks in the Norwegian stock market. Our analysis is thereby limited to the stock market in Norway, more specifically, Oslo Stock Exchange. 91 of 279 companies listed on OSE have an ESG rating through the database Sustainalytics, where the stocks that are rated with the lowest ESG risk rating are studied. In this thesis, a low ESG risk rating means that the firm has a low risk of being affected by environmental, social and governance-related issues. In other words, only the most sustainable companies are considered in the thesis when taking all the aspects of ESG risk into account. The length of the time series we use in our analysis depends on both relevance to the thesis statement and data availability. The time frame extends from 2015 to 2020 because this is the period where ESG stocks have started their significant growth, following increasing interest from investors.

1.3 Methodological approach

To analyze the thesis statement, we have chosen to primarily use a quantitative approach where we consider a classic valuation model. The valuation model is based on Cuthbertson and Nitzsche (2004) and their proposed rational valuation model, which includes a bubble term that captures a growing bubble, i.e., a bubble model. Following Anderson and Brooks (2014), we create a regression specification based on the rational valuation model to perform statistical analysis on the data. We consider both a one- and three-factor model based on research from Fama and French (1993), taking different systematic risk factors into account. To further discuss the thesis, we consider previous bubble theory mainly based on Shiller (2016) and historical events such as the dot-com bubble in 2000. A hypothesis is constructed to highlight the thesis statement, which we want to accept or reject based on the two different approaches. By considering a qualitative and a quantitative approach, it will contribute to giving a comprehensive understanding of the ongoing growth in the ESG stocks on Oslo Stock Exchange.

2. Previous research

2.1 Capital Asset Pricing Model (CAPM)

The CAPM is the equilibrium model that underlies all modern financial theory. It gives a precise prediction of the relationship that we should observe between the risk of an asset and its expected return. It mainly serves two functions; it provides a benchmark rate of return for evaluating possible investments, and it allows to guess the price of an asset that has not been traded yet. The CAPM consists of variables, as seen in the equation below (Bodi, Kane and Marcus, 2018).

$$E(r_i) = i + \beta_i[E(r_m) - i]$$

The expected return ($E(r_i)$) in the CAPM is equal to the risk-free return (i) plus Beta (β_i) times the market risk premium ($E(r_m) - i$). The Beta represents the asset's systematic risk and indicates how the asset performs compared to the market. It is possible to test the relationship and whether it holds in financial data using, e.g., a time-series regression. The linear relationship between the expected security return and the market risk premium proposes using linear regression. Still, it is also possible to use other regression approaches to test the CAPM (Bodi et al., 2018).

The model consists of a set of assumptions and predictions as well as a logical development of the CAPM through manipulation of those assumptions. Bekaert and Hodrick (2008, p. 446) list these assumptions and predictions, found below:

1. There is a single-period investment horizon
2. Individual investors are price takers
3. Investments are limited to traded financial assets
4. There are no taxes and transaction costs
5. Information is costless and available to all investors
6. Investors are rational mean-variance optimizers
7. Expectations are homogenous; that is, all investors agree on the expected return, standard deviation and covariance between security returns.

(List 1, collected from Bekaert and Hodrick, 2008, p. 446)

The CAPM predictions are as follows:

1. All investors hold the same portfolio of risky assets, called the market portfolio.
2. The market portfolio contains securities and the proportion of each security is its market value as a percentage of total market value.
3. The risk premium on the market depends on the average risk aversion of all market participants.
4. The risk premium on individual security is a function of its covariance with the market portfolio.

(List 2, collected from Bekaert and Hodrick, 2008, p. 446)

2.1.1 CAPM limitations

The underlying assumptions and predictions are theoretical and would not apply in the real world, limiting the model predictions. Individuals care about mean and variance, which is not always what investors care about in reality. The assumptions overlook human capital and private enterprises as it claims that all assets are publicly held. Managing transaction costs is also an issue since such costs, in reality, make the values of an asset respond more slowly to new information (Bodie et al., 2018). The assumptions are strict, but it serves as a good benchmark for evaluating portfolio managers and is the basis of cost-of-capital computations (Bekaert and Hodrick, 2008).

2.1.2 Domestic versus World CAPM

It is possible to distinguish between two different CAPMs, namely domestic and world CAPM. The domestic CAPM assumes that the securities of a specific country are held only by investors that reside in that country. Therefore, the investor is not exposed to the international market, and there would be no international diversification of risk. In an ever more globalized world, it makes sense to use an internationally diversified portfolio, especially in economies that are open and with global investors. World CAPM would then be a better measurement than domestic CAPM (Bekaert and Hodrick, 2008).

2.2 The Fama-French three-factor model

The CAPM has its flaws but is still a reasonable model to use. An alternative to the traditional CAPM is the factor model researched by Fama and French (1992). In 1992 Fama and French questioned the CAPM and its ability to explain the cross-section of stock return in the US. Studies showed that the market value of a firm's equity and the book value ratio related to its market value contributed to the explication of average stock returns. They found that average returns were higher for firms with small market capitalization, which indicates that investors require higher rates of return from smaller firms, perhaps because of asymmetric information. Firms with high book value equity to the market value of the equity also have higher average returns, i.e., value stocks outperform growth stocks, which the CAPM fails to explain (Bekaert and Hodrick, 2008).

Based on these empirical findings, Fama and French (1995) constructed a three-factor model to explain average equity returns. The first factor of their model is the same as in CAPM. The second factor is the difference in return in small and big firms (SMB), holding other factors constant. The third factor is the difference in return between a portfolio of firms with high values of BE/ME and small values of BE/ME (HML). Today, the model is also applicable to the US and worldwide (Bekaert and Hodrick, 2008).

2.3 Valuation model

There exist several approaches in the literature when it comes to valuing different types of securities. Cuthbertson and Nitzsche (2004) suggest a valuation model when trying to find a portfolio or a stock price. The model states that the value of any stock is equal to the discounted present value of future dividends, given a constant discount rate. This is also called the rational valuation formula (RVF). Cuthbertson and Nitzsche (2004) claim that this valuation model is a good place to start when valuing either a portfolio or a stock. It is also possible to expand the model to investigate further issues such as bubble theories. Following comes the derivation of the valuation model from Cuthbertson and Nitzsche (2004, p. 245-248).

2.3.1 The rational valuation formula (RVF)

The expected return is defined as:

$$E_t R_{t+1} = \frac{E_t F_{t+1} - F_t + E_t D_{t+1}}{F_t} \qquad (2.1)$$

Where F_{t+1} is the stock's fundamental value at time t, and D_{t+1} are dividends paid between the period t and t+1. E_t is the expectations operator based on information Ω at time t (or earlier), meaning that the expectation is formed once about the future dividend, and once about the future price, so that $E(D_{t+1}|\Omega_t) \equiv E_t D_{t+1}$. This assumes that the stockholders are long and expect to earn a constant return of k. The constant return can also be defined as the required return, which means the rate of return is what the stockholder requires for the implicit risk of the stock. This rate of return comes from an asset pricing model, like the CAPM.

$$E_t R_{t+1} = k, k > 0 \qquad (2.2)$$

The stochastic behavior of $R_{t+1} - k$ is for no abnormal returns being made on average, and excess returns are equal to zero, meaning:

$$E(R_{t+1} - k|\Omega_t) = 0 \qquad (2.3)$$

Using equation (2.1) and (2.2) combined, we get the Euler equation which gives us the movement in value over time:

$$E_t R_{t+1} = \frac{E_t F_{t+1} - F_t + E_t D_{t+1}}{F_t} = k \qquad (2.4)$$

If we solve for the current value F_t, we get:

$$F_t = \delta E_{t+1}(F_{t+1} + D_{t+1}) \qquad (2.5)$$

The δ is the discount factor and equals 1/(1+k), assuming 0 < δ < 1, which means that the Euler equation has to hold for the next period, t+1. From (2.5), this leads to:

$$F_{t+1} = \delta E_{t+1}(F_{t+2} + D_{t+2}) \qquad (2.6)$$

Taking the expectation of (2.6) and assuming the information is only available until time, t:

$$E_t F_{t+1} = \delta E_t (F_{t+2} + D_{t+2}) \qquad (2.7)$$

By deriving (2.7), the law of iterated expectations is being used:

$$E_t (E_{t+1} F_{t+2}) = E_t F_{t+2} \qquad (2.8)$$

The left side of equation (2.8) shows that the expectations formed today of what one's expectation will be tomorrow at t+1 for F_{t+2}, which equals the expectations today for F_{t+2}. This results from the assumption that we do not know how our expectations will alter in the future - which is the concept and definition of iterated expectations. Equation (2.7) holds for all periods so that:

$$E_t F_{t+2} = \delta E_t (F_{t+3} + D_{t+3}), etc. \qquad (2.9)$$

Then, substitute (2.7) into (2.5):

$$F_t = \delta[\delta E_t (F_{t+2} + D_{t+2})] + \delta (E_t D_{t+1}) \qquad (2.10)$$

And continuous substituting yields:

$$F_t = E_t [\delta D_{t+1} + \delta^2 D_{t+2} + \delta^3 D_{t+3} + \ldots + \delta^N D_{t+N} + F_{t+N}] \qquad (2.11)$$

If we let N → ∞, then δ^N → 0. A requirement is that the expected growth of dividends (g) is smaller than the discount rate (k), i.e., that the growth rate of dividends is not explosive, resulting in $E_t F_{t+N}$ also being finite. Given this assumption:

$$\lim_{n \to \infty} E_t \delta^N [D_{t+N} + F_{t+N}] \to 0 \qquad (2.12)$$

If we just consider the fundamental price F_t we have:

$$\lim_{n \to \infty} E_t \delta^N [F_{t+N}] \to 0 \qquad (2.13)$$

Equation (2.13) is the transversality condition, which can be defined as the optimal path in an economic model, assuming there is no gain in deviating from the optimal path (Kamihigashi, 2008). This means it is possible to have an excess return, but there is no gain in having an abnormal return. In this case, the condition excludes rational speculative bubbles.

With the transversality condition, equation (2.10) can be expressed as:

$$F_t = E_t \sum_{i=1}^{\infty} \delta^i D_{t+i} \qquad (2.14)$$

The assumptions that are taken into account when deriving (2.14) are that the expected returns are constant, the law of iterated expectations holds for all investors and that the transversality condition hold. The fundamental value of a portfolio is the discounted present value of expected future dividends. When the price does not equal the fundamental value, there will be profit opportunities in the market. Cuthbertson and Nitzsche (2004) assume that the investors have a subjective view of the probability distribution of the fundamental values that reflect the true underlying distribution. Although this is the case, we assume that arbitrage is instant so that investors set the market price P_t equal to the fundamental value, F_t. The final rational valuation formula will be as seen in equation (2.15) below (Cuthbertson and Nitzsche, 2004, p. 245-248)**:**

$$P_t = E_t\left[\sum_{i=1}^{\infty} \delta^i D_{t+i}\right] \qquad (2.15)$$

2.3.2 Gordon Growth Model

It is possible to derive a special solution for the dividend discount model, namely, the Gordon Growth Model. This closed-form solution makes some assumptions for the dividend process. Cuthbertson and Nitzsche (2004, p. 249) assume that the best forecast of dividends is a time series model when there is a dividend growth of a constant rate g, as shown in the AR (1) model (2.16).

$$D_{t+1} = (1 + g)D_t + w_{t+1} \qquad (2.16)$$

Here, w is the white noise of the model and g is the expected dividend growth. The g can be found by equation (2.17):

$$\frac{E_t D_{t+1} - D_t}{D_t} = g \qquad (2.17)$$

By leading equation (2.16) and by repeated substitution, we will find the optimal forecast for the dividends as seen in equation (2.18).

$$E_t D_{t+j} = (1+g)^j D_t \qquad (2.18)$$

Then equation (2.18) is substituted into the rational valuation formula, which gives equation (2.19):

$$P_t = \sum_{i=1}^{\infty} \delta^i \, (1+g)^i D_t \qquad (2.19)$$

After rearranging the equation along with laws of algebra, we get the Gordon Growth Model, as seen in equation (2.20):

$$P_t = \frac{(1+g)}{(k-g)} D_t \; with \; (k-g) > 0 \qquad (2.20)$$

The Gordon Growth Model in equation (2.20) is then used to calculate the intrinsic value of a stock by taking the expected future dividends into account. It is a special case of the dividend discount model, but more straightforward to use and assumes constant growth in dividends. The requirement is that the growth rate of dividends (g) is less than the discount rate (k), as this assures that the discounted expected dividends are finite, thus making prices reasonable. With the model, some assumptions have to be taken into account. The model is based on an infinite series of dividends per share, which is then discounted back into the present using the rate of return. The model also assumes that the company exists forever. Moreover, the dividends will increase at a constant rate, limiting the Gordon Growth Model to work best with a company with a steady growth rate over time (Cuthbertson and Nitzsche, 2004, p. 249).

2.4 Efficient markets

The efficient market hypothesis (EMH) claims that stock prices reflect all available information at any given moment in time. Whenever new information about a stock becomes public, the stock price changes until expected returns are precisely proportional to perceived risk. New information is unpredictable by definition. If it could be predicted, then the prediction would be a part of today's information. Stock prices that change in response to new information also move unpredictably. Thus, stock prices will follow a random walk, a random process where the path consists of random steps. Empirical work done by Fama and French (1995) suggests that stock prices fluctuate arbitrarily and therefore provide evidence to support the hypothesis about stock prices following a random walk. There are different versions of the EMH theory, and we differ between weak, semi-strong and strong market efficiency (Bodie et al., 2014).

In a *weak market efficiency*, the prices reflect all information obtained from market trading data, looking at historical prices, trading volumes, and short interest. It is possible to do a fundamental analysis to determine if the companies in the weak market efficiency are over or underpriced by looking at a company's financial performance (Bodie et al., 2014).

In a *semi-strong efficient market*, all publicly available information regarding a firm must reflect its stock price. This includes market trading data and fundamental information for firms. Doing a technical or fundamental analysis of the market is pointless because if all information is already public, it should be reflected in the stock price (Bodie et al., 2014).

Strong market efficiency also includes information available only to insiders and is reflected in the stock price. Insider trading is trading a public company's stock or other security by individuals who have access to nonpublic information about the company. In a rational society without inside information, no investor can generate a risk-adjusted excess return (Bodie et al., 2014).

The common denominator for all three market efficiencies is that the stock price reflects available information. If we assume that the hypothesis of efficiency in the market holds, there is reason to believe that extraordinary return requires extraordinary information (Bodie et al., 2014). The EMH theory, where the available information is reflected in the price at every given time, has a hard time explaining anomalies in the market, such as a financial bubble. EMH is a theoretical perspective on the market and rarely fits reality where other factors are often considered, such as momentum and behavioral finance (Goodnight and Green, 2010).

2.4.1 Momentum

Momentum can be defined as the speed or velocity of price change in either a stock, security, or other financial instruments. It is possible to interpret the strength of a trend based on the change in price movements. It can be a strong indicator of a trend in a stock or the overall market. When a stock is driven by momentum, the price will accelerate (either up or down) based on the actions of the majority of the traders, regardless of fundamental values (Investopedia, 2021). The existence of profitable momentum strategies usually attracts speculators, which will increase the instability in the market. Momentum strategies are usually used to get abnormal returns, which is above what the market usually offers by predicting future prices based on historical prices. The efficient market hypothesis does not support momentum because momentum opens possibilities to speculators and is affected by behavioral finance (Chakrabarti and Sen, 2020).

2.5 Behavioral finance

Behavioral finance contradicts the Efficient Market Hypothesis and seeks to explain anomalies. Behavioral finance research is based on behavioral hypotheses from psychology that are not consistent with economic theories of rational market behavior under uncertainty. Modern finance defines the average economic person to have expected utility maximization, risk-aversion, rational expectations and Bayesian updating (basing decisions on the probability of successful outcomes). People are able to see the full consequences of each possible action and choose objectively, under complete rationality. This perfect example of a rational economist applies when there are perfect markets and perfect people, but this is rarely the reality when one considers behavioral finance (actual observed behavior) (Cuthbertson and Nitzsche, 2004; De Bondt, 2003).

Researchers have documented that individuals make decisions that deviate from economist's definition of rational behavior under uncertainty through empirical studies. This research suggests that humans are unable to make rational decisions under uncertainty even though they have information about probabilities. Two essential concepts used when explaining decisionmakers thoughts in risky situations are mental frameworks and heuristics. The mental framework is about the decision-maker simplifying the perspective on a complex problem in reality. Such a framework defines how the problem is formulated and how actions and results are experienced relative to certain levels of aspiration. Heuristics is a rule of thumb for processing and handling new information. Heuristics will, in general, lead to the desired outcome but can also lead to errors in judgment (De Bondt, 2003).

The three most used heuristics when processing new information are representativeness, availability, and anchoring-and-adjustment. Representativeness occurs when people judge the probability of an event based on a superficial resemblance to a stereotype. This leads to a deviation from the Bayesian decision-maker. This theory has been used to explain why the stock market often overreacts. The reason is that people often create patterns in the market, when in reality, it is only coincidence that comes into play (noise in the market is interpreted as systematics). Availability occurs when, for example, a probability is assessed based on how far the event lies in consciousness. This theory might explain why people ignore the possibility of certain intervening and negative events even though the possibility for it happening exists (crisis myopia). Anchoring-and-adjustments explain the power of first impressions. People adjust their anchor when new information is considered. This makes people interpret events differently depending on their anchor in the first place, leading to different conclusions. This leads to investors holding on to perceptions even though it can be contradicting what the data shows (De Bondt, 2003).

De Bondt (2003) suggests that the most common errors that investors make can not be explained by rational behavior. Therefore, behavioral finance can try to explain it. The most common mistakes, according to De Bondt (2003) is:

1. Excessive optimism
2. Excessive use of simple, popular models
3. Excessive trust and confidence in one’s own judgments and perceptions
4. Excessive rationalization (place too little emphasis on unexpected earning news)
5. Excessive agreement between analysts (herding)

Behavioral finance has proved to be a more realistic way of looking at investors and the approach to asset pricing research. The theory is not in line with the efficient market hypothesis, but behavioral finance research provides support to the fact that market psychology is vital for understanding anomalies in the market, such as financial bubbles (De Bondt, 2003; Kindleberger, 2000).

2.6 Bubble theory

2.6.1 Definition

There are several definitions of a financial bubble. Kindleberger and Aliber (2005) define a bubble as changes in price that is a non-sustainable pattern over time. A price increase often comes from optimism among investors. When the optimism becomes too high, it is possible to see a gap between the market value and the fundamental value of a security. There are different types of bubbles which makes it hard to find an overall definition. Common for all the different definitions of a bubble is an elevated interest in the asset due to favorable conditions, that will lead to abnormal nominal values in relation to the fair value. Rapidly growing prices are not justified and are driven by momentum buyers who buy for the purpose of selling quickly at a higher price to lock in profit (Kyriazis, Papadamou and Corbet, 2020).

A financial bubble burst is often a part of a financial crisis in general, and Grytten and Hunnes (2014, p. 26) quotes Goldsmiths (1982), which defines a financial crisis as:

"A sharp, brief, ultra-cyclical deterioration of almost all financial indicators, short-term interest rates, asset prices, commercial insolvencies and failure of financial institutions."

A more specific definition of a bubble is defined by Kindleberger (2000, p. 13) as

"an upward price movement over an extended range that then implodes."

Brunnmeier (2007, p.2) defines a classic bubble as;

"bubbles are typically associated with dramatic asset price increases, followed by a collapse."

Bubbles can be difficult to identify before they burst or implode. There is no accurate and objective way to define and measure fundamental values, although they can be detected by comparing characteristics of previous bubbles. Examples of such characteristics may be high returns in the market, or high valuations where assets are valued at far higher prices than rational economic theory would suggest. Other characteristics are speculative features such as large-scale action with a high proportion of debt among investors. It is possible for a bubble to form in the market in general, but often we see a tendency of a bubble in a specific industry such as tech stocks, oil and gas, or cryptocurrency markets (Kyriazis, Papadamou and Corbet, 2020). Even though it is possible to look at different bubbles in different industries, it is common to sort them into either rational or irrational bubbles.

2.6.2 Bubble in rational markets

If the market efficiency is weak and investors have the same expectations and the same information available, bubbles would not exist. Rational bubbles can occur when considering an infinite horizon. If there is asymmetric information, a bubble can arise even in an infinite rational economy. When there is a bubble tendency in the rational market, it is often due to irrational traders, not irrational markets. (Tirole, 1982; Brunnmeier, 2007).

2.6.3 Bubble in irrational markets

There can be both rational traders and irrational traders in an irrational market. Rational traders will, as always, invest in the belief of selling at a higher price. The market is irrational when not everyone in the market can do so, or act on the same information. When both markets and traders act irrational, we call it a state of mania (loss of touch with rationality). The mania phase is where the prices rise quickly. At this stage, the securities have received a lot of attention, and everyone wants to invest (O’hara, 2008).

2.6.4 Minsky’s bubble model

Hyman Minsky (1982) developed a general five-phase crisis model that can be used to describe typical crises in the economy. Minsky's model focuses on monetary conditions and is, therefore, more theoretical than empirical. A weakness with this model is that different bubbles often have their own unique course, and therefore it can be challenging to try to fit every bubble into these different phases. The five stages of the model are listed below.

- *Displacement*

The first phase of Minsky's model is defined as a period in which there is an exogenous macroeconomic demand shock. The economy leaves its natural growth path as it makes a positive shift. Such shocks can be of financial nature, economic-political, purely political or caused by other major shocks such as war or new innovations. Such changes are often the first step and the beginning of a financial crisis (Grytten, 2003).

- *Overtrading*

The positive demand shocks lead to expectations of increased profitability and increased activity. The economy enters a new growth phase where the expectations for profit are higher than the actual value. When investors try to catch the price increase, it will drive the price further away from its actual value. As a result, the turnover exceeds its natural trajectory to an increasing degree. This is when it is possible to see tendencies of a financial bubble (Grytten, 2003).

- *Monetary expansion*

The exogenous macroeconomic shock and overtrading are leading to increased demand for money and credit. Monetary policy is then typically shifted in an expansive direction with an increase in the money supply or reduction in interest rates, leading to increased production volume. In this phase, the activity and optimism in the economy have now risen to a level where financial bubbles can occur, often in the form of stock speculation (Grytten, 2003).

- *Revulsion*

As monetary growth surpasses growth in the real economy, a positive financial bubble arises, which will sooner or later burst. When it breaks, the turning point comes, where the growth in money and credit volume slows and the economy enters a substantial downturn (Grytten, 2003).

- *Discredit*

In the last phase of Minsky’s model, profitability expectations fall sharply and gradually become lower than the fundamental value would suggest. A negative shift in the product demand curve leads to a negative shift in the demand for money and credit. The economy is going into a negative bubble and enters into a growth below its expected trajectory. Thus, an economic crisis has arisen (Grytten, 2003).

2.6.5 Shiller's indicator list: How to detect a potential bubble

Shiller defines a bubble as; *"a period when investors are attracted to an investment irrationally because rising prices encourage them to expect, at some level of consciousness at least, more price increase (...) the bubble comes to an end when people no longer expect price increase, and so the demand falls and the market crashes"* (Shiller, 2003, p. 35). Shiller has suggested a checklist to consider when trying to detect a potential bubble, listed below. If all of the points are adequately met for a given industry or security, it may be an indication of an existing bubble (Ewing, 2010; Shiller, 2016).

1. Rapid increase in the security price
2. Growing interest and excitement from the public
3. Huge media attention
4. Stories about ordinary people who have made huge money
5. Growing interest from society's middle class
6. Constant discussion that defends incredible prices increases, often with arguments such as "time has changed"
7. A decline in lending standards from institutional facilities, such as banks.

Shiller (2003; 2016) mentions that it can be difficult to define and recognize a bubble in the market, but the seven bullet points above can contribute to understanding the psychology behind growing asset prices and speculative markets.

2.7 Previous bubbles

Bubbles in the market have existed for a long time. The earliest bubble noted was the Dutch Tulip bulb market bubble in 1636. Since then, the world has experienced several imploded bubbles. Two of the newest bubbles in modern time are the dot-com bubble in the late 90s and early 2000, and the financial crisis in 2007/2008. We will account for the dot-com bubble.

2.7.1 The Dot-com bubble

In the late 1990s, the stock market was highly overvalued and showed extreme growth in the tech industry, especially the so-called internet stocks or dot-com companies. Nasdaq, which has a predominance of technology stocks, doubled in value from late 1999 to late winter 2000, without any fundamental news to support such a rise in equity values. The market eventually started to drop, and from February 2000 to September 2002, the Nasdaq had lost three-quarters of its value, also without any fundamental news to support the fall. In figure 1, we can see how the nominal value of the Nasdaq increased in value before dropping significantly (DeLong and Magin, 2006).

Figure 1, nominal value of the Nasdaq index (DeLong and Magin, 2006)

The reason for the rapid growth in internet stocks was the prospects and imagination of a “new era”, where computers available for everyone and new technologies within robotics, biotechnology, machines and national computer networks were the force of the growth. The “new era” theories were used to justify the rapid growth because there was a strong belief in prosperity and strengthening of the industry and economy. IPOs became popular, and not only wall-street investors were starting to enter such positions, but also “regular” investors had seen the growth and potential of IPOs. In early 1996, Yahoo offered an IPO which traded up 152% the first day, and these kinds of returns on stocks and IPOs became the new normal (Goodnight and Green, 2010).

Later in 1996, the speculations of the internet stocks being an irrational exuberance started. In 1998 the Asian financial crisis led to a dip in the dot-com market, but it quickly bounced back to sky-high levels. In 1999, 446 companies went public and had a first-day average return of over 70 percent. People continued to ride the bubble and it did not go unnoticed as it got a lot of media coverage. The number of households that invested directly into stocks grew by over 30%. Magazines and news channels started writing and reporting about positive and euphoric investment stories where people went from "rags-to-rich" (Goodnight and Green, 2010, p. 126). Many young and inexperienced investors also entered the market and bet heavily on the tech stocks, having a trend-chasing behavior (Greenwood and Nagel, 2009).

Eventually, the mania had to come to an end, and so it did in 2000. Many of the dot-com companies were newly established and could not cover their expenses in the establishment phase. The industry relied solely on the form of issuing shares for sales in the market. Share prices were high because of the complexity of valuing companies when there was such a growing interest. A large proportion of the dot-com companies were having a market value far greater than the fundamental value. Irrational investors followed each other without doing any research or analysis of the companies and markets themselves. This contributed to the rise of the stock prices, along with short-term speculators looking for a short-term profit. The restrictions on shorting IT stocks were a good indicator that the IT sector was overpriced as well. As the market started to fall, short-term speculators got out quickly. This gave the course of the market a double effect, and the market fell rapidly. The bubble burst, and it was considered sudden and unforeseen by most people deeply invested in internet stocks (Goodnight and Green, 2010; Ofek and Richardson, 2003).

2.8 Potential green bubble

In 2020 the Covid-19 virus spread across the world at a rapid pace, and there was a sharp fall in the world economy. The pandemic quickly evolved not only into a health crisis, but also an economic crisis. The demand for fossil fuels has fallen during the pandemic, while the demand for renewable energy has risen in many countries, especially in Europe. A change in such demand could indicate the likely effects of Covid-19 and the climate momentum. We find the most significant declines in stock prices of carbon-intensive industries, such as petroleum extraction and industries, metals and air transportation (largest negative abnormal return). Sectors that are less carbon-intense were affected less in comparison. Also, more prominent firms could handle the shock of the pandemic better (Mukanjari and Sterner, 2020). Even though less carbon-intensive firms were less affected by the pandemic, Mukanjari and Sterner (2020) also found through their study that having an official ESG rating had no effect on the performance during the pandemic. The authors claim that it is better to look at carbon intensity rather than ESG rating in this case. In the years before 2020 and Covid-19, researchers are in a general split when it comes to the question if green assets outperform conventional assets over time or not (Chang, Nelson and Witte, 2012; Yuan, 2017).

In the last decade, and especially within the last five years, the financial world has seen a significant increase in green investments and typical ESG-stocks. When looking back into this period, one can see a shift from investing in more traditional value stocks to more growth stocks and newly listed firms with a specific green profile. This has especially been the case for the period after the Covid-19 market decline and until today, where some green firms have seen returns of more than 100% in this period. Some of the main reasons for this shift in investment come from the introduction of new young investors specifically seeking these kinds of investments due to a greater focus on sustainability, as well as decreasing interest rates, which in turn favors growth firms (AksjeNorge, 2021; KPMG, 2021). From 2016 until 2020, the market value of green firms listed on Oslo Stock Exchange increased from 44,7 billion to 215,4 billion, an increase of 381%. This is a consequence of share prices increasing, as well as an increasing number of IPOs and new listings in the ESG segment. The growth in green market value is shown in figure 2 below (Oslo Stock Exchange, 2020).

Figure 2, green market value in bn of NOK and share of total market value (Oslo Stock Exchange, 2020)

The rapid growth in demand and increased prices for green stocks have started speculations about a potential bubble in the ESG segment in the Norwegian stock market. Some of the symptoms in the market today could arguably be similar to previous bubbles, such as the dot-com bubble. This is what lays the foundation for our topic question; Is there a bubble within ESG stocks on Oslo Stock Exchange?

2.9 Hypothesis

Based on previous research and literature, a hypothesis has been formulated to examine whether there is a bubble within ESG stocks in the Norwegian stock market.

The null hypothesis, H_0*:*

There is no bubble within ESG stocks on Oslo stock exchange.

The alternative hypothesis, H_A*:*

There is a bubble within ESG stocks on Oslo stock exchange.

As discussed, a bubble in the market can be defined in many ways, which leads to different ways of using a methodology to detect a possible bubble. This thesis will test whether we have a bubble or not by using the valuation model approach with an additional bubble term, as suggested by Cuthbertson and Nitzsche (2004). In the spirit of Anderson and Brooks (2014), this model is further incorporated into a regression specification which will allow us to conduct statistical tests to assess the presence of a bubble. In addition, we also carry out a qualitative analysis based on Schiller's indicator list to discuss the likelihood of there being an ESG bubble present in the Norwegian stock market today.

3. Methodology

3.1 Research method

The design of the study and how to explore the hypothesis are presented in this chapter. The purpose of the research design is to provide an overall view of how the research is supposed to be done, meaning that the data collection must be done in accordance with the chosen research design (Gripsrud, Olsson and Silkoset, 2010). A quantitative approach is primarily used to explore the thesis, and a deductive design is appropriate for our purpose. In addition, we include a qualitative approach to discuss further a potential ESG bubble in the market, based on previous theory from Shiller (2016). Implementing two approaches will give a solid foundation when either rejecting or accepting the hypothesis.

The thesis aims to investigate if there is a bubble present in ESG stocks in the Norwegian financial market. We address the topic by constructing a portfolio of the 17 stocks with the lowest ESG risk rating on Oslo Stock Exchange, as we believe this will create a fair representation of ESG stocks in Norway as a whole. The ESG risk rating is collected from the Morningstar site Sustainalytics to create an ESG portfolio based on objective criteria. An equally weighted portfolio will be considered in the main analysis, while a value weighted portfolio will be used in a robustness check. We will give a further review of the portfolio construction in our data chapter.

We apply a direct bubble test on the ESG portfolio by approaching a rational valuation model in addition to a bubble term, as Cuthbertson and Nitzsche (2004) suggest when capturing a potential rational bubble. This method introduces a link between stock return and the return of the fundamental value, and the growth rate of a potential bubble. The theories about the rise of bubbles are torn between it being caused by irrational behavior such as herding and market psychology or, like Cuthbertson and Nitzsche (2004) claims, that bubbles can be consistent with the theory about rational behavior among investors. They argue that the actual stock price consists of a bubble element that causes a gap between the stock price and its fundamental value. To explore the question about a possible bubble in the Norwegian ESG stocks, we will consider the model of Cuthbertson and Nitzsche (2004) and base our research design on the theory about a bubble term being captured in the actual stock price.

Researchers have pointed out that a bubble-like behavior in certain stocks originates from high technology and innovative sectors. This is because it is challenging to calculate a fundamental value due to the extreme growth factor (Anderson and Brooks, 2014). In our thesis, this fundamental value is based on the theory of the present value of dividends, as introduced in chapter two. However, the problem with using for instance the Gordon Growth formula to calculate dividends is that it assumes a constant rate of growth for dividend (and a constant required rate of return), which is rarely the case for stocks in the real world. In addition, the calculation of a constant growth rate based on, e.g., previous dividend realizations could be inaccurate due to the variance in dividends paid out.

To solve the issue of calculating the fundamental value of stocks based on dividends directly, we follow Anderson and Brooks (2014) and create a regression line that incorporates dividends. This regression is based on the rational valuation model including a bubble term and is constructed to perform statistical tests to test our hypothesis, i.e., if there is a bubble present. Following comes the derivation of the foundation for the specified regression.

3.2 Bubble model

Cuthbertson and Nitzsche (2004) claim that rational bubbles arise because of the uncertain factors in valuation models, and that this can be captured in the Euler equation, which is a part of the process that decides the stock price. The price investors are willing to pay today for a stock is dependent on the expectations for the stock price in the future, but the expectation of the future is again dependent on the price even further into the future. The Euler equation does not set a specific price level, and therefore we have to take into account the transversality condition in the original valuation model. However, in the next section, we will show that the equilibrium condition (Euler condition) also could allow for the price to contain a bubble term besides the fundamental value, if the transversality condition is not assumed to hold.

3.2.1 Euler equation and the rational valuation formula

When exploring the possibility of a bubble, Cuthbertson and Nitzsche (2004) look at how the market value of a stock deviates from its fundamental value. To find the equation that includes a bubble term and further base the price of this term and the fundamental value, we start again from the Euler equation as shown previously in chapter two; equation (3.1).

$$P_t = \delta(P_{t+1} + D_{t+1}) \qquad (3.1)$$

Here, δ equals 1/(1+k), P_t is the price and D_t is the dividend. We solve the equation using repeated forwarding substitution, still assuming that the transversality condition holds ($lim\delta^N E_t D_{t+N} + F_{t+N} = 0\ as\ n \rightarrow \infty$), which gives us equation (3.2).

$$P_t = F_t = \sum_{i=1}^{\infty} \delta^i E_t D_t \qquad (3.2)$$

F_t is the fundamental value, as previously stated. The idea behind a rational bubble is that there is another expression for P_t, which includes a bubble term that can capture the deviation between the price, P_t, and the fundamental value, F_t . When the observed price of a security over a longer period separates itself from the fundamental value, it is often looked upon as opposition from the assumption of rational agents and efficient markets, i.e., irrational. However, the idea behind a rational bubble is that the price could originate from speculation in future prices, but that this speculation, in turn, is entirely rational from an investor's point of view. Anderson and Brooks (2014) explain this idea behind a bubble being rational as:

"Such price dynamics at first blush seem inconsistent with the efficient markets hypothesis, but proponents of rational speculative bubble theory suggest that this price behavior is entirely consistent with market rationality since investors are compensated for the increased risk of a price collapse by ever-increasing returns" (Anderson and Brooks, 2014, p. 20).

In addition, even if investors observe that the stock is highly priced and might contain a bubble, they still might not want to sell the stock because holding it offers at least the required rate of return (k) - which in turn makes it rational.

Now we can show how the price containing a bubble term can also fulfill the Euler equation. We follow the derivation from Cuthbertson and Nitzsche (2004) and add the new term that captures this rational bubble, B_t. The new expression that takes the bubble term into account is equation (3.3):

$$P_t = \sum_{i=1}^{\infty} \delta^i E_t D_{t+i} + B_t = F_t + B_t \qquad (3.3)$$

Equation (3.3) should satisfy the Euler equation in (3.1), and we show that this is possible if the bubble process B_t satisfies certain restrictions. Therefore, we lead equation (3.3) by one period while obtaining expectations at time t:

$$E_t P_{t+1} = E_t[\delta E_{t+1} D_{t+2} + \delta^2 E_{t+1} D_{t+3} + \ldots + B_{t+1}] = [\delta E_{t+1} D_{t+2} + \delta^2 E_{t+1} D_{t+3} + \ldots + E_t B_{t+1}] \qquad (3.4)$$

In equation (3.4), it is possible to see that the law of iterated expectations is considered; $E_t(E_{t+1} D_{t+j}) = E_t D_{t+j}$. The right-hand side of the Euler equation in (3.1) is given by $\delta(E_t P_{t+1} + E_t D_{t+1})$, and by using equation (3.4), we can see that this again is given by equation (3.5):

$$\delta[E_t D_{t+1} + E_t P_{t+1}] = \delta E_t D_{t+i} + [\delta^2 E_t D_{t+2} + \delta^3 E_t D_{t+3} + \ldots + \delta E_t B_{t+1}] \qquad (3.5)$$

Then, we substitute the definition of the fundamental value, F_t, that is to be found in equation (3.2), into the right-hand side of equation (3.5):

$$\delta[E_t D_{t+1} + E_t P_{t+1}] = F_t + \delta E_t B_{t+1} \qquad (3.6)$$

Substituting (3.6) into (3.1):

$$P_t = F_t + \delta E_t B_{t+1} \qquad (3.7)$$

We now have equations (3.3) and (3.7) that both can be solutions to the Euler equation, which seem to contradict each other. However, we can make the two solutions of (3.3) and (3.7) equivalent if:

$$E_t B_{t+1} = B_t / \delta = (1 + k) B_t \qquad (3.8)$$

Now, both equations (3.3) and (3.7) are the same expression, and the price including the bubble term will satisfy the Euler equation in (3.1). B_t must behave as a stochastic process, i.e., assuming that the best forecast of the future bubble value must be based on the current value. This means that the discounted bubble must be a martingale, i.e., $E_t B_{t+1}/(1+k)^1 = B_t/(1+k)^0$, where $(1+k)^0 = 1$. A stochastic process is a martingale if $E[X_{i+1}] = X_i$, here $X_i = B_{\{t+i\}/(1+k)^i}$, and i is the time index. Although B_t satisfies the Euler equation, it does not satisfy the transversality condition since B_t does not equal zero and because the stock price is non-unique. Such a bubble term will be a good solution if considering that it is expected to grow at the rate of return that investors require for them to hold the stock. This means that the expected growth rate of the bubble could be rewritten from (3.8) and equal:

$$E_t(B_{t+1}/B_t) - 1 = k \qquad (3.9)$$

However, this is not precise because the bubble grows at rate k only if it has the same systematic risk as the fundamental value, F_t. Regardless of the fundamentals (i.e., dividends) being constant or not, the presence of a bubble means that the price can rise continually since (1 + k) > 1, where k is the rate of return. We also have to assume, not subject to a constant dividend or not, that the stock price has a growth rate that is less than the growth of the bubble because of the payments of dividends. Investors can not be sure about it being the fundamental values that are the reason for a rise in price, or if it is the bubble term. This is why investors are willing to pay a higher price than the fundamental value, as long as the required rate of return for the next period is expected to persist.

With the above in hand, we can further look at the fundamental price in relation to the actual returns in our model. Since the price is expressed as $P_t = F_t + B_t$ we derive to find what the return should look like (we substitute $P_{t+1}$with $F_t + B_t$) and get:

$$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} - 1 = \frac{F_{t+1} + B_{t+1} + D_{t+1}}{P_t} - 1 \qquad (3.10)$$

If we furthermore split up the fundamental price return and bubble return into separate returns, we get equation (3.11):

$$R_{t+1} = \frac{F_{t+1} + D_{t+1}}{F_t}\frac{F_t}{P_t} + \frac{B_{t+1}}{B_t}\frac{B_t}{P_t} - 1 \qquad (3.11)$$

To simplify equation (3.11), we can rewrite the returns from the fundamental price growth and the bubble growth (b) term into R^F and R^B (Note that $F_t/P_t + B_t/P_t = 1$ and $(F_t + B_t)/(F_t + B_t) = 1$):

$$R_{t+1} = (1 + R_t^F)\frac{F_t}{P_t} + (1 + R_{t+1}^B) * \frac{B_t}{P_t} - 1 \qquad (3.12)$$

We simplify and get that the return can be expressed as equation:

$$R_{t+1} = R_{t+1}^F * \frac{F_t}{P_t} + R_{t+1}^B * \frac{B_t}{P_t} \qquad (3.13)$$

Now we can introduce the asset pricing model, with some assumptions required to be able to derive testable equations. As previously listed in the theory chapter, it is possible to distinguish between domestic and world CAPM. Since a small and open globally integrated financial market like Norway is explored, a world CAPM is being used. A large number of investors on Oslo Stock Exchange are from abroad, and the asset pricing model should take this into account. Furthermore, we assume that fundamental return (R_{t+1}^F) is given by the CAPM. We have that $R_{t+1}^F = i + \beta rp_{t+1}^m + \sigma u_{t+1}$ *and* $u_t \sim N(0,1)$, where σu is the error term.

Furthermore, the model specification requires that the growth rate of the bubble is not explained by the asset pricing model. This means that the CAPM only explains the return from the part of the price that contains the fundamental value. This indicates that there is no systematic risk related to the bubble term, assuming that if there is a bubble, it will not be the overall market that is bursting - only the stocks in our model. If we now add the bubble term with the assumptions above, the return is expressed as:

$$R_{t+1} = (i + \beta rp_{t+1} + \sigma u_{t+1}) * \frac{F_t}{P_t} + R_{t+1}^B\left(1 - \frac{F_t}{P_t}\right) \qquad (3.14)$$

Rearranging this, we get:

$$R_{t+1} = (R_{t+1}^B - i) - (R_{t+1}^B - i) * \frac{F_t}{P_t} + \beta rp_{t+1} * \frac{F_t}{P_t} + \sigma \frac{F_t}{P_t} u_{t+1} \qquad (3.15)$$

With the growth rate of the bubble being stochastic, i.e., $R^B_{t+1} = E[R^B_{t+1}] + \sigma u$, our model for return with a bubble element becomes:

$$R_{t+1} - i = E(R^B_{t+1}) - i - (E(R^B_{t+1}) - i)\frac{F_t}{P_t} + \beta rp_{t+1}\frac{F_t}{P_t} + \sigma\frac{F_t}{P_t}u_{t+1} + (R^B_{t+1} - E(R^B_{t+1}))(1 - \frac{F_t}{P_t})$$
(3.16)

Where $E(R^B_{t+1})$ represents the expected growth rate of the bubble and $\sigma\frac{F_t}{P_t}u_{t+1} + (R^B_{t+1} - E(R^B_{t+1}))(1 - \frac{F_t}{P_t})$ is the error term.

If no bubble is present, then $P_t = F_t$, and we get the usual CAPM specification.

$R_{t+1} - i = \alpha + \beta rp_{t+1} + \sigma u_{t+1}$, where α equals zero. (3.17)

3.3 Our approach

In this paper we consider the Gordon Growth Model as the foundation for the fundamental value needed in the regression (F_t). However, we do not calculate the fundamental value directly due to the weakness of calculating a constant growth rate of dividends based on past dividend realizations. This would not be useful as we have relatively few observations that are subject to unpredictability, making it hard to obtain a reliable estimate for a constant dividend growth rate. That is especially the case when the stocks of interest are typical growth firms, as often is the case for ESG stocks. We solve this by creating a proxy κ (kappa) for the fundamental value (F_t) by utilizing the Gordon Growth Model. This approach employs the growth rate of the dividends implied in the market prices, although this is through the κ, and not the growth rate directly. The fundamental value, given by the Gordon Growth Model, then becomes equal to:

$$F_t = \frac{1+g}{r-g}D_t = \kappa\, D_t \quad (3.18)$$

Here we have that κ equals $\frac{1+g}{r-g}$ from the Gordon Growth Model. This κ therefore showcases the growth rate of the fundamental value. In our model, the κ is captured directly in the regression coefficients originating from equation (3.16). We then get the following regression line for the fundamental bubble model:

$$R_{t+1} - i = E(R^B_{t+1}) - i - (E(R^B_{t+1}) - i) * \kappa \frac{D_t}{P_t} + \beta * \kappa * rp_{t+1} \frac{D_t}{P_t} + G\,\kappa \frac{D_t}{P_t} u_{t+1} + w_{t+1} \quad (3.19)$$

The critical point is that the fundamental value and the bubble term are captured in the price, while the growth rate of the bubble, κ and β, are captured in the coefficients. The intercept of the regression line gives the growth rate of a potential bubble. Based on this and the underlying assumptions previously mentioned, it is possible to collect and calculate the regressors being used. This leads us to the final regression of return which includes the bubble growth rate $(E(R^B_{t+1}) - i)$ and the proxy κ, as well as the β. By this approach we have all the regression input by collecting the return and dividend yield from our ESG portfolio, together with the market risk premium (rp) and risk-free interest rate (i). To test for a bubble, we run a time series regression. By doing this regression we are able to detect if there is a bubble present or not, i.e., we create a bubble model. For the regression line above, we can now add the market return as an additional independent variable so that it is also included as a single regressor representing the systematic risk from the CAPM. This is the one-factor bubble model. The final regression for the one-factor bubble model with γ coefficients then becomes:

$$R_{t+1} - i = \gamma_0 + \gamma_1 * \frac{D_t}{P_t} + \gamma_2 * rp_{t+1} * \frac{D_t}{P_t} + \gamma_3 * rp_{t+1} + u_t \quad (3.20)$$

3.3.1 Statistical test for bubble

When testing for a bubble, the key is to interpret the significance and direction of the coefficients. The γ_0 is equal to $E(R^B_{t+1}) - i$, representing the growth rate of a potential bubble minus the risk-free interest rate. The γ_1 equals $-E(R^B_{t+1} - i)\kappa$, representing the growth rate (of a bubble) multiplied with the proxy κ. The γ_2 represents the κ multiplied with the systematic risk as shown by β (the market risk). The γ_3 gives the β only, which is the systematic risk of the portfolio.

Based on this, it is possible to run a regression and do a statistical test for a bubble. If there is no bubble present, γ_0 should equal zero since there is no bubble growth. γ_1 and γ_2 should also equal zero for the same reason. γ_3 should equal β, as the systematic risk is present in this coefficient. If there is a bubble present, γ_0 should not equal zero or be the same as the risk-free interest rate as it should give the growth rate of the bubble, given by $E(R^B_{t+1}) - i$. The γ_1 should equal the negative expected growth rate of the bubble minus the risk-free interest rate. The γ_2 should equal the market risk premium (β), while γ_3 should equal zero.

Using the regression above, we run a statistical hypothesis test for the hypothesis expressed in chapter 2.9 and test if the γ will equal the presence of a bubble or not. A null hypothesis, H_0, expresses no connection between the variables one wishes to test. An alternative hypothesis, H_A, expresses the difference or correlation between the variables that one desires to test. If H_0 is rejected, H_A is accepted, but this does not necessarily mean that H_A is true. By interpreting the p-values for our γ, one can see whether the independent variables are significant or not at a given confidence interval. We set the confidence level at 95% significance in our analysis, i.e., coefficients with a p-value higher than 5% are considered insignificant.

3.3.2 Three-factor model

Doing an extension of the one-factor bubble model above, we use the Fama and French three-factor model and introduce two new systematic risk premiums. Fama and French's (1993) three-factor model is one of the most widespread models in financial research for both theoretical and practical use. The model focuses on the relationship between expected return and risk factors such as company size and value. The three factors are the market risk premium, SMB (small minus big) and HML (high minus low).

The market factor is the same as in the one-factor model. SMB is taking into account the difference between small and big firms in terms of market capitalization, showcased by the difference between portfolios of small stocks and big stocks value weighted returns. HML considers the book value relative to the market, looking at the difference between value weighted return on portfolios of value stocks and growth stocks. Empirical research from Fama and French confirms that the smaller companies tend to generate higher returns and that book value will impact the return. This is what we take into account by adding the two additional risk factors SMB and HML, extending our one-factor model with another asset pricing model. This three-factor bubble model is expressed in equation (3.21):

$$R_{t+1} - i = \gamma_0 + \gamma_1 * \frac{D_t}{P_t} + \gamma_2 * rp_{t+1} * \frac{D_t}{P_t} + \gamma_3 * rp_{t+1} + \gamma_4 * SMB_{t+1} * \frac{D_t}{P_t} + \gamma_5 * SMB_{t+1} + \gamma_6 * HML_{t+1} * \frac{D_t}{P_t} + \gamma_7 * HML_{t+1} + u_t \qquad (3.21)$$

3.3.3 Backing out parameters

We have from our fundamental bubble model, regression line (3.19), that the return minus the risk-free rate, and the dividend yield ($\frac{D_t}{P_t}$) multiplied with the market return, is the input in the regression. The intercept (growth rate of bubble term), γ_1 (growth rate of bubble term and κ) and γ_3 (κ and β) are all captured in the coefficients. This means that we are able to back out the parameters from the coefficients and analyze them. The regression line we use to back out the parameters is without the market factor as a single regressor, as this is the fundamental bubble model - given by:

$$R_{t+1} - i = E(R^B_{t+1}) - i - (E(R^B_{t+1}) - i) * \kappa \frac{D_t}{P_t} + \beta * \kappa * rp_{t+1} \frac{D_t}{P_t} \qquad (3.22)$$

It is possible to calculate the growth rate of the bubble by utilizing the coefficients coming out from this regression. We can also derive the fundamental value by utilizing the κ (calculated from the coefficients) and the relation that $F_t = \kappa * D_t$, from the simplification of the Gordon Growth formula. Using this relation, we could compare the fundamental price with the actual price to highlight any deviation in the pricing. In addition, it is possible to back out the β using the same reasoning. The same approach is possible to use in the three-factor model. For backing out the parameters, we take advantage of the following relations in the regression line:

$$\gamma_0 + i = E[R^B_{t+1}] \qquad (3.23)$$

$$-\frac{\gamma_1}{\gamma_0} = \frac{(E[R^B_{t+1}] - i)\kappa}{E[R^B_{t+1}] - i} = \kappa \qquad (3.24)$$

$$\frac{\gamma_2}{-\frac{\gamma_1}{\gamma_0}} = \frac{\beta\kappa}{\kappa} = \beta \qquad (3.25)$$

3.3.4 Ordinary Least square (OLS)

To estimate the parameters in both the one-factor and three-factor regression, we use a Ordinary Least Squares (OLS) regression to be able to do a statistical test. The error term in the regression above could cause problems concerning a non-constant residual variance (non-constant around zero), and for that reason, we run a heteroscedasticity test. Breusch-Pagan is a heteroscedasticity test where it is possible to determine if heteroskedasticity is present or not. The test produces a chi-square test statistic and a p-value where the null hypothesis is either rejected or accepted. The null hypothesis supports that homoscedasticity is present. Homoscedasticity describes the error term as being the same across all of the values of the independent variables. Running a Breusch-Pagan test on both the one-factor and the three-factor model, for both the equally weighted and the value weighted portfolio, we get the results presented in table 1 below.

Breusch – Pagan test	1-factor model	3-factor model
Equally weighted	Prob > chi2 = 0,0136	Prob > chi2 = 0,7092
Value weighted	Prob > chi2 = 0,2675	Prob > chi2 = 0,9260

Table 1, Breusch-Pagan test for factor models

The results of the test states that there is homoscedasticity in all our models and portfolios, except for the equally weighted one-factor model. To correct for heteroskedasticity in the first model, we apply robust standard errors to obtain unbiased errors of our coefficients. By approaching the issue of heteroskedasticity with robust standard errors, it is still possible to run an OLS regression, assuming the observations are independent (Stata, 2020).

3.4 Weakness of the method

The primary shortcoming in this paper is the underlying assumptions that have to be considered when using the valuation method. The valuation method based on the Euler equation with a bubble term has to take into account certain assumptions for it to work in theory, and therefore it can be harder to apply in practice. The assumptions taken into account are; agents are homogenous and rational, the market is informationally efficient, rational agents are willing to hold the stock, and no excess profit can be made. In addition, we assume that agents are risk-averse and have rational expectations, and that investors want a constant rate of return on the security. Assumptions like this are necessary for the method to hold, but are more theoretical than practical.

A rational bubble can not be negative because the stock price falls at a slower rate than the bubble term. A negative bubble would therefore end with zero price and rational investors would recognize this, knowing that the bubble would burst (probably at once since no one would pay a bubble premium). Also, the model states nothing about the start or the end of a bubble; it only tells us about the time-series properties of the bubble once it starts and is on its way. These assumptions are considered weaknesses of our method since it is very theoretical, but it is necessary to consider for the method to hold and explore the thesis.

4. Data

4.1 ESG risk rating and selection of firms

ESG stands for Environmental, Social and Governance, and is a set of standards that can be used to screen firms and how they score on these specific measures compared to their counterparts. ESG can be measured in different ways depending on what kind of reference is used. This is due to the screening and parameters used to provide the ESG scores, which vary across ESG rating providers. In this thesis we make use of ESG ratings provided by Sustainalytics, an independent screening platform created by Morningstar. This will give an objective and standardized evaluation of how companies score in terms of ESG.

Morningstar (Sustainalytics, 5.5.2021) explains their ESG rating as *"a rule-based methodology to measure a company's unmanaged ESG risks driven by its exposure and management of material ESG issues."* The rating has five categories that a company can be placed in based on the ESG factors: negligible (0-10 points), low (10-20 points), medium (20-30 points), high (30-40 points), severe (40+ points). 95% of all companies rated are below 50 (maximum 100 points) (Sustainalytics, 2021). Many investors look at ESG ratings to avoid companies that might be a financial risk due to their environmental or human capital factors. Explaining the three letters of ESG on a basic level, the environmental criteria could be described as a score considering energy use, waste, pollution, natural resources and treatment of nature and animals. The social criteria are about the company's relationship with its investors, employees and local community. Finally, governance is about transparency with their economic situation and the structure of the firm in general (Sustainalytics, 2021; Investopedia, 2020).

Several perspectives are considered when deciding a company's overall rating. These three main perspectives are divided into corporate governance, material ESG issues and idiosyncratic ESG issues. Corporate governance is the fundamental element in the rating criteria, where poor corporate governance is a potential material risk for a company. Material ESG issues are the core of Sustainalytics rating, which are topics related to management initiatives, human capital and resources, and the environmental and social impact. There are 20 material ESG issues, 300 ESG indicators and over 1300 data points analyzed when setting an ESG score. Idiosyncratic issues are unexpected issues that affect the company, so-called "black swans". To calculate the company's particular ESG score, Sustainalytics multiply the sub-industry exposure score with the companies' issue beta. A big part of the model is built on predictions as it uses indicators to generate scores. Although it is built on prediction, the model has an average R-squared value of 92%, which indicates a 92% accuracy on average (Sustainalytics, 2021).

4.2 Data collection

The data used in this paper was collected from the Refinitiv database and Kenneth French's (2021) data library. Stocks from Oslo Stock Exchange were used to construct a portfolio of the lowest risk rated ESG stocks in Norway. Morningstar Sustainalytics was used to gather information about the ESG risk rating of all the firms on OSE, and this laid the foundation for the chosen stocks included in our portfolio.

Sustainalytics reports the ESG risk rating for 91 companies out of 279 companies listed in total at OSE. Out of the 91 companies with an ESG risk rating score, we selected the 25% lowest ESG risk rated stocks, which resulted in 23 firms. These 23 firms should give an objective and fitting representation of ESG stocks, in general, in the Norwegian market. Given our methodical approach and the incorporation of dividends in our valuation model, we exclude those firms not paying any dividends in our period. Six of the 23 lowest risk rated firms did not pay any dividends and were therefore excluded from the portfolio. This resulted in 17 firms included in our final ESG portfolio, found in table 2.

Company	Rating (0-100)
Kitron	11,1
Schibsted A	11,2
Scatec	12,8
Entra	13,6
Kid	14,2
Fjordkraft Holding	15,6
DNB	15,7
Europris	16,4
Bonheur	16,6
Sparebank 1 SR-bank	17,0
XXL	19,9
Orkla	20,0
Sparebank 1 Østlandet	20,2
Gjensidige Forsikring	20,9
Sbanken	21,1
Bouvet	21,9
Itera	22,0

Table 2, portfolio of low risk rated ESG stocks

The Refinitiv database was used to collect firm-specific financial data. This included returns (from Refinitiv's return index) and market capitalizations, as well as dividend yields for the 17 firms in the portfolio. This data was collected on a monthly basis from January 2015 to December 2020, a total of 72 months. The returns and market capitalizations are collected in Norwegian kroner from Refinitiv. The market return, risk-free interest rate and the risk premiums SMB (small minus big) and HML (high minus low) are collected from the Kenneth French data library. We assembled this data from the European three-factor model in French's library, as this model aligns best with the Norwegian stock market. Since the returns of the firms in the portfolio are expressed in Norwegian kroner from Refinitiv, we convert it into American dollars to match with the currency of the data collected from Kenneth French's library. The exchange rates used for the conversion are also collected monthly from Refinitiv.

4.3 Portfolio construction

We construct an equally weighted ESG portfolio in our main analysis, while a value weighted portfolio is constructed to perform a robustness check.

4.3.1 Equally weighted portfolio

The equally weighted ESG portfolio returns are formed by calculating the total average return of the 17 firms each month. The same is done with the dividend yield, where the average dividend yield of the portfolio is obtained for every month in the period. This means that every firm is assigned with a weight of 5,88% each in the equally weighted portfolio. This approach allows every firm to contribute with the same amount of weight in the regression, meaning that the smaller and volatile firms affect the result just as much as the larger, more stable firms.

4.3.2 Value weighted portfolio

In the value weighted portfolio, each firm gets assigned a weight based on the market size of the firm relative to the other firms. The weights change each month as the market capitalization changes, thus an increase in the market value for a firm in one month leads to a higher weight the following month, ceteris paribus. By following this approach, we get 17 different weights for every month, for a total of 72 months. The weights for every firm, for each month, are then multiplied with the corresponding return of the firm before it is summarized, which equals the value weighted returns. The same procedure and weights are also used to calculate the value weighted monthly dividend yield of the ESG portfolio. Following this method, the larger firms will dominate most of the portfolio, meaning that the smaller firms contribute less than the big firms in the regression.

4.4 Reliability and validity

Reliability can be described as the measuring instrument's ability to provide reliable and precise answers. Reliability relates to issues such as measurement, reliability and consistency of measurements. When repeating the study described, one wishes to get the same result if the reliability is good. Random errors that always occur in a study should be minimized and be as small as possible (Kjellberg and Sörqvist, 2015). The data is collected from databases such as Refinitiv and Sustainalytics, which provide exact numbers. If the study were to be replicated, the numbers collected from the databases would be the same for the period 2015 to 2020. Therefore, the information and data collected from the databases are believed to have high reliability. Although, a weakness of the reliability is that we convert the return from NOK to US dollars, which could be a source for inaccuracy. The data collected from French's website will also be the same if replicated and has academic support through Fama and French (1993;1995) research articles.

Validity represents the reflection of truth regarding the method of research. It refers to the measure of the concept and whether it is consistent with what it is supposed to measure and what it actually measures. It is possible to differentiate between internal and external validity. Internal validity is about the variables affecting each other as they are supposed to and that there is no spurious connection between variables that creates noise in the analysis. External validity deals with the degree to which the results of a study can be used in similar situations (Roe and Just, 2009). The purpose of the thesis is to examine a potential bubble of ESG stocks on OSE, and it is essential that the data measures what we intend to measure and creates a realistic picture of reality. The thesis is also constructed based on previous research and theory from Cuthbertson and Nitzsche (2004) and Anderson and Brooks (2013), which also strengthens the validity.

We base our analysis on factors such as returns, dividend yields, exchange rates and ESG risk ratings collected from the Refinitiv and Sustainalytics database. The risk-free interest rate and the market portfolio risk premium are collected from Kenneth French's (2021) website. If one wants to control the sources validity even further, it would require microdata used to construct the numbers from each stock. Unfortunately, this is not possible to collect in the time frame of the thesis, and therefore the sources being used are well-established institutions used within other studies and articles. Therefore, all of the sources used are considered reliable and we consider the data to have high reliability and to be valid, both external and internal.

4.5 Weakness of data

There are potential improvements and weaknesses that are worth mentioning when considering the data. It is possible to criticize the time horizon used in the model. The data is based on a relatively short time horizon from January 2015 to December 2020, to investigate the potential bubble. ESG stocks have primarily had a growing interest and rise since 2015, which is the reason for the chosen period, as we consider it to be little value added to the analysis going further back in time.

Using the relevant databases, we have included 17 stocks in our portfolio, which could be considered a weakness as well. On Oslo Stock Exchange, only 91 out of 279 stocks have an ESG risk rating, where only a certain amount are considered to have a low risk rating, resulting in a relatively limited selection. 23 stocks were initially chosen, but because of missing dividends on specific stocks, 17 stocks remained in the portfolio.

The data assembled from French's library is based on European data because it corresponds best with the Norwegian stock market. The fact that the data is collected from the three-factor model based on Europe as a whole, as opposed to only Norway, could lead to a lower degree of reliability. However, the Norwegian stock market is a small and open economy that is highly affected by European financial markets in general, making the data applicable in our analysis.

5. Results and analysis

5.1 Equally weighted portfolio

The results from the regression of the equally weighted portfolio for a one- and three-factor model are presented in table 3.

Equally weighted portfolio

γ	One-factor model	Three-factor model	γ for κ calculations
dividend yield, γ_1	0,154 (0,996)	-1,021 (1,000)	-0,051 (0,913)
market risk premium*dividend yield, γ_2	64,684** (24,315)	71,436** (23,966)	25,644** (2,927)
market risk premium, γ_3	-1,427 (0,880)	-1,676 (0,859)	-
SMB*dividend yield, γ_4	-	-19,878 (50,349)	23,253** (6,820)
SMB, γ_5	-	1,505 (1,854)	-
HML*dividend yield, γ_6	-	-147,455** (44,368)	-9,3420 (4,827)
HML, γ_7	-	5,089** (1,628)	-
intercept, γ_0	0,007 (0,034)	0,040 (0,035)	0,006 (0,032)
N	72	72	72
R-squared	58,1%	70,6%	65,6%
Adjusted R-squared	56,2%	67,3%	63,5%

Stars indicate significance on the 99% (**), 95% (*) levels

Table 3, results for the equally weighted portfolio

5.1.1 One factor model

The intercept, which represents the growth rate of the bubble, is calculated at 0,007. This could appear as if the bubble part of the return from the portfolio grows at a positive rate. However, this number is not statistically significant, so we can not conclude with statistical precision that the intercept is different from zero. The dividend yield coefficient is calculated at 0,154 and is also not significant. This coefficient should have a negative sign if there is a bubble present. Potential noise (from the error term) in our data is very likely the reason for the γ_0 and γ_1 being insignificant. A problem arises if the bubble growth rate is too close to the risk-free interest rate, while at the same time, the standard error of the regression is relatively large. This is the case in the regression, making it difficult to get the coefficients related to bubble growth rate and the interest rate statistically significant from zero. We have that the average risk-free interest rate in our time series is only 0,074% annually. Also, if the asset pricing model misses relevant risk factors, then the intercept will capture the pricing error - which could be the case here. For this reason, we have decided not to be too strict on the results of γ_0 and γ_1. We remark this as we continue our analysis.

The γ_2, representing the coefficient of the market risk premium*dividend yield, is statistically significant. This indicates that something is developing in the pricing and is pointing in the direction of a possible bubble. The main indication for a bubble is that the market risk premium*dividend yield is significant as this coefficient contains the κ, as well as accounting for the risk premium. From the significant coefficient of market risk premium*dividend yield, we can interpret that the risk premium is present and significantly different from zero, which leads us in the direction of a bubble trend.

Furthermore, the market risk premium coefficient γ_3 is insignificant, which corresponds with a significant γ_2 when there is support for the bubble model in the data. The fact that the estimate of γ_3 is insignificant and negative could derive from firm-specific risk taking up large parts of the total risk of the assets in the portfolio. This could be the case, given that the portfolio consists of ESG stocks in the early phase, making the firms more prone to unforeseen events increasing the firm-specific risk. Nevertheless, the market factor is not statistically significant, so we can not reject that this coefficient is equal to zero. From our model, this aligns with a bubble term, given that γ_2 is significant since the market factor could explain zero parts of the total return. This is because the asset pricing model only explains return from the fundamental part of the price.

We want to note that the output of the regression does not perfectly match the model described in chapter three. The issue when moving from the very theoretical model and applying it to our time series data is that there could be noise in the data, which could lead to the output not coinciding. This noise could derive from the number of observations (72) as well as the set-up of the data. Even when all underlying assumptions in the model are retained, and the regression specifications are appropriate, there could still be noise from the error term that affects our result. As a result, we emphasize the significance and direction of coefficients that are particularly important for the interpretation, and put less weight on the resulting coefficients subject to noise. We want to point this out as a caveat in the analysis, as our results probably are affected by this.

From the one-factor equally weighted portfolio, it is difficult to conclude with a high degree of certainty whether there is a bubble element present in the returns. As previously derived, the return from the portfolio comes from the growth in the fundamental value plus growth in a potential bubble term. The growth rate of the bubble found in the intercept and γ_1 (together with κ) does not give a reliable or conclusive outcome due to the insignificance. We do get a significant market risk premium*dividend yield, which should be the case if a bubble term is not equal to zero, i.e., a potential bubble. This concurs with the market factor coefficient being insignificant, as this means that it is not possible to reject that this coefficient is zero. If the market coefficient could be zero, this corresponds to the return not being explained by the asset pricing model alone, but by a bubble term. In total, it is not possible to conclude with certainty in either way. However, we find that there could be bubbly tendencies in the pricing of our portfolio given a significant market risk premium*dividend yield coefficient.

5.1.2 Three factor model

The intercept in the three-factor model is estimated at 0,040, indicating a possible positive growth rate of a bubble being captured. The intercept is still not significant, so it is not possible to interpret this as evidence; nonetheless, it shows a decrease in the p-value from the one-factor to the three-factor model. The dividend yield now contains a negative sign, which is in accordance with the bubble model. This coefficient should be negative if the bubble growth rate is positive and larger than the risk-free interest rate. The sign of the intercept and the dividend yield should return as opposites when a bubble term is captured. Still, we can not accept that this output is significantly different from zero. As with the one-factor model, we consider that the intercept and γ_1 are affected by the low risk-free interest rate and general noise in the data, so we do not emphasize this in our analysis.

The coefficient market risk premium*dividend yield is highly significant at a 5% level. Like in the simplified one-factor model, this is the most crucial variable to be significant - if there is a bubble present. The market factor from the three-factor model still has a negative sign, but is now close to significant. Nevertheless, we can not conclude that it is different from zero. The added risk factor SMB is not significant, neither when multiplied with the dividend yield or as a risk factor on its own. This means that the SMB factor is not able to contribute to any additional explanatory power in our model. However, the risk factor HML*dividend yield is highly significant, even at the 1% level. As with the market factor, a significant coefficient from the risk premium (here HML) multiplied with the dividend yield points in the direction of bubbly tendencies. This corresponds well to the results from the one-factor model. Overall, this means that both factor models coincide with a bubble term present in the equally weighted ESG portfolio.

5.1.3 Fundamental value from κ

As seen in our three-factor model above, it is possible to see indications of a potential bubble being captured in the price of our low rated ESG risk portfolio. When comparing the fundamental value of a stock with the actual value, it is also possible to detect the tendencies of a bubble. To find the fundamental value of our portfolio, we back out the κ from the fundamental bubble model (without risk premiums as single regressors), as explained in chapter three. When calculating the κ of our equally weighted portfolio, the three-factor model is used as this model gives the best fit to the data (see table 3). None of the p-values from the coefficients used to calculate κ is significant, so we need to be precautious. However, it is still possible to interpret the fundamental value coming from regression. The κ is calculated to be 8,60, before the fundamental value is derived from the relation $F_t = \kappa$*dividends. Dividends are equal to the average monthly dividends for the portfolio. The actual value is the average market value of the portfolio, also monthly. The κ is equal to:

$$-\frac{\gamma_1}{\gamma_0} = \kappa = 8{,}60$$

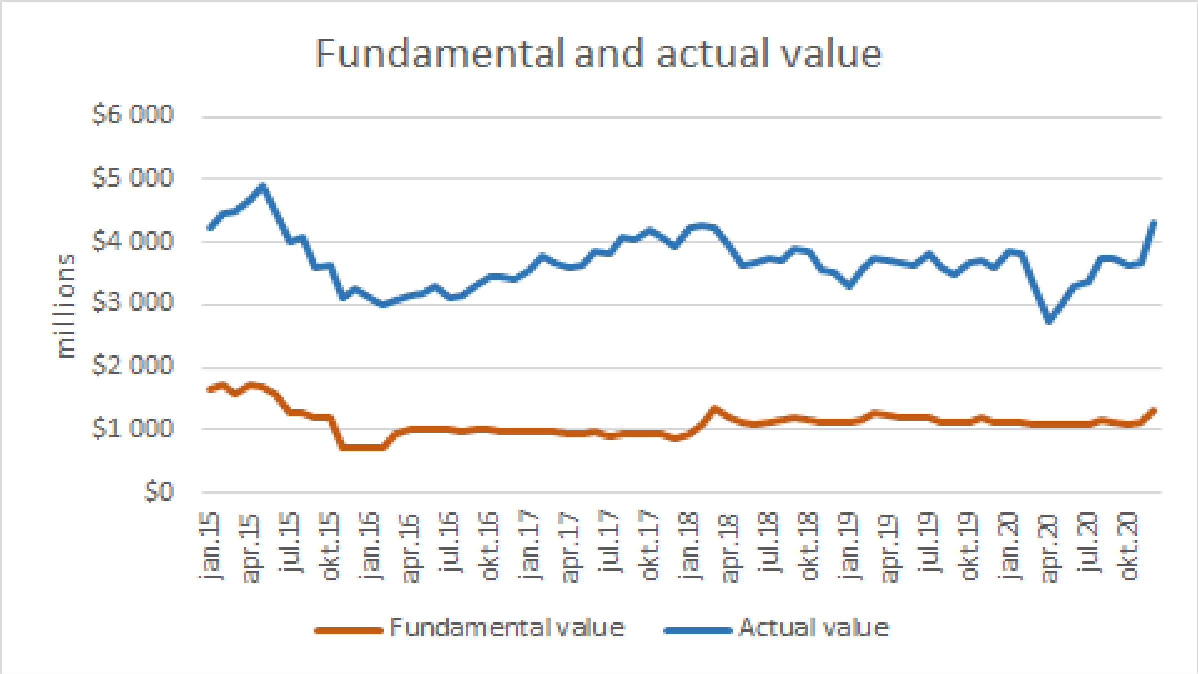

Figure 3, fundamental value vs. actual price in the equally weighted portfolio

When backing out the κ, we can construct figure 3 that shows how the fundamental value and the price of our portfolio are moving. We see that the fundamental value is below the actual value throughout the entire period, thus illustrating systematic deviations in market prices compared to fundamentals. A discrepancy between these values means that the fundamental price is exceeded by the market price, potentially showcasing bubble prices in the portfolio.

Even though the fundamental value is considerably lower than the actual value through our period, they are still moving at approximately the same rate and following each other's movements, more precisely from 2016 to 2019. What is important to note is how the graphs move at the end of our period, in 2020. When the Covid-19 pandemic hit the world in March 2020, it affected the financial markets negatively. It is possible to see this crack in our portfolio as well, when looking at the actual price. The fundamental value was not affected much because the fundamental value does not react at the same speed as the actual price due to the slower reaction of the dividends paid out, included in the fundamental value. The actual price bounced back quickly after the small crack, and interesting enough, the actual price has shown a higher growth rate at the end of 2020 than the fundamental value, which looks like it is flattening out.

By backing out the κ to calculate the fundamental value, we can showcase a potential growing bubble in the low rated ESG risk stocks included in the portfolio. This is consistent with the three-factor regression analysis above, which also highlights a growing bubble in the ESG stocks. By analyzing the graph above, it is possible to see bubble tendencies because the fundamental value is lower than the actual price of our portfolio throughout the entire period. It is also possible to see that the actual price deviates from the low fundamental price at the end of 2020. It is natural that the price stabilizes after such a sharp fall as in the first half of 2020, due to the pandemic. However, it is less natural that the price seems to continue to rise at the same rate, not following the fundamental value, which seems to stabilize. In a market without a bubble, the price should have followed the fundamental price more closely than it does during this period, given by the bubble model.

5.2 Value weighted portfolio - Robustness check

Running a robustness check, we can see if the conclusion and results change when the assumptions change. The difference between the primary analysis and the robustness check, in this case, is the construction of the portfolio. In a value weighted portfolio, each stock has been assigned a weight based on the firm's market capitalization for each month in the period. By this approach, some stocks will dominate the entire portfolio as there are significant differences in market size between the firms. The results of the value weighted one- and three-factor model are presented in table 4 below.

Value weighted portfolio

γ	One-factor model	Three-factor model	γ for κ calculations
dividend yield, γ_1	1,264 (0,903)	1,294 (1,194)	1,317 (0,907)
market risk premium*dividend yield, γ_2	29,755 (18,105)	9,733 (21,026)	18,199** (2,647)
market risk premium, γ_3	-0,438 (0,7789)	0,320 (0,872)	-
SMB*dividend yield, γ_4	-	54,979 (44,414)	11,893 (6,246)
SMB, γ_5	-	-1,761 (1,832)	-
HML*dividend yield, γ_6	-	29,101 (43,422)	0,401 (4,038)
HML, γ_7	-	-1,236 (1,908)	-
intercept, γ_0	-0,047 (0,037)	-0,049 (0,049)	-0,050 (0,037)
N	72	72	72
R-squared	57,7%	60,5%	59,7%
Adjusted R-squared	55,8%	56,1%	57,3%

Stars indicate significance on the 99% (**), 95% (*) levels

Table 4, results for the value weighted portfolio

5.2.1 One-factor model

We see that none of the coefficients are statistically significant at the 5% level in the value weighted portfolio, taking the one-factor model into account. The market risk premium*dividend yield coefficient is very close to being statistically significant at a 10% level. Since nothing is statistically significant, it is difficult to interpret and conclude. Overall, this means that we can not conclude with statistical accuracy that there is a bubble present or not in a one-factor model with a value weighted portfolio.

5.2.2 Three-factor model

The results remain similar when considering the three-factor model for the same portfolio. None of the coefficients are statistically significant and we can not conclude anything with statistical accuracy. As with the one-factor model, we can not conclude that there is a bubble present in the three-factor model, but we can back out the κ and interpret the results to see any tendencies in the market.

5.2.3 Fundamental value from κ

Based on the three-factor model, the parameter κ is backed out to get the fundamental value of the value weighted portfolio. Since this is the value weighted portfolio, we must consider the ever-changing weights of the portfolio. We solve this by assuming we own all the outstanding shares of the firms in the portfolio throughout the period, i.e., the weights and the value of the portfolio adjust with the changes in market capitalizations. By this approach, dividends are equal to the total monthly dividends paid form all of the 17 firms. The actual value is equal to the total actual market value of the firms, also monthly. The κ is calculated to 26,20, before the fundamental value is derived from the same relation as previously; $F_t = \kappa$*dividends.

$$-\frac{\gamma_1}{\gamma_0} = \kappa = 26{,}20$$

Based on the fundamental value and the actual price of the portfolio, a graph is constructed to show how they have been related to each other over our period of six years. The fundamental value and the actual price have been following each other closely for the past couple of years, as seen in the graph below. However, the actual price fell faster and steeper during the outbreak of the Covid-19 pandemic than the fundamental value. The actual price has recovered quickly and is back at following the fundamental value closely at the end of 2020. The reason for the fundamental not following the actual price during the fall in March 2020 could be because the fundamental price is based on dividends, which takes longer to adjust to changes in the market. The actual price will react quickly to news and follow the reactions in the market.

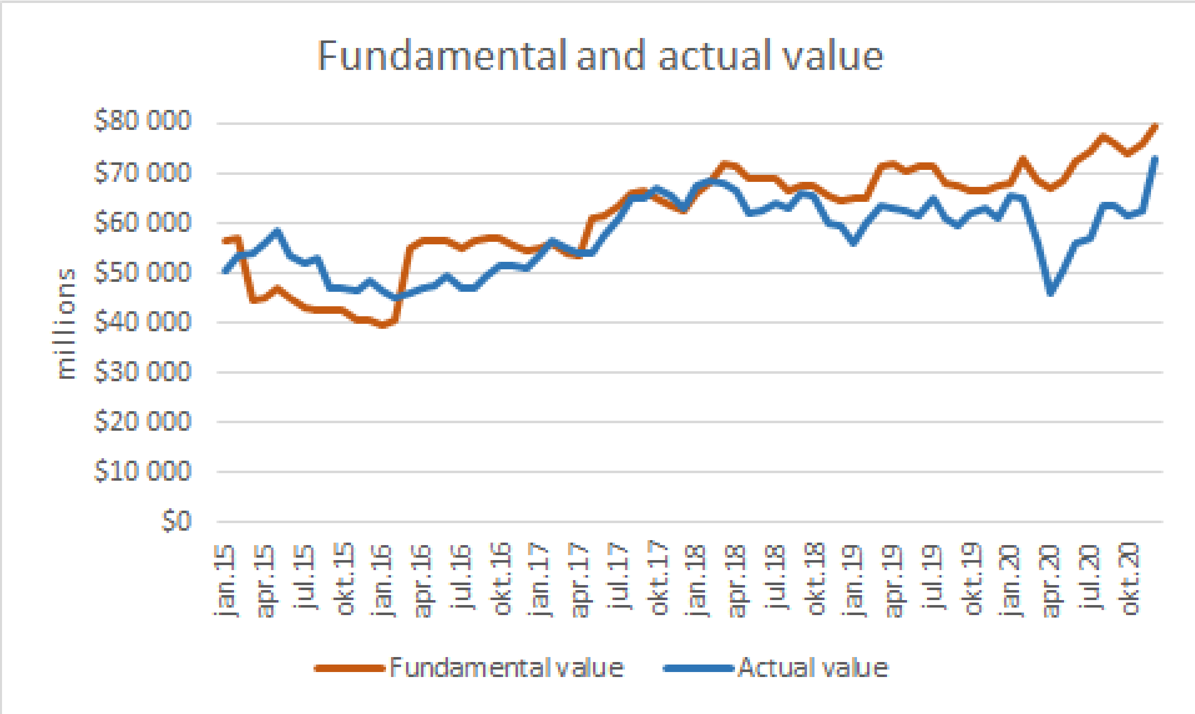

Figure 4, fundamental value vs. actual price in the value weighted portfolio

Although it is not possible to conclude whether there was a bubble present or not in the regression analysis, the κ is still possible to interpret in this case. Considering figure 4, one can argue that there is no bubble present in a value weighted portfolio. The result differs from the result in the main analysis with the equally weighted portfolio due to the skewed weight distribution of the shares. The three stocks with the lowest ESG risk rating in a value weighted portfolio also get the smallest weight because of their lower market capitalization. In such a portfolio, Kitron weights 0,2%, Schibsted of 5% and Scatec of 1%. The stock with the most weight in the portfolio is DNB which weights 40%. When basing the analysis of such skewed weights, we would potentially only be looking for a bubble in the few stocks that dominate the portfolio. DNB is the bank in Norway with the most significant market share and is a proxy for the oil price following the Norwegian economy closely. Therefore, by using only a value weighted portfolio in the analysis, the regression analysis would give us a biased result, and the stocks with the lowest ESG risk rating would no longer be emphasized as much.

By running a robustness check, it is possible to see that the results change due to the changed assumptions. Using a value weighted portfolio in a regression analysis will not give any statistically significant coefficients. Therefore, it is not possible to conclude whether there is a bubble present or not in the value weighted portfolio consisting of 17 stocks. While looking at the fundamental value, it is possible to see a difference between the value weighted and the equally weighted portfolio. Unlike the equally weighted portfolio, it is not possible to detect any bubble trends in a value weighted portfolio when looking at the fundamental value relative to the actual price. This is because a value weighted portfolio will give greater weight to the shares with the largest market capitalization and give a skewed result based on a few number of the shares in the portfolio.

5.3 Hypothesis based on the bubble model

A hypothesis was formed based on previous research and literature, where the aim of the hypothesis was to examine the thesis statement further. Our first approach for the hypothesis is a quantitative method where we test for a bubble within ESG stocks on Oslo Stock Exchange, based on the bubble model and rational bubble theory. We applied this model to our constructed ESG portfolio consisting of the 17 lowest ESG risk rated stocks on OSE. The hypothesis formed were expressed as follows:

The null hypothesis, H_0:
There is no bubble within ESG stocks on Oslo Stock Exchange.

The alternative hypothesis, H_A:
There is a bubble within ESG stocks on Oslo Stock Exchange.

By running a regression analysis on both a one-factor model and a three-factor model for equally weighted and value weighted portfolios, we can consider our hypothesis to accept or reject it. From the one-factor equally weighted portfolio, we got results that give support for the bubble model. However, this is subject to uncertainty from some of the insignificant coefficients, namely γ_0 and γ_1. The key takeaway is that the market risk premium*dividend yield coefficient is statistically significant, while the market coefficient is insignificant. This would indicate a potential bubble being captured in the data.

To further research the data, an equally weighted portfolio with a three-factor model was considered. The market risk premium*dividend yield is still significant, with an insignificant market coefficient, when adding the additional risk factors SMB and HML in the model. The added risk factor SMB do not provide any significant coefficients, and do not contribute to any additional explanatory power in the regression. However, the HML*dividend yield coefficient is highly significant. This gives further support for the bubble model, implying a bubble present in the equally weighted ESG portfolio.

When running a robustness check with a value weighted portfolio, the results were indecisive and differed from the equally weighted approach, both with a one- and three-factor model. In these regressions, none of the coefficients were statistically significant at any level. A possible reason for this could be that the assigned weights were based on market capitalization, where the big firms dominated the portfolio and the small firms had little to no weight. As a result, there was no support for the bubble model in data with the value weighted approach.

Based on the results from the bubble model with an equally weighted portfolio, we reject H_0 and keep H_A. This applies to both the one- and three-factor model, based on market risk premium*dividend yield and HML*dividend yield being statistically significant. In contrast, the market risk premiums as a single regressor are insignificant. This is in accordance with a bubble term being present in the portfolio, based on the rational bubble theory from Cuthbertson and Nitzsche (2004). Therefore, we accept the hypothesis; there is a bubble within ESG stocks on Oslo Stock Exchange, considering the ESG portfolio of the 17 lowest risk rated ESG stocks.

5.4 Schiller's indicator list

To further discuss the question concerning a potential bubble, we will consider Schiller's indicator list in the light of the market environment we see in ESG stocks on Oslo Stock Exchange. We will assess the theory primarily based on Norwegian ESG stocks in general, while also making use of the 17 stocks in our ESG portfolio. Schiller sets seven criteria that should be present if there are bubble tendencies in the ESG stocks, as presented in chapter two. In this chapter, we will analyze each indicator before we conclude based on this.

1. Rapid increase in the security price

The first criteria are a fast and somehow surprisingly high growth in the prices of equities. One can argue that this applies to ESG-stocks in Norway as a whole, at least for the period 2015-2020. According to Oslo Stock Exchange data, the increase in green stocks saw a doubling in terms of total market value from 2019 to 2020 and now amounts to just under 10% of the total market value on OSE (Oslo Stock Exchange, 2020). This increase is likely due to increasing prices in green securities. Still, it could also be a consequence of an increasing number of green shares coming from new listings, as well as established firms transitioning into more sustainable management. Considering the stock exchange has, and still is, dominated by the oil sector and raw materials, this could be viewed as an extraordinary increase.

The increase in stock prices within ESG stocks has been particularly strong since the Covid-19 outbreak. The pandemic could be defined as an exogenous macroeconomic demand shock, as the economy was affected by government restrictions and lockdowns. As a result, financial markets fell dramatically in a few weeks, before prices quickly returned to previous levels. This was especially the case within the ESG segment (Mukanjari and Sterner, 2020). Minsky (1982) defines such a course in the economy as a displacement and overtrading phase, which he claims is the beginning of a potential bubble. The common denominator for the phases seen in today's market is an expectation of increased profitability and activity related to the financial market, and that the expectations for a profit are higher than the actual value of a stock (Grytten, 2003).

Some of the stocks in our constructed portfolio have been an essential contributor to this particular growth, for instance, Kitron, which has the lowest ESG risk rating on OSE. Kitron has seen an increase of the stock price from 1,7 NOK in January 2015 to 18,1 NOK in December 2021, an increase of almost 1000 percent in only six years. Kitron is a producer of electronic compartments related to developing a more sustainable industry; thus, it is a perfect investment case for investors seeking green stocks. It can be argued that this particular increase in the price could come from a strong belief in the company's future profits and potential growth in Kitron's business model, as could be the case for many of the ESG stocks that have seen a significant price increase. It is possible that many investors believe ESG stocks will be affected by momentum, thus buying these stocks to benefit from a possible price increase. This seems to be the case for many ESG stocks, particularly within the renewable energy sector (Oslo Stock Exchange, 2020).

As a result of this, our equally weighted ESG portfolio has seen rapid price increases. The returns have diverged a lot from the Norwegian market index OSEBX from 2015 to 2020, where our ESG portfolio has returned 147,58% compared to the OSEBX return of 69,03% in those six years. The annual return for our equally weighted portfolio and the OSEBX is shown in figure 5.

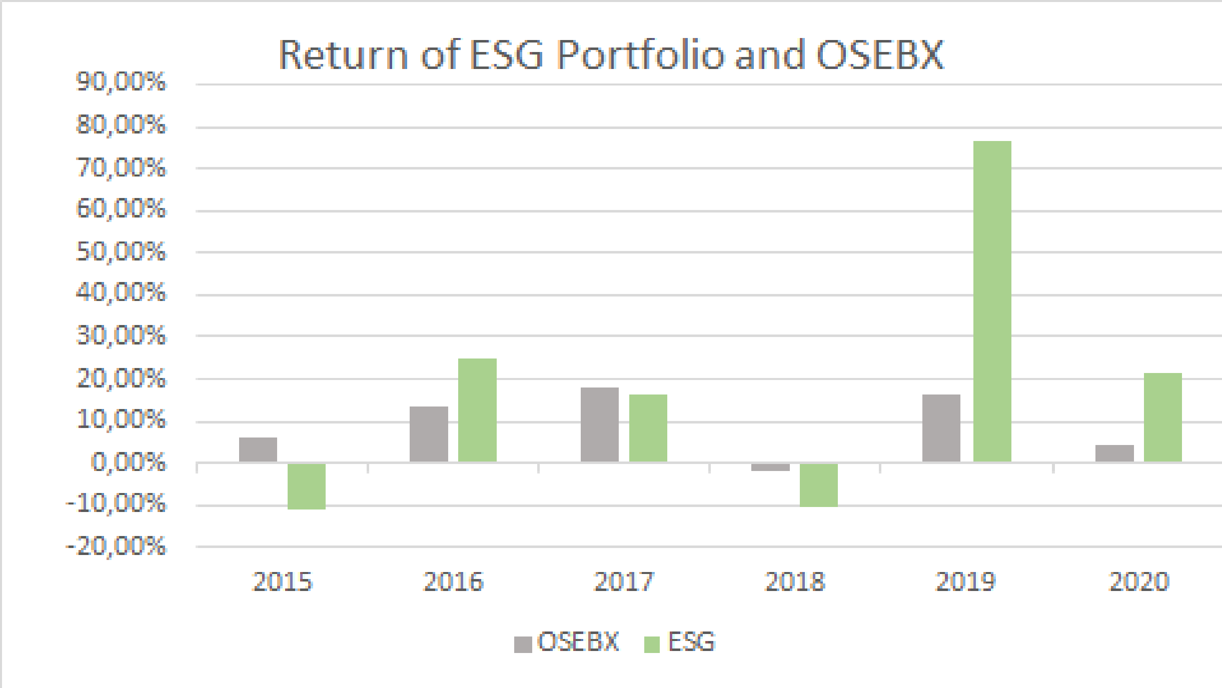

Figure 5, ESG portfolio return vs. OSEBX return

We see that the return from the ESG portfolio is affected by a higher degree of volatility in the period compared to the OSEBX index. The annual return diverges from -11,32% in 2015 up to an incredible return of 76,82% in 2019. The OSEBX, on the other hand, has provided less volatile returns, which is typical in general for an index covering a whole market. We see that when the OSEBX had fewer good years in terms of returns, the equally weighted ESG portfolio has been affected even more on the negative side. This is illustrated in 2015 and 2018, where the constructed portfolio had a negative return of over 10%. Similarly, when the OSEBX had rather good years, the ESG portfolio has given higher returns, especially in 2019. However, it is important to note that the price increase in the ESG portfolio is largely driven by some specific stocks, like Kitron. Other stocks in the portfolio had lower returns than the OSEBX in the period, while some had a negative return, for instance, XXL. This highlights the fact that there are major differences between the low risk rated ESG stocks as well, where typical cyclical stocks and firms within the bank sector had less growth in security prices in the period.

The overall growth seen from our ESG portfolio could indicate that for some part of the ESG segment, the pricing has been overly rapid, and some stocks could therefore be in a bubble, e.g., the renewable sector. Nevertheless, this is not necessarily the case for ESG stocks in the Norwegian market in general, as some of the stocks had more conservative price increases. However, a rapid increase in the security prices for ESG stocks on OSE seems to apply overall.

2. Growing interest and excitement from the public

In the market in general, there has been a significant increase in private investors who own shares and equity certificates at the Oslo Stock Exchanges marketplaces. In 2018 there were approximately 350 000 private investors, while at the end of 2020, this number was up to 476 000 investors, which is an increase of about 36 % (see figure 6). About 35% of the people on the OSE are under 40 years old, which indicates that younger investors have entered the market. Based on the recent increase in the numbers of investors, 23% of all stock owners are now considered newcomers in the Norwegian stock market. This also indicates an increase of interest and excitement from the public regarding the stock market in general (AksjeNorge, 2021).

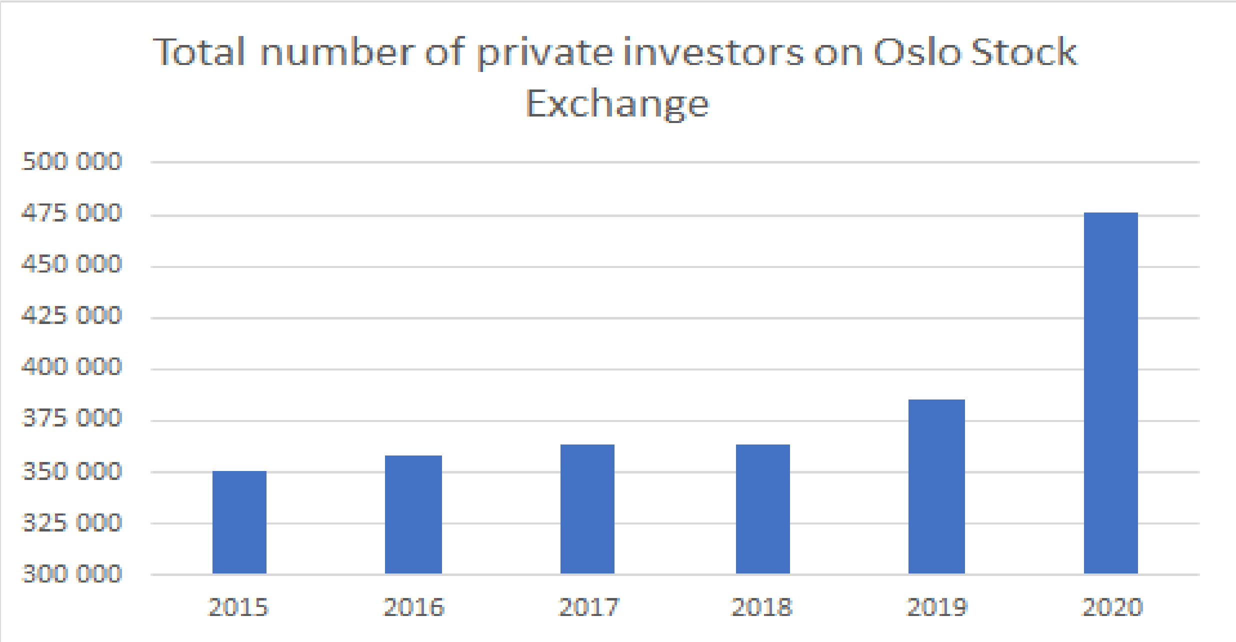

Figure 6, total number of private investors on OSE from 2015-2020 (AksjeNorge, 2021)

Out of the 20 most bought stocks on Oslo Stock Exchange in 2020, nearly half are considered green or having a low ESG risk rating (AksjeNorge, 2021). Some of these stocks were IPOs listed on Euronext growth, which is the market for smaller stock listings in Norway. Euronext Growth is a stock exchange where it is not as strict to be listed, compared to the main list of OSE. As a result, IPOs and newly listed firms carry a higher risk than usual, which means that the stocks most investors hold have a very high risk. Examples of green IPOs listed during 2020 were Aker Offshore Wind and Aker Carbon Capture, both companies focusing on green renewable energy. Since they were listed on Euronext Growth from August 2020 to December 2020, Aker Offshore Wind had a rise in the price of about 211%, while Aker Carbon Capture price rose by over 252%. Even though many of these IPOs and new listings do not have an ESG risk rating yet, it is reasonable to assume that these are to be rated as potential low ESG risk stocks in the future, based on the sector they operate in (Oslo Stock Exchange, 2020).

Looking at parallels with previous bubbles such as the dot-com, one can see similarities when talking about a rise in interest from the public. In the late 1990s, the stock market was overvalued, especially when looking at tech stocks with excessive growth. Also, during this time in history, IPOs were very popular, and so-called "regular" investors started to show interest in these kinds of listings (Goodnight and Green, 2010).

2020 was a record year in terms of listing activity. 49 new companies were listed on Euronext growth in 2020, which is a lot for a small country with only five million inhabitants. In 2019, only three new companies were admitted to trading on Euronext growth. In comparison with our Nordic neighbors, Nasdaq Stockholm had 41 listings in 2020, Copenhagen had 12, and there were three in Helsinki (KPMG, 2021). It is possible to see similarities of the behavior of the public compared to the behavior right before the crash of the dot-com bubble, based on the fact that some of the most traded stocks during 2020 were IPOs and newly listed on Euronext Growth. Although this concerns the market in general, one can argue that we see these tendencies in the green market as well, since the new listings were mainly in the renewable energy sector (KPMG, 2021).

3. Huge media attention

When the media gives a lot of attention to a specific topic, such as a potential bubble, it could be a sign of a possible state of mania in the market, according to Shiller (2016). Even though there is no exact measure of how many articles there have been about a bubble for the past six years, it is possible to see an increase in the search results from the past year when looking at articles addressing a potential green bubble. In 2020 there were twice as many Norwegian articles addressing a green financial bubble compared to 2019, based on the number of hits on news search using Google (Google search, 2021). This showcases an apparent increase in media attention around the green financial market for the past year. Media attention could be a factor to consider when looking at a price increase in specific stocks. Such attention could increase group mentality and herding in the market (De Bondt, 2003). Behavioral finance tries to explain the psychology behind such irrational behavior as herding, as it does not match the classic rational market behavior theories.

4. Stories about ordinary people who have made huge money

During a state of mania in the market, people are easily triggered by the success of others and stories about fast and easy money (Shiller, 2016). There are plenty of examples of investors that have made money taking a considerable risk in certain stocks, but have been fortunate when buying and later selling. Shiller (2016) includes this point in his indicator list since such behavior often creates a mania in society. This was also one of the hallmarks of the technology bubble in early 2000. Compared to the dot-com bubble, there was also a lot of media attention. The media wrote about the so-called "rags-to-rich," where stories about ordinary people earned a lot of money on risky assets (Goodnight and Green, 2010).

When taking a closer look at the increasingly younger investors entering the market, it is possible to see that the information they obtain is characterized by information found in social media, where stories about quick money spread fast. Tik Tok, Twitter, Instagram, and Snapchat have taken over the role of the online newspaper, and young investors seem to get inspiration and information on where to invest their money without being critical to the source. The so-called FOMO - Fear of Missing Out, is a popular term describing the feeling of missing out on stocks and popular investments, and it is possible to see that many young investors are driven by the fear of missing out on potential money in the market (CNN, 2021).

5. Growing interest from society's middle class

Environmental issues are today claimed to be one of the biggest problems that the world is facing, which has engaged people, in general, to be more conscious in rising emerging economies. People are more aware as consumers due to increased knowledge and awareness around such environmental problems. Many companies try to be mindful of this and appeal to consumers through, for example, marketing (Dangelico and Vocalelli, 2017). It is difficult to measure how much the interest in green stocks and ESG stocks has grown among the general public. Anyhow, we know that there has been a massive increase in the numbers of investors that have entered the market, as discussed above. Investors seem to be more exposed to green risk since the demand for this industry is growing. In 2020 there were 28 companies on Oslo Stock Exchange that were considered "green"; in 2019, there were only 12, which can be interpreted as a massive increase in demand for sustainable companies and industries (KPMG, 2021). Based on supply and demand within the green economy, the green paradigm is a fact, and there is a change towards a more sustainable way of living in most parts of the emerging economies.

Another reason for new investors entering the market could be the low-interest rates. The interest rate of having money in the bank is close to zero, especially after the Covid 19 pandemic. The central banks lowered the interest rate dramatically to stabilize the economy after such an event. When the following interest rate in the bank is as low as zero, people's money will decrease in value over time due to inflation. Therefore, people could feel like they have no other option than to invest their money in the stock market to get a return on their savings. A term to describe such a phenomenon is the acronym TINA which stands for "there is no alternative," representing investors considering investing the money in stocks as the only option due to the low interest rate (Investopedia, 2020). This can describe the increased numbers of new investors entering the market, but it does not necessarily mean that this is why especially green or ESG stocks' values are rising quickly.

The point about green stocks being subject to an increased interest from society's middle class can be argued in both directions. We still find most of the investors in the cities and the urban areas, so whether it has fully spread to society's middle class is also a question about definition (AksjeNorge, 2021). Based on the massive increase in people entering the market and the increasing interest in new ESG firms being listed on OSE, it could be argued that we see tendencies of growing interest among society's middle class. Although, based on the assessment, one can debate both for and against whether this indicator applies.

6. Constant discussion that defends incredible prices increases, often with arguments such as "time has changed".

The question that can be asked is whether we are in the midst of an environmental revolution and that times are changing, and whether it is possible to use this to defend such abnormal prices as seen in the market. The Confederation of Norwegian Enterprise (NHO) claims that consumers today, with strong purchasing power, demand more sustainable products and want higher ethical standards. To keep up with the consumers' developments regarding the demand, companies and enterprises must integrate a more sustainable and ethical way of doing business while fighting climate risk and taking social responsibility. Furthermore, having sustainable and ethical contracts with subcontractors has become more critical since consumers also demand transparency regarding the products and services (NHO, 2020).

Consumers' demand changes, and businesses have to adjust, but another reason for shifting the business model is the new laws and regulations being passed by governments worldwide. The European Commission (EU) has a green growth strategy, called the Green Deal, which is a holistic approach in the climate and environmental policy regarding different policy areas. The EU has set a goal of climate neutrality in 2050. The goal is to ensure a more sustainable and circular economic development with less pollution, lower greenhouse gas emissions, better health, increased quality of life, and new jobs. Businesses, as well as civil society, must be involved in the restructuring of society.

The goal of climate neutrality is an essential part of EUs 2030 agenda and sustainability goals. The EU has committed to limiting the global temperature increase to well below 2% through the Paris agreement, limiting the rise to 1,5%. It is possible to divide these goals into three main points. The first goal is to cut greenhouse gas emissions by at least 55% compared to 1990. This is a binding part that all EU members have to reach. The second goal is to increase the share of renewable energy to at least 32%. Finally, the third goal is to increase energy efficiency by at least 32,5% (EU, 2020; Regjeringen, 2020).

The climate goals from the EU impact how countries, governments, businesses, and investors have to think about their business model and how exposed they are to climate risk. If the goals are reached within the near future, institutions have to reflect on how it will affect their business model and how it is possible to adjust to these changes. Based on such laws and regulations, it may seem as if the world is entering a new era where the focus is on sustainability and higher ethical standards than before, at least in the emerging western economies (NHO, 2020). These can all be valid arguments as to why prices of Norwegian ESG stocks have skyrocketed. It is possible to argue that there are new times due to EUs green deal and consumers' increased focus on sustainability.

On the other hand, historically, we have seen that prices have been justified with the promises of a new era, but in the end, it has turned out that it was, in fact, an underlying bubble. Looking back at the dot-com bubble, one reason for the rapid growth was the imagination of a new era where new technology and computers were available for everyone. Because of the justification of the new era theories, the prices of IPOs and other technology startups rose to unreasonable heights but came crashing down later. During this period, there were also many words of praise for a lasting change in society. Still, looking back, it is possible to argue that the hope of a lasting change came too early and that the actual change in technology came a few years later. There was indeed a change in the way we use technology, but it was not yet realistic that technological growth stocks had such high pricing, as many tech companies had a lot of debt and no income (Goodnight and Green, 2010). The question is whether history repeats itself regarding the ESG stocks, or whether the high prices have a justified increase.

It is possible to see similarities between the tech stocks in the early 2000s and the green stocks today. Many green stocks are in an early phase of developing new technology, and some of them are yet to make a profit. Although, the most significant difference between then and now is the overriding goals of the EU, as well as regulation and laws from both the EU and the Norwegian government. Greater demand for change is required since climate-related challenges are quickly becoming a reality.

7. A decline in lending standards from institutional facilities, such as banks.

The last condition Shiller added after the financial crisis in 2008 and is mainly aimed at the financial sector such as banks. We therefore find little relevance for our thesis to comment on this indicator.

5.5 Hypothesis based on Schiller's list

To further highlight the discussion regarding our hypothesis, we extend our analysis with a qualitative approach. The approach is based on a constructed indicator list by Schiller (2016), which consists of seven factors considered when trying to detect a bubble in a specific market. If there is a general trend in the seven points indicating a bubble, one can assume that the particular market is either growing to a potential bubble, or that it is one already present. We have discussed the seven points included in the list to identify a possible bubble in the ESG stocks on Oslo Stock Exchange. The hypothesis is as previously stated:

The null hypothesis, H_0:

There is no bubble within ESG stocks on Oslo Stock Exchange.

The alternative hypothesis, H_A:

There is a bubble within ESG stocks on Oslo Stock Exchange.

Taking the first indicator into account, there has indeed been a rapid increase in the security price of ESG stocks over the past years. Based on total return, our constructed ESG portfolio had a return of 147,58%, while OSEBX has given a return of 69,03%, from 2015 to 2020. Such abnormal returns are also typical for the onset of a bubble, according to the bubble theory of Minsky (1982). The excitement from the public regarding ESG stocks and sustainable sectors are also present. 23% of all stock owners are considered newcomers in the market, where the most bought stocks on Oslo Stock Exchange are rated as either having a low ESG risk rating or in a sustainable industry. Many new investors are entering the market, which could signify a growing interest from society's middle class. The increasing interest in IPOs, where most of the latest listings in 2020 were in the renewable energy sector, is remarkable. This could substantiate the theory of a potential bubble, when comparing with previous bubbles.

We have seen increased media attention around a potential green bubble, as there were twice as many Norwegian articles including the words "green financial bubble" in 2020 compared to the year before. Although the articles do not always address ESG stocks in particular, it is still addressing stocks within the sustainable or green segment. The media is also covering stories about ordinary people who make huge money on risky investments. In addition, there is a lot of attention on stocks and other volatile assets in social media. This point can not be directly connected to ESG stocks, but it is relevant to the stock market in general.

It is possible to argue that the incredible price increases and huge attention related to ESG stocks are due to a new era consisting of a more sustainable and conscious way of living and investing. Although, such promises of a “new era” and that “time has changed” have been a common factor for previous bubbles in the financial market. At this point, we can not be sure what the case is before time has passed. Still, as in the discussion above, it can seem to be an actual new and more sustainable and transparent era we are entering, based on EU and government laws and regulations, as well as subsidies.

In summary, it is possible to see that at least three of Shiller’s points indicate an ESG bubble, supporting the alternative hypothesis. This applies to indicator 1, 2, and 3; the rapid increase in security price, a growing interest and excitement from the public, and huge media attention. Indicator number 5 and 6, about the increasing interest from society’s middle class and defending price increase with “new era” theories, may also indicate the direction of a potential bubble. Although, one can also argue that these criteria’s give ambiguous indications, not providing sufficient support for a potential bubble. In indicator 4 and 7, regarding stories about ordinary people who have made huge money and a decline in lending standards, we do not find any specific support for a possible bubble.

Considering these points, it is ambiguous whether we can accept or reject our null hypothesis with certainty. Based on the fact that most of the points included in Schiller’s indicator list are also applicable for today’s ESG stocks in Norway, we choose to reject the null hypothesis. The overall discussion indicates that the alternative hypothesis is true, accepting a potential ESG bubble on Oslo Stock Exchange. It is important to emphasize that the analyses are based on a subjective and discretionary assessment and that the results are therefore subject to our interpretation. The discussion is also based on news articles and financial reports, which could give an unbiased view of the market environment. Nevertheless, empirical evidence based on this subjective assessment provides support for a bubble phenomenon within ESG stocks on Oslo Stock Exchange today.

6. Conclusion

The main objective of this thesis was to discuss the following topic question: Is there a bubble within ESG stocks on Oslo Stock Exchange? To achieve the objective we applied two approaches, both quantitative and qualitative. In the main analysis, we adopted the quantitative approach, which involved using the valuation model by Cuthbertson and Nitzsche (2004), including a bubble term. This valuation model was further incorporated into a time series regression to test for the presence of a bubble in the data. To further highlight the discussion regarding the thesis, we considered previous bubble theory established by Shiller (2016) as a qualitative approach. We formed a hypothesis based on previous research to test and analyze the thesis statement. The time frame studied extends from 2015 to 2020.

To test the hypothesis and thesis statement, we applied a direct bubble test by approaching a rational valuation model in addition to a bubble term to our constructed portfolio. The portfolio consists of the 17 lowest ESG risk rated stocks on Oslo Stock Exchange, as reported by Sustainalytics. An equally weighted portfolio was considered in the primary analysis, and a value weighted portfolio was used for the robustness check. Following Anderson and Brooks (2014), we constructed a regression specification based on the rational valuation model to perform statistical analysis. We used a one-factor model, which included the market risk premium as the only risk factor, and a three-factor model, including the additional risk factors SMB and HML from Fama and French (1993).

We find support for the bubble model by running the regression for a one- and a three-factor model with an equally weighted portfolio. This indicates that there is a bubble present in the data sample. Although, there is uncertainty due to some of the insignificant coefficients. The market risk premium*dividend yield is significant along with an insignificant market coefficient, which is the focal aspect to consider when detecting a bubble in the model. None of the coefficients were significant in the robustness check. This was due to a few firms taking up large portions of the value weighted portfolio, which gave a biased result.

Shiller (2016) constructed an indicator list to consider when trying to detect a bubble. When analyzing the seven points included in the list, we can argue for a bubble being present in the ESG segment. At least three of the points on Shiller's list are applicable for ESG stocks in general on Oslo Stock Exchange today. This applies when looking at the rapid increase in security price, a growing interest and excitement from the public, and huge media attention. Two points that could be argued either for or against a bubble are the aspects about growing interest from society's middle class, as well as defending price increase with arguments such as "time has changed". We could not find clear indications for stories about ordinary people who made huge money or declines in lending standards when looking at the ESG segment specifically. To conclude, it is possible to identify many of Shiller's seven points among the ESG stocks in the current Norwegian stock market. One can also argue that there are many similarities in today's market compared to the dot-com bubble in 2000, with respect to the indicator list.

The overall results imply that the alternative hypothesis is true, accepting an ESG bubble on Oslo Stock Exchange. This applies when considering both approaches; the valuation model capturing a bubble term, and the discretionary assessment of ESG stocks in the Norwegian financial market today. Although, we want to acknowledge that both approaches have their weaknesses and that the results can therefore be ambiguous. Using both a quantitative and a qualitative method, we got a broader perspective on the discussion around our thesis question. Based on this, we find evidence for it being a bubble present within ESG stocks on Oslo Stock Exchange.

7. Further research

Our results led us to the following proposals for further research. Primarily, we suggest approaching our thesis statement while expanding the period studied to include the first part of 2021. After 2020, stock prices in the ESG segment in Norway have started to show weaker returns in general compared to our period. Several ESG stocks in our portfolio have seen a distinctive correction in their prices since January 2021, which would be interesting to further investigate with the bubble model. Moreover, one can consider other approaches to the selection of firms in Norway. For example, one can look at different criteria for ESG ratings from other databases. Also, it is possible to examine stocks within a specific industry, such as renewable energy. Using such a selection, we propose including newer firms and firms that focus more on the environmental perspective in the ESG rating. Lastly, we suggest that future research could implement the approach on other stock markets of interest, such as American, Asian, or other European markets. One could also include data for several countries to compare the results across different markets.

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