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Abstract

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Keywords: Behavioral Finance, behavioral asset pricing, behavioral biases, sustainable investing, sustainable stocks, consumer confidence, investor irrationality.

The purpose of this study is to examine the impact of prevailing sentiment among economic actors as measured by economic sentiment index and consumer confidence index on returns of stock indices classified as sustainable investment in Finnish and Swedish stock markets. Data set consist of Economic sentiment indicator published by EU and consumer confidence indicators published by national statistics offices in Finland and Sweden as well as monthly returns on sustainable stock indices for Finland between 2010 and 2022 and for Sweden between 2007 and 2022. This model uses ordinary least squares (OLS) method as the basis of time series regression analyses conducted on the data set. Instead of comparing the two markets, the goal is to observe the patterns throughout the whole existence of both sustainable investment indices.

Evidence from Finnish market points to the conclusion that there seems not be clearly observable causal relationship between the prevailing sentiment and returns on sustainable stocks. Whereas results from Swedish market indicate that there seems to be weak but statistically significant effect the sentiment has on returns on indices classified as sustainable investment. This slight effect might be attributable to existence of biases and heuristics economic actors have regarding sustainable investing.

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Tämän tutkimuksen tarkoitus on tutkia taloudellisten toimijoiden subjektiivisten arvioiden ja uskomusten vaikutusta kestäväen kehityksen mukaisiksi luokiteltujen osake indeksien tuottoon Suomen ja Ruotsin osakemarkkinoilla. Tutkimuksen itsenäisinä muuttujina ovat taloudellisten toimijoiden uskomuksien mittaamiseen käytetyt kansallisten tilastokeskusten julkaisemia kuluttajaluottamus-indeksejä Suomessa ja Ruotsissa, sekä Euroopan Komission julkaisemia *Economic sentiment*-indeksejä Suomelle ja Ruotsille, kun taas muuttuvina muuttujina käytetään Helsingin ja Tukholman pörssien kestäväen sijoittamisen indeksien kuukausittaista tuottoa vuosien 2010 ja 2022 välillä. Tämä tutkimus käyttää OLS-regressiota aikasarja dataan pohjautuvan regressio analyysiin menetelmänä.

Empiiriset tulokset viittaavat hieman erilaisiin kausaalisuhteisiin muuttujien välillä kahdella tutkimuksen kohteena olevalla markkinalla. Tulokset Suomen markkinoilta eivät pysty todentamaan kuluttajaluottamuksen tai taloudellisen sentimentin tilastollisesti merkittävää vaikutusta kyseisten osakeindeksien tuottoihin. Ruotsin markkinoilla sen sijaan näillä muuttujilla vaikuttaisi olevan pieni mutta tilastollisesti merkittävä vaikutus kestäväen kehityksen mukaisten osakeindeksien tuottoihin.

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List of abbreviations:

CCI: Consumer confidence index

CTI: Consumer tendency indicator

ESI: Economic sentiment indicator

OLS: Ordinary least squares (regression)

1. Introduction

As the theories of behavioral asset pricing have in last decades complemented the traditional models of neo-classical finance the possible impacts of investor and consumer sentiment on stock market returns have become under stricter scrutiny in several studies done across several markets and using variety of different variables. The aim of this thesis is to contribute on that batch of research by modeling the impacts of sentiment on Nordic stock markets. Particular focus of this study is on the impact economic sentiment has on those stocks classified as sustainable investments in Helsinki and Stockholm stock exchanges.

Although definitions of the term can vary, sustainable investment has been rising in popularity in recent years, for example Bloomberg estimates that total assets in sustainable investments are set to reach 41 trillion USD in 2022 and continue to grow to about 50 trillion by 2025, while the consulting firm Deloitte forecasts that half of all professionally managed assets are in ESG-mandated assets (Kishan, 2022) (Collins, Lynn Taylor, 2022). This growth has been a result of both the searching of potentially better long-term financial value as well as demand for investment that both better aligns with investors values and has a positive effect on sustainability goals (OECD, 2022). Nevertheless, whatever the motivations of every individual investor may be, at the time of increased economic uncertainty, it is relevant to ask whether the shifting sentiments could have an impact on returns of these fairly new type of assets classified as sustainable investments.

Stock indices under investigation in this thesis both have been constructed based on not only traditional financial indicators but also fulfillment of certain criteria relating to sustainable investment principals and environmental, social and governance issues, as such it is reasonable to expect that decisions to invest in accordance with these indices reflects not only expectations about profitability but also investors desire to have their investments in-line with sustainable development goals. Even though decisions to invest in stocks underlying these indices might therefore reflect a broader set of considerations than simple short- to medium-term profit-orientation, there is no intuitive reason to expect that this would make the indices returns necessarily less sensitive than any other stocks or indices based on them. Instead, it is debated whether sustainable investment returns can be assumed to

be more stable or more volatile than traditional assets with respect to economic sentiment. This thesis aims to make a contribution to this debate by also comparing the volatility of sustainable indices to in relation to economic sentiment with regular stock indices in the same stock exchanges.

So far, the studies of the impact of consumer confidence and economic sentiment to stock returns have yield mixed results, although majority seems to point toward at least weak negative causal relationship between different sentiment indices and stock market returns in different markets. This negative relationship has then generally been attributed to impact of noise traders and prevalence of biases like risk aversion among traders. These studies often use wide variety of macroeconomic and financial factors as control variables in order to disentangle what might be called rational or business-cycle related effect of sentiment from residual that more fully reflects the irrational part of prevailing economic confidence and sentiment. Like these previous studies it is this irrational component that also this paper is mainly interested.

1.1. Research problem

The goal of this study is to bring this analysis framework into new context of Nordic sustainable investment markets by conducting regression model about the relationship of between the national consumer confidence indices and economic sentiment indicator as independent variables and returns of sustainable stock indices in Helsinki and Stockholm stock exchanges as dependent variables. Like in previous studies done in different contexts this study too aims to distinguish the changes in sentiment indicators from clearly business cycle related variation and aims to model the extent this underlying sentiment can be used to explain returns in sustainable investment markets. This topic is especially relevant at the time when series of external shocks from Covid-19 to war in Ukraine and soaring energy prices have induced severe shocks to consumer confidence and economic sentiment at large all around the Europe. Although the analytical part of this thesis takes look back in time extending beyond these recent events it aims to deepen the understanding on how confidence affects the returns of sustainable investment and offer a way to interpret similar events in future where new shocks in confidence, especially ones which can be assumed to have lingering negative effects, seem plausible and where investment on stocks filling the sustainability criteria is a growing trend.

Sample of this study goes back to December of 2010 containing significant period with both ups and downs in wider macroeconomic environment. Early to 2010s being characterized by lingering effects and uncertainties of Eurozone crises while the late 2010s were a period marked by economic growth and low inflation only to be suddenly abruptly by outbreak of coronavirus pandemic over the first quarter of 2020 which induced first sharp decline in economic output and then rebound growth which was again interrupted by Russian invasion of Ukraine and subsequent sharp rise in energy prices after the February of 2022 which among other things exacerbated inflation already brought about by supply chain constraints induced by pandemic.

It is common knowledge that these kind of changes in macroenvironment which have doubtless implications on asset prices also affect the sentiment of overall populous thus it is not unreasonable to assume at least correlation between measurements of sentiment and asset prices. However, simply studying the impact that sentiment indices have on asset prices is not attractive from academic perspective as drawing practical implications beyond possibly confirming intuitive expectations about correlation would be hard due to very fact that sentiment can be generally assumed to be reflective of changes in surrounding environment. Indeed, according to simple principals of neoclassical theory investors as rational individuals would take into account changes in macroenvironment and would adjust their decision-making accordingly. However, what is interesting, and a matter of some academic debate, is whether sentiment has an *independent* impact, and even predictive power, on asset prices. This goes into a heart of a tension between two different yet complementary schools of thought on asset pricing namely neoclassical and behavioral.

In the other words, even if one would be able find statistically significant results using only sentiment measurement as independent variable and asset returns as dependent variable this wouldn't necessarily confirm much else than that rational investors are making trades according to economic and financial variables which can rationally be assumed to affect their expected returns, these variables are often referred to as fundamentals. This is because both sentiment and asset prices can be assumed to reflect the changes in wider economy, and that is why this research uses major economic indicators as control variables. In this thesis we use these control variables to separate a component from sentiment measurements which the variation in macroeconomy cannot explain. This measure of sentiment obtained after controlling against major economic and financial indicators can be assumed to represent "irrational" component of the prevailing sentiment, one that cannot be

fully explained by changes wider financial environment given the magnitude of these changes. This irrational component can be assumed to contain either over- or underreaction to changes in fundamentals and/or a “mood” based on factors wholly unrelated to the key economic and financial indicators.

Investors are not uniform class, and thus it shouldn't be assumed that every single investor adjusts their decision-making in lockstep. Fisher Black himself theorized that presence of so-called noise traders, who don't trade according to the financial and economic fundamentals of different assets, is what makes the markets effective, but mere existence of such a traders wouldn't disapprove the principal concepts of neoclassical theory of finance, namely the fact that asset prices in any case still reflect the fundamentals as rational arbitrageurs force the prices to reflect those despite the presence of noise traders (Black, 1980). What would contradict the neoclassical principals would instead be if research (like this thesis) would find that in addition to fundamentals stock returns would be affected also by the irrational component of prevailing sentiment.

1.2. Limitations

This study naturally contains also some limitations regarding the empirical time series analysis part of the thesis. One obvious limitation is that the control variables included in this do not form an exhaustive list of all the macroeconomic and financial factors that have potential to impact asset prices of Finnish and Swedish stock indices, and thus we cannot unequivocally say that the sentiment term used as independent variable to explain the variation in stock returns is wholly a measure of irrational sentiment as it is a residual of control regression. Selecting the control variable set of this thesis follows the previous literature and even though completely pure measure of irrational “mood” might be impossible, the set of control variables used in this study is capable of distinguishing the sentiment from variation in major economic and financial indicators that are widely followed and reported in society.

The second limitation relates to generalization of the results of this study. As stock markets both Helsinki and Stockholm stock exchanges are relatively small compared to ones in major economies like Germany, France and United Kingdom, not to mention United States, one should always keep in mind reading the results of this study that patterns observed here might not be as easily generalizable as patterns observed in similar study done on major

European or American stock exchanges. On the contrary this study aims to rather fill the gaps in the existing research. As most of the previous studies have focused on the on Western European stock exchanges and even more into American ones, this thesis brings the research into the context of Nordic markets which might be even characterized as “frontier markets” in the world of international finance and with added angle that brings the focus on sustainability related indices.

Furthermore, it should be noted that this study has two time-series that are of different lengths it is therefore obvious that this study doesn't aim to draw any comparisons about the relationship between the two markets per se, but instead the goal is to observe the patterns throughout the existence of both sustainable investment indices (i.e., from 2010 onwards for Finland and from 2007 onwards for Sweden). Another reason for this that the domestic consumer confidence indicators are not exactly the similar in their composition as questionnaires they are founded are not similar.

2. Preliminary literature review

In this section presents a brief overview of the theories in the background of this study, these theories can be broadly classified into two larger schools of thought: the neo-classical asset pricing and behavioral asset pricing. This study is more based on the latter than on the former of these two approaches, but it is crucial to understand the basic concepts of both in order draw conclusions from this study, and even though behavioral finance emerged as a response to the theoretical and empirical difficulties found in neoclassical paradigm, these two offer a complementary understanding about asset pricing (Nanayakkara, Nimal, Weerakoon 2019). After reviewing the key theoretical concept, next chapter then presents an overview about the findings of previous research about the subject of sentiment-stock returns-relationship.

2.1. Neo-classical approach on asset pricing

In neoclassical model of asset pricing, value of a stock in a capital market is equal to the present value of its expected future cash flows i.e., cash flows that holder of any given stock is expected to receive in the future are discounted into present moment and sum of these forms the intrinsic value of a stock. If price of a stock differs from its own intrinsic value, the rational arbitrageurs will instantly correct for the mispricing to its fundamental value. The asset pricing theory assumes investors are always rational and that there are unlimited opportunities for arbitrage in a market. (Nanayakkara et al. 2019)

The three core assumptions that form the basis of neo-classical model asset pricing are the following: investors are rational, and markets are perfect and efficient (Nanayakkara et al. 2019). Rationality of investors can be described to mean that they define their preferences to maximize their expected utility in the face uncertain outcomes, underlying theory of this was famously developed by Von Neuman and Morgenstern, who expanded their utility theory from the concept of marginal utility satisfaction which is often described as a goal of rational actor in basic economics to a concept of expected utility which function depends on probabilities of possible outcomes (Von Neuman, Morgenstern 1944). There is also an assumption in neoclassical finance that upon receiving new information rational investors update their beliefs using a kind of statistical judgement and Bayesian Updating (Nanayakkara et al.). Bayesian Updating assumes that decision-makers have prior beliefs regarding distribution of payoff-relevant states and relevant signals which enables them interpret information content of each signal accordingly (Zhao, 2022).

The term perfect markets are often used in economics to describe the ideal state of the marketplace that in itself holds several assumptions including the fact that markets very liquid, in a sense that there a lot of both buyers and sellers and therefore actions of any one individual cannot alter the market price (in the context of capital markets perfect markets hypothesis sometimes replaced by the efficient market hypothesis that is introduced below) (Hyytinen, Maliranta 2016). Another key assumption is that both buyers and sellers can enter or exit the markets freely, also in classical economics the assumption of homogeneity of the goods is added into a description of the perfect markets which would lead to fact that the buyers are basing their decisions only to a price, the fourth assumption linked to the perfect market is that every actor in the market has complete knowledge of all the relevant information (Hyytinen, Maliranta 2016). Needless to say, the term perfect market is only applicable to ideal and likely unachievable state, but it offers a much-used reference point for theory and research. Also, as a reader might be aware, the term perfect market or perfect competition is most often used in the context of consumer product markets, that doesn't mean it cannot be applied into a context of capital markets, but it should be kept in mind that there are some keyways the capital markets differ from other kind of markets. It is worth pointing out also that some very sophisticated models have been developed which allow for taking things like illiquidity, barriers of exit and entry as well as information asymmetry into account, and none of these things of course necessarily violates the assumption of market players rationality. However, the concept of perfect markets should be first and foremost regarded as a theoretical state under which suppliers and purchasers aggregated utility is at the maximum, this market balance is considered as a reference point in many different theories which sets the optimal price of an asset (Hyytinen, Maliranta 2016). Although perfect markets are foundational concept in the modern economics deeper examination of this concept is not relevant for understanding the topic of this study and for general theory about the perfect markets, I would refer interested reader to the article by Nobel prize winning economists Kenneth Arrow and Gerard Debreu "*Existence of an Equilibrium for a Competitive Economy*" (Arrow, Debreu, 1954).

Efficiency of the capital markets is famously described efficient market hypothesis by Fama in 1970, according to his definition the markets can described to be efficient when prices at the market "fully reflect" all the available information at the market (Fama, 1970). It is important to note that even though fully efficient market and perfect market are not exactly the same concepts, also the efficient markets describe an ideal state of the market where

investors can choose among securities in markets where “prices provide accurate signal for resource allocation” (Fama 1970). Fama latter defended this theory with regard to presence of market anomalies by stating that the efficient market hypothesis shouldn't be abandoned because the expected value of abnormal returns amounts to zero because as a result of chance apparent anomalies are randomly split between overreaction and underreaction both being about equally common (Fama, 1997). Fama presents three possibilities regarding market efficiency, in the weak form of market efficiency information fully reflected in prices would be only the historical price information, whereas in so-called “semi-strong” form of efficiency the prices also fully reflect the other clearly public information like annual reports, new securities issues and stock splits, and in “strong” form of market efficiency prices would reflect in addition to aforementioned also other information that would be relevant for price formation (Fama, 1970). It is worth saying regarding the distribution of information in the markets that disagreement among market participants about implications of any given piece of information is not necessarily a mark of inefficiency as long as no group of market participants constantly make better evaluations of available information than is reflected in marketplaces (Fama, 1970).

Theories mentioned above describe the market condition, but foundational normative theory about the investors' actions in the field of neoclassical asset pricing has doubtless been the portfolio theory by Markowitz. This theory states that investor should choose his/her portfolio of securities according to the principal of maximizing the expected return and minimizing the variance of the expected return (risk), and that investor can achieve this by diversification of his/her investments (Markowitz, 1952). Markowitz considered this E-V optimizing as suitable guiding maxim for investor operating in the capital markets (Markowitz, 1952). In the hindsight one can come into conclusion that this has indeed largely become guiding maxim for investors decision-making.

Another huge development in neoclassical asset pricing has been the introduction of capital asset pricing model (CAPM) which is based on the work of Sharpe, Lintner and Black (thus sometimes referred as SLB-CAPM) who continued the development of the equilibrium risk-return relationship from the portfolio theory (Levy, 2012). Key insight leading to the development of CAPM was the notion that risk component in investors decision-making consist of unsystematic risk and systematic (non-diversifiable) risk and that presence of these two categories defines the capital market line which describes the relationship between risk and the return (Sharpe, 1964). Lintner further concluded that the measurement

of risk and therefore determinant of risk premium (pay-off expected over risk-free asset) should be related to the variance of returns (Lintner, 1965). Subsequently the variable indicating the risk in CAPM model became to be denoted by β (beta). Market beta is usually defined by simple equation: covariance of return on given asset and market portfolio divided by variance of market return, return on market portfolio often meaning a comprehensive portfolio that captures the market asset is traded, this usually is defined as a given stock market but can be theoretically expanded to include also other financial assets (Fama, French, 2004). Full equation of so-called Sharpe-Lintner CAPM can be therefore defined as: “expected return on any asset is the risk-free interest rate plus a risk premium, which is the asset's market beta times the premium per unit of beta risk” (Fama, French, 2004, p.29). Black outlined that expected return on any risky asset is a linear function of its beta, he further noted if there would be riskless assets then the slope relating expected return on risky asset to its beta has to be smaller if no restrictions on borrowing exists (Black, 1972).

Despite its popularity, the CAPM model has been criticized particularly for the fact there has been empirical evidence concluding that beta doesn't capture all cross-section variability of returns, as well as for the fact that underlying hypothesis of the model which states that returns are normally distributed has found empirical evidence against it (Levy, 2012). After the development of CAPM there have been several other models in neoclassical tradition in response to empirical evidence about anomalies which couldn't be captured by CAPM alone, these have included both different expansions of Sharpe-Lintner-Black CAPM model as well as atheoretical factor models constructed on the basis of observed anomalies (Nayakkara et al. 2019). One of the most famous of these more recent neoclassical models is factor model by Fama French which originally used size of the firm, book-to-market ratio, and excess return on the market as explanatory factors for performance of a stock and later expanded this model to include also two more factors: “profitability” and “investment” (Fama, French, 2015). Also, other expansions of the Fama-French framework exist, taking into account factors such as “momentum”.

In conclusion, neoclassical asset pricing usually assumes a situation where rational investors are making decisions based on all available information in order to maximize the expected utility (usually by optimizing the return in relation to risk in their investments), these maximizations can be assumed to broadly take a form of mathematical formulas that lead to similar conclusions irrespective of an individual applying them.

The neoclassical approach on asset pricing assumes that rational actors are making decisions in order to maximize their expected utility in the conditions where markets are perfect and efficient, information is readily available and rationally processed by market actors who have limitless arbitrage opportunities. Two key theories build on this foundation are the portfolio theory by Markowitz and capital asset pricing model by Black et al. which have defined the traditional point-of-view on questions regarding the pricing of assets. This neoclassical approach has however been challenged by newer behavioral approach especially regarding two of its foundational concepts: rationality of market actors and limitlessness of arbitrage opportunities (Nayakkara et al., 2019).

2.2. Sustainable investing

Motifs of any given investor for opting to invest into sustainable assets classes could be multitude. It should be said however that such motifs may not be exclusively about factors related to ones' concern for environmental and social issues or one's desire for contributing to sustainable development in the future.

Perhaps the most prominent example of underlying considerations that could have an effect on people's decision-making regarding sustainable investing is climate change. Changing climate raise special concerns also regarding profitability of investments. This can be seen as failure of markets to account for the potential impact of extreme events damaging the business, sometimes referred as physical risk as well as the potential effect of unexpected legislation accelerating decarbonization in ways company might be unprepared for, sometimes referred as transition risk. Both of these risks "might prompt the abrupt repricing of 'exposed' financial assets". (Guogaliano, Linciano, Soccorso, 2022)

In addition to financial risks associated with non-action in many sustainability related issues there can also be opportunities associated with acting on those, for example the so-called green transition into low-carbon economy has been hailed as potential opportunity for financial gain for companies provided that transition process is smooth (Carney, 2018).

2.3. Behavioral approach on asset pricing

Behavioral approach on asset pricing challenges and complements key notions in traditional neo-classical concept of asset pricing by introducing several theories about imperfect rationality of the market actors and limited opportunities for arbitrage. It should however be pointed out these are not in every situation interlinked assumptions, for not all limits to arbitrage disapprove the theory about the fully rational actors, transaction costs or other impediments can put limits on arbitrage for even fully rational investors (Statman, 2017).

Questioning the rationality of investor however goes into foundations of neoclassical finance which is largely founded on the groundwork laid by Von Morgenstern's utility theory. Some criticism of neoclassical finance might be rather obvious, for example Richard Thaler stated that: "IQ of homo economicus has become bounded only by IQ of smartest economic theorist", in reference to the fact that simple lack of knowledge or mathematical ability from investors part could put certain limits to practical usefulness of some neoclassical models (Thaler, 1980). From his part Meir Statman, who wrote a paper titled *Finance for Normal People*, argued for an asset pricing model based on Lancaster's (1966) consumer theory according to which holding assets and expected benefits from those assets should be looked in the light of also expressive and emotional benefits associated with those rather than just associated utilitarian benefits as is classically done (Statman, 2017). From experimental side for example Lo and Repin found in their study where they measured psychophysiological variables of professional traders that emotional responses indeed play a part in processing of financial risk (Lo, Repin, 2002). This chapter aims to drill down on the key issues where behavioral field has complemented neo-classical approach focusing mainly on biases and heuristics; set of theoretical concepts detailing how assumption of rationality often fall short on reality.

In the scientific terms behavioral finance has much more descriptive than normative point of view into the financial markets, and it has been at the times criticized for being rather incoherent collection of theories that lacks the mutual structure (Nanayakkara et al. 2019). According to Shefrin the discipline of behavioral finance has been characterized by a kind of ad hoc approach which has resulted of custom models being built to fit the empirical findings which have not led to one general approach as theories are developed to construct a behavioral explanation empirically found phenomena (Shefrin, 2005). However, despite occasional criticism leveled on behavioral finance as a paradigm, theories presented in behavioral finance literature can prove to be very useful in explaining the phenomena which also this study aims to model. As the rest of this chapter goes through the key theories classified as a part of behavioral finance literature, reader should note that this is not exhaustive review of all or even majority of theories presented as part of behavioral finance, but instead the focus is solely on those theories that are relevant for understanding the phenomena described in the empirical part of this thesis. For more complete look into the field of behavioral asset pricing, one should read for example the 2005 book by Shefrin: *A behavioral approach to asset pricing* (Shefrin 2005).

Shefrin argues that fundamental theories in behavioral asset pricing challenge the two basic pillars of neoclassical approach, he dubs the prospect theory as counterpart of behavioral finance for Von Neuman-Morgenstern utility theory and various “heuristics and biases” as counterpart in the behavioral field for Bayesian updating of beliefs in neoclassical approach (Shefrin, 2005). Challenges to the interpretation that people “form judgements in accordance with Bayesian principals” have been made for example with respect to the fact that in many situations acting according to Bayesian updating would assume unrealistically high informational and computational requirements from decision-makers part (Shefrin, 2005) (Zhao, 2022). Practical limitations in real-world applicability of Bayesian updating have spurred more advanced models about updating of beliefs such as Zhao’s “Pseudo-Bayesian updating” (Zhao, 2022). In this thesis however, more focus is put on the various heuristics and biases, many of which have been developed from empirically observed patterns in people’s behavior in various decision-making situations.

2.3.1. Prospect theory, heuristics and biases

Prospect theory was developed by Kahneman and Tversky who critiqued theory of expected utility as foundational model for decision-making under uncertainty. They demonstrated that tendencies to choose between risky prospects exhibit several effects that are not consistent with the framework of utility theory. They concluded that people tend to underweight those outcomes that are only probable compared to ones that are certain, this which they called as *certainty effect* leads to both risk aversion in situations involving certain gains and risk seeking behavior in situations certain losses. Kahneman and Tversky further concluded that if all prospects share one or more of the same components people making choices tend to discard those components from decision-making which contributes to inconsistency of preferences when the same choice to be made is depicted in different forms. Kahneman and Tversky proposed probabilities which are basis of decision making in expected utility theory should be replaced by decision weights and instead of assigning value to final assets it should be assigned to gains and losses in the given situation. Decision-weights tend to generally be lower than corresponding probabilities would be except for low probability range, they concluded. They further concluded that resulting value function tends to concave for gains and convex as well as normally steeper for losses. (Kahneman, Tversky, 1979)

Indeed, the concept of risk aversion and related concept what has sometimes called the myopic loss aversion have been focus of much study in decades since Kahneman and Tversky first introduced the prospect theory. Myopic loss aversion is part of the concepts of

biases and heuristics which according to Shefrin form behavioral asset pricings' counterpart to Bayesian updating of beliefs assumed in neoclassical approach, although Nayakkara et al. links heuristic and beliefs to both prospect theory and concept "erroneous beliefs" that they consider as behavioral counterpart to Bayesian updating of beliefs (Shefrin, 2005) (Nayakkara et al., 2019). The term "myopic loss aversion" was first coined by Benartzi and Thaler who deemed it be combination of the fact that investors are markedly more sensitive to losses than to gains and the tendency of even long-term investors to frequently evaluate their portfolios, they found this myopic loss aversion to be consistent with the empirically documented equity premium puzzle (tendency of equities to outperform bonds by surprisingly large margin) (Benartzi, Thaler, 1995). Tendency to frequent evaluation is itself part of heuristic called mental accounting which refers to certain implicit and explicit cognitive activities which individuals use to engage to functions analogous to accounting in organizations which then subsequently determines how investors frame their decision-making and how they experience the outcomes of their actions (Thaler, Tversky, Kahneman, Schwartz, 1997). In financial decisions this usually determines whether individuals' asses each of their holdings separately or as a portfolio and how often they do such evaluations (Thaler et al. 1997). Since the publishing of article by Benartzi and Thaler in 1995 existence of myopic loss aversion has remained much researched topic in the field and in 2005 Haigh and List found in their study of Chicago Board of Trade traders that even professional traders tend to exhibit myopic loss aversion even into greater extent than undergraduate student tended (Haigh, List, 2005).

Slightly larger concept in the realm of biases and heuristics is called framing which refers to the fact that assumption of rationality that states that preferences between options should not change even if the frame of the decision changes doesn't hold true due human imperfections perception and decision-making (Tversky, Kahneman, 1981). In fact, Kahneman and Tversky have demonstrated in their 1981 article that changes that at first seemed inconsequential in the formulation of choices caused significant shifts in preferences (Tversky, Kahneman, 1981).

Another bias adjacent to loss aversion is so-called disposition effect, observed pattern for traders to hold losing position for too long and sell the winning position too early (Shefrin, Statman, 1985). Shefrin and Statman conducted a study about this were they factored in mental accounting, regret aversion, self-control, and tax consideration and found that tax consideration alone were not enough to explain the observable patten of gains and losses in

markets, but that those patterns indeed were comparative to the effects of those four factors combined (Shefrin, Statman, 1985). Another concept affecting buy/sell/hold decisions in markets is so-called status-quo bias, which presence has empirically been documented in experiments which show individuals tendency to disproportionately stuck with the existing status quo state (Samuelson, Zeckhauser, 1988).

Bias that sometimes can have opposite effect than loss aversion is human tendency of overconfidence which can lead to increasing expected trading volume and depth as well as decreased expected utility of overconfident traders in the market they trade (Odean, 1998). Overconfidence can further lead to markets overreacting to salient, anecdotal and less relevant information and conversely underreacting to abstract, statistical, and relevant highly information which results the fact overconfident traders can obscure information of rational traders in the marketplace (Odean, 1998). Overconfidence can be dynamic property which varying along with successes and failures experienced by any given trader, degree of overconfidence is also dependent upon to what extent does a trader attribute his or her successes into his or her own abilities (Gervais, Odean, 2001). A concept which can sometimes relate to overconfidence is cognitive dissonance. Cognitive dissonance is psychological phenomenon which stems from general desire of people to see themselves as “smart and nice” which leads information conflicting with this picture to be ignored, rejected or accommodated by some changes in other beliefs of a person (Akerlof, Dickens, 1982). Akerlof and Dickens have taken this theory to economic context by making three propositions based on it: in addition to having preferences over the states of world people also have preferences about their beliefs over the state of the world, people have some control over their beliefs and can manipulate them by selecting sources of information, and finally once chosen beliefs tend to persist for a considerable period of time (Akerlof, Dickens, 1982). Practical implication of overconfidence and cognitive dissonance as well as another biases and heuristics in the asset pricings perspective is that it offers theoretical framework which can explain seemingly irrational choices among investors by drawing attentions on the differences how people interpretate the available information.

Heuristics and biases are sometimes viewed as an opposite of economic rationality, but it could be argued that phenomena like loss aversion, mental accounting and overconfidence are consistent with individual’s adaption to changes in their environment according to evolutionary model proposed by for example Lo (2004) who coined the term adaptive market hypothesis in an attempt to reconcile the efficient markets hypothesis with emerging

discipline of behavioral economics and finance (Lo, 2004). This might be applicable to especially for field of sustainable finance and offer a theoretical explanation why market prices don't seem to fully reflect things like new risks arising sustainability challenges (Schoenmaker, Schramade, 2020). According to the adaptive markets hypothesis things like fear and greed, which can cause irrational thinking and result individuals value functions to look more like those described by prospect theory, are products of "evolutionary forces" and according to Lo these traits can in fact increase the probabilities of survival, his theory is founded on batch of research in economics and behavioral sciences which imply that rationality in decision making and emotions are in fact not antithetical but in certain circumstances can instead be regarded as complementary (Lo, 2004).

2.3.2. Noise and noise trading

This leads to the concept noise and noise trading. Noise can be defined to those action and information that mask the underlying fundamentals based on which rational investors are assumed to make their decisions. Noise was theorized by Black in 1986 who contrasted the actions of noise traders against rational investors who traded based on (relevant) information and while stating that the noise traders couldn't really expect profit for their trading, he also concluded that the very presence of noise in financial markets ensure their continued liquidity, and while noise brings inefficiencies into the financial markets it often prevents economic actors from taking full advantage of those inefficiencies as noise can thought to be relating to fundamental uncertainties in the market (Black, 1986). He also further noted that the noise is the exact thing that sometimes can make our observations imperfect (Black, 1986). Tetlock theorized that if we assume both noise traders and rational investors to be risk averse and (or) capital constrained, then as noise traders experience negative shock to their essentially random beliefs, they start selling stocks into arbitrageurs with Bayesian beliefs leading to increased trading volume and temporarily depressed returns, however if these belief shocks are assumed to be stationary this also leads to rebound in the following period when there is a new belief shock (Tetlock, 2007). According to Brooks financial data tends to often be particularly noisy masking underlying trends and patterns (Brooks, 2019). Schleifer and Vishny note that, especially in the case of equities noise trading can sometimes push prices long away from their fundamentals before new information corrects the mispricing (Schleifer, Vishny, 1997). Result of all this might be that rational arbitrageurs are not so aggressive to enforce pricing according to fundamentals which would be suggested by neoclassical models. Ultimately this leads to the second

assumption in behavioral finance, namely that there are limits to arbitrage at the markets (Nayakkara et al., 2019).

So according to the theory noise traders can but not necessarily do alter the balance way from fundamentals-based equilibrium suggested by neoclassical theory. Whether they do, depends much on whether conventional wisdom that noise traders' biases are independent from each other and therefore to large extent cancel out each other holds true. This has been researched by Yan (2010) and he suggests that biases do have significant effects on asset prices equilibrium even if those would be independent from each other (Yan, 2010). There are two essential reasons for this, first of all independent biases can have an effect on asset prices equilibrium in cases where investors demand for given asset is non-linear function of given bias, secondly even in the cases where investors demand for any asset is subject to a linear function of its bias fluctuations in wealth distribution may lead for that bias to have a significant impact on asset price equilibrium (Yan, 2010).

2.3.3. Behavioral finance models

The field of behavioral finance has not of course been only about the creation of new theoretical frameworks, often concepts and theories regarding phenomena described by authors in the field of behavioral finance have been integrated into modelling of for example asset pricing. This has been motivated partly by desire create models that appear more realistic in light of expanding empirical evidence provided by field of behavioral finance and partly by early success of moment-matching exercises conducted using such models (Zin, 2002). This has naturally led questions whether new findings in the behavioral finance field can be integrated into structural models like tightly parameterized general equilibrium models used traditionally to characterized asset-market data (Zin, 2002). Zin (2002) suggests that there have been questions about the sufficient structural stability in behavioral asset pricing modelling and he notes that evaluating this will likely always require a degree of subjective judgment about reasonableness of the assumptions that any such model would make (Zin, 2002). In her comment to Zin's work Wachter suggests parsimoniousness as solution to the problem that arises when assumption of rationality is discarded leaving room for multiple degrees of freedom at actors' utility functions in behavioral models (Wachter, 2002).

On a final note, if behavioral hypothesis about potential irrationality of traders and limits to arbitrage is accepted it opens possibility of the existence of underlying factors that can affect the strength of biases and heuristics impact on asset prices. For example Chui, Titman and

Wei found that individualism as described by Hofstede's individualism index has a positive impact on magnitude of momentum profits, this is significant because individualism is related to overconfidence and self-attribution biases thus empirically linking those to asset prices (Chui, Titman, Wei, 2010). Subsequently also e.g., Schmeling (2011) and Wang, Su and Duxburry (2021) have linked cultural explanations to their analyses about sentiment and asset prices in behavioral framework.

The concepts like myopic loss aversion, risk aversion, mental accounting, disposition effect, overconfidence, as well as presence noise and noise traders in the markets are important factors to keep in mind as we move forward to review previous research about the topic of this thesis. All these concepts can be used to formulate theories about failure of financial asset markets always to yield the outcome that would be rationality expected, and furthermore, all these concepts can help us understand phenomena that seems unexplainable by traditional models of neoclassical approach to asset pricing.

3. Previous research

Several studies have been done in recent years in order to research the relationship between the different measures of sentiment and returns on different stock indices. Most of these studies have treated sentiment indices as independent variables and stock indices as dependent variables and methodology has often been either OLS time series regression or fixed effects panel data regression, but also other methods of analyzing the relationship have been applied. Often the studies have used large sets of control variables in order to isolate what can be called “pure” effects of sentiment variables for stock returns, these control variables have generally been economic and financial factors like for example: unemployment rate, growth in industrial production, GDP growth rate, annualized CPI inflation rate, and detrended short term (three or six months) interest rate.

Sentiment indices most often used in the previous research in the US markets seem to be the Conference Board Consumer Confidence Index and University of Michigan’s consumer sentiment index, both released monthly and based on surveys done about public outlook on the development and state of the economy (Conference Board, 2022) (University of Michigan, 2022). Whereas at the European markets researchers often use either the consumer confidence indicator published by the European Commission based on the harmonized surveys conducted by Directorate General for Economic and Financial Affairs for different economic sectors in the European Union (EU) and in the applicant countries or alternatively the consumer confidence data published by national statistics offices in every country subject to the given research (European Commission, 2022). It is further interesting that consumer confidence is used in some studies also as a proxy for investor confidence. In addition to survey-based data, some studies have opted to use some other measurements like Baker-Wurgler composite investor sentiment index based on quantitative market data. Like said, these independent variables are then used to measure their impact on dependent variable which almost always is return on the main stock index in the market in questions, in the US market this being Standard & Poor’s 500.

3.1. Summary of previous empirical findings

Aim of this section is to concisely summarize key previous empirical findings of the subject matter this thesis, in total fifteen academic journal articles which posed a relevant research question were reviewed. However, it is noteworthy that research questions and used

variables do slightly vary as does scope of the studies. Overall, we can conclude that the previous research has found mixed results regarding the subject matter.

At the beginning, it is worth noting that Jansen and Niek studied the contemporaneous correlation and Granger causality between the EU Commissions consumer confidence indicator and main stock indices in 11 European countries and found stock returns to be positively correlated with changes in sentiment, with Germany being the main exception. Moreover, they also found that stock returns have a causal relationship with the consumer confidence at very short term (2 weeks to 1 month) but apparently not vice versa. They further broke down the consumer confidence indicator down to its four components (personal financial and general economic conditions, unemployment and ability to save), and found the stock return confidence relationship to be driven by the expectations of general economic conditions instead of about personal financial conditions. (Jansen, Niek, 2003)

Rather than simple correlation and causality test that Jansen and Niek used, most of the studies focused on studying the effect of sentiment to the stock returns by means of different types of regression analyses. For example, using fixed effects panel regressions Schmeling found in study about the impact of consumer confidence (used in this case as a proxy for investor sentiment) on the return of aggregate stock market in US, Japan, Australia, New Zealand and 14 European countries that overall there seems to be a significant negative relationship between sentiment of investors and returns for stocks which he considers to be in line with theoretical considerations and previous studies of US markets, also he further found that the impact of sentiment has on average future returns will decline with the forecast horizon. Interestingly he further presented evidence that impact of sentiment to returns seems to be stronger in countries with less market integrity and more cultural tendency to overreaction and herding behavior. (Schmeling, 2011)

In a similar study like Schmeling's, Wang, Su, and Duxbury found, using also fixed effects panel data regression and similar set of control variables, a negative relationship at global level between consumer confidence (again as a proxy for investor sentiment) and returns of 50 global stock market, this negative relationship seemed to hold separately for both developed and emerging markets. Interestingly they also found that sentiment has more enduring effect on returns in developed markets but more immediate in emerging markets. In comprehensive analysis they also looked various potential explanatory factors drawn from cultural dimensions, intelligence and educational factors, and market institutions, and found

that some such variables hold explanatory power, which is in-line with finding of Schmeling (2011). Additionally, they also found the relationship between investor sentiment and returns to be largely similar even after controlling for economic sentiment (on those markets where it was available) which disentangled the expectations about future business condition from confidence indicators. (Wang, Su, Duxbury, 2021)

Many of the studies also used time series regression, particularly, OLS as methodology. One such a study was done by Lemmon and Portniaguina who focused their study on the link between size premiums and sentiment by studying the returns on M110 portfolio. They found that over the last two decades consumer confidence, measured using the University of Michigan and Conference Board indices, has been exhibiting forecasting power for both small stock returns and future macroeconomic activity. They differentiated the so-called “sentiment” component of confidence and found that this “forecasts time-series variation in the size premium when allowing for (time-series) variation in market beta.” (Lemmon, Portniaguina, 2006, p.1511)

Bathia, Bredin and Nitzsche used OLS regression together with VAR to analyze international spillover effects of the US market sentiment by studying the relationship between stock returns in other G7 countries than US and sentiment indicators such as market sentiment measured by composite sentiment index constructed by Baker and Wurgler (2005) and University of Michigan index which they deconstructed in order to obtain the component distinguished from rational factors sentiment measure may contain. They found that direct measure of investor sentiment i.e., investor survey doesn't have explanatory power outside of US borders but that indirect measure of investor sentiment, Baker-Wurgler composite sentiment index, has a significant role affecting the stocks of other G7 countries. They further note that value stocks seemed to be most significantly affected by US sentiment spillovers which they attribute to the financial crises. Going even further they also studied the spillover effects on different sectors for British, Canadian and Japanese markets and found that several Japanese sectors are affected by US spillovers measured by Baker-Wurgler index but that only IT and telecommunication sectors in British and Canadian markets were affected. (Bathia, Bredin, Nitzsche, 2016)

Sum studied in research of 7206 country-month observations changes (first difference) in business and consumer indices by OECD and CRSP's value-weighted index 31 different countries by applying OLS regression over pooled data and found positive effect of changes in indices to the stock market returns, with consumer confidence having stronger effect than

business confidence across the countries (Sum, 2014). Sum's study had considerably large scope, but some researchers have also focused their research about the subject more narrowly. For example, Akhtar, Faff, Oliver and Subrahmanyam focused solely on Australian markets, where they studied the effect of consumer sentiment index announcements by Westpac-Melbourne Institute on daily values of AOI by using the daily values MSCI World index as control variables in order to isolate the effects of the announcements, Australia having been one of few places at the time where such a regular announcements have been published long enough for a valid study to be concluded (Akhtar, Faff, Oliver, Subrahmanyam, 2011). They concluded that consumer sentiment indeed contains valuable information, they documented the existence of version of "negativity effect" where upon announcement of news inducing bad sentiment, the equity market experiences a significant negative effect on announcement day, whereas good sentiment news seemed not to have announcement day effect, they further found that the market recovers post-announcement from the bad news shock fairly quickly (Akhtar et al. 2011). Akhtar et al. theorized that as the stock market is seen as one determinant of sentiment and as consumer sentiment is thought as indicator of either optimism or pessimism, it could be that good sentiment news in upmarket is not seen as news at all and vice versa (Akhtar, et al. 2011). Another study by Rojo-Suárez and Alonso-Conde used two-pass cross-sectional regression in order to study the effects of consumer confidence and GDP rate in two stock returns in Japanese stock markets, they constructed different portfolios of Japanese stocks and compared the effect of consumer confidence in different pricing models such as CAPM, CCAPM, Fama-French model with 3 and 5 factors and q -model (Rojo-Suárez, Alonso-Conde, 2020). They found consumer confidence to be a good instrument in consumption-based asset pricing model and greatly improved their performance (Rojo-Suárez, Alonso-Conde, 2020).

Some researchers have tried to find further insight by even further augmenting the standard OLS regression with other techniques. One such a study was done by Møller, Nørholm and Rangvid who used OLS regression together with Newey-West estimator and Bootstrap simulation in order to study the effect of both consumer confidence (EU data) and output gap (calculated using Cooper-Priestly quadratic trend model) into excess returns of stocks in 11 European countries and found that both have an impact in many countries (Møller, Nørholm and Rangvid, 2014). However, their further insight was that the output gap and consumer confidence are highly positively correlated, and that consumer confidence didn't seem to contain independent information about the expected returns (Møller et al., 2014).

Another study by Concetto and Ravazzolo coupled the OLS regression with Bayesian inference, aiming to reduce parameter uncertainty due to short sample, study impact of several indicators of investor sentiment on excess returns on S&P500 and Euro Stoxx 50 indices (Concetto, Ravazzolo, 2019). Among the measures used as independent variables were Conference Board's consumer confidence index as well as normal and orthogonalized versions of Baker-Wurgler composite index for US markets and consumer confidence, economic sentiment, and industrial confidence indices published by EU as well as IFO Business Climate index (Concetto, Ravazzolo, 2019). They concluded that sentiment seem to have predictive power on stock market returns in American context but for Europe the research provides weaker results, they further noted the existence spillover effects form US to European market (Concetto, Ravazzolo, 2019).

One study that took a rather different approach on the analyses was made Lawrence and Leone who conducted research about the changing risk structure in UK stock markets in the wake of dotcom bubble and integrated the effect of consumer confidence as part of their analyses which they completed using principal component regression i.e., first conducting a principal component analysis and then using selected number of principal components as independent variables of OLS regression. Ultimately, they concluded that of the 17 different variables that were judge to possible having an impact on either expected dividend or discount rate, only market capital gain, dividend yield, and consumer confidence seemed to reveal any explanatory power, thus giving validation for consumer confidence as predictive variable. (Lawrence, Leone, 2008)

Some researchers altogether abandoned regression-based models as their empirical framework. For example, Chen and Shiu-Sheng used Markov switching model with fixed transition probabilities as they studied the impact of consumer confidence measured in University of Michigan index on fluctuations of returns of S&P500 index, and again controlled against variety of economic factors (Chen, Shiu-Sheng, 2011). They found evidence that the lack of confidence has indeed an asymmetric effect on stock returns. They further noted that impact is greater in bear markets, and also demonstrated that the stronger the market pessimism, leads to higher probability of switching from a bull to a bear market (Chen, Shiu-Sheng, 2011). This result largely in line with a previous study by Fisher and Statman who also focused their research on the effect of sentiment (using University of Michigan index, Conference Board survey and AAll's investor survey as independent variables) on returns of S&P500, they ultimately found that there is a statistically significant positive relationship

between changes in consumer confidence and S&P 500 index returns (Fisher, Statman, 2003).

From previous examples we can see the popularity of using survey-based sentiment indices published by third parties as proxies for consumer or investor sentiment, but not all researchers are happy with the predicting power offered by commonly used indicators. Instead, Huang, Jiang, Tu and Zhou proposed wholly new investor sentiment index which according to them reached better predicting power over aggregate stock market once the noise component often used in current sentiment proxies is separated (Huang, Jiang, Tu, Zhou, 2015). They found that “aligned index” they proposed has remarkably good predictive power over stock returns. They arrived on this conclusion by measuring predictive power of their “aligned index”, constructed based on Baker-Wurgler index, on excess returns of S&P500 using univariate and bivariate regression and using mean squared forecasting error (MSFE) to compare results (Huang et al. 2015).

As we can see from articles reviewed above, the effect of sentiment to the stock prices seems to be rather well-established phenomena in the United States with little bit less evidence regarding European markets, there is also evidence of spillover effects of US sentiment on stock returns in other developed markets particularly in Europe as well as about the existence of kind of “negativity bias” where impact of negative turn in sentiment has a stronger effect on stock returns than corresponding positive turn would have. One article that offers slightly more nuanced take on the situation in US markets is one by Ciner who studied the impact of consumer confidence indices of University of Michigan and Conference Board to S&P 500, Nasdaq and S&P 600 Small Cap stock indices using frequency dependent regression model (Ciner, 2014). In study he found high levels of consumer confidence to have a short-term impact of greater returns but medium-term impact negative returns and what is more, even this effect was demonstrated to be valid only for the returns of small firms’ stocks (Cetin, 2014).

To summarize these previous findings, we can conclude that there seems not be full consensus about the impact sentiment has on stock returns. On the one hand there are enough theoretical context and empirical findings to suggest that this potential relationship is worth researching for. On the other hand, empirical research on the subject has yielded results that far from unanimous and neo-classical asset pricing that lend very little credence on sentiments independent impact on asset pricing is still dominant point-of-view in many relevant circles.

4. Research questions and hypothesis

As already stated this study aims to explain the relationship between the economic sentiment and returns of sustainability related stocks. In order to achieve this, the following research questions is formulated:

The main research question: Does economic sentiment alone hold an explanatory power over the returns of sustainability related stock in Finnish and Swedish markets?

Under this main research question there is also one sub-research question this study aims to answer, in order to further shed light into the relationship between the sentiment indicators and stock returns. Namely whether the relationship between the investor sentiment and stock returns is stronger for precisely the indices constructed of sustainability related stocks than with the main indices of these two given stock exchanges. So can we say that sentiment contains more explanatory power over subsequent returns in stocks classified as sustainable assets than it contains for stock markets overall.

The sub-research question: Does variation in the sentiment variables contain more predictive power over future sustainability related stock indices in Finnish and Swedish markets than regular indices?

The two research questions based on previous studies and theoretical considerations will together explain the nature of possible causal relationship between the sentiment and sustainable stock returns. The sub-research question will form an important complementary part of the analysis and tests the accuracy the basic intuition that investors have different motivations and therefore different set of criteria when they put their money into sustainable assets rather than on traditional ones. This sub-research also enables the analysis to draw more conclusions about the rationality of investors as it is very possible that investments into sustainable assets would be subject to considerations differing from “regular stocks”.

This study assumes that the theoretical frameworks, developed by academics in several different countries, regarding the relationship between the economic sentiment and stock market returns are largely applicable to Finnish and Swedish markets. Hypothesis of this study is further based on the assumption that also the dynamics regarding this relationship

that have been documented by previous empirical findings hold to some extent true also in Finnish and Swedish stock markets. Therefore, the main hypothesis of this thesis is that after controlling for economic and financial factors there is a negative relationship between the investor sentiment and returns on sustainability related stocks, in the other words there is a reverse causality between the two variables.

H1: There is a negative relationship between the economic sentiment and returns of sustainability related stocks.

In particular the first hypothesis rests on the work of Lemmon and Portniaguina (2006) and DeLong et al. (1990) and assumes presence of significant number of noise traders at the markets and limits to arbitrage. According to behavioral view sentiment of noise-traders can persist in financial markets and affect asset prices when there are limits to arbitrage, thus it is not unreasonable to predict negative relationship between the returns of stock held to large extent by noise traders and sentiment as the market corrects for mispricing arising from noise trading (Lemmon, Portniaguina, 2006). This is dependent about the fundamental relationship between the noise traders and so-called rational speculators who bet against them based on fundamentals. Even rational speculators can however be assumed to be risk averse, and thus reluctant to take large arbitrage positions allowing the noise trading to affect prices as rational speculators wont fully eliminate the noise-driven movements in prices (DeLong, Shleifer, Summers, Waldmann, 1990). This relationship might be further complicated by the third class of traders called positive feedback traders by DeLong et al. which can drive prices further away from fundamentals and result an overreaction by market to corrective move instigated by rational speculators (DeLong et al. 1990).

From the theory we can further determine two alternative explanations how economic sentiment can be assumed to affect into the stock returns: investors can take the sentiment news as a new exogenous information and factor it into their prediction about future expected cashflow and risk, this would in effect treat the sentiments as news which publication may provoke both rational and irrational trading (Heston, Sinha, 2017). Treatment of sentiment as news would not necessarily support the hypothesis about negative relationship very well, on the contrary Heston and Sinha (2017) found through comprehensive neural network analysis that news indicating positive sentiment tended to increase stock returns and vice versa, although notably they also found that effect of the positive news on stock return was relatively quick to occur but negative news tended to have

more delayed impact (Heston, Sinha, 2017). Similarly, Tetlock has found that high pessimism in media predicts downward pressure for prices at stock markets whereas opposite is true for high media optimism (Tetlock, 2007). An example of this interpretation of sentiment as an exogenous factor would in practice go as follows, decrease in consumer confidence may signal that consumers are intending to cut back consumption in future time periods which may lead to lesser demand for output of companies which in turn would hurt their profits and thus expected cashflow for stockholders.

Another possible way for economic sentiment measurements to affect stock prices is if we consider these sentiment measurements as proxies for investor confidence as is sometimes done in academic research because investors are also consumers and economic actors so the sentiment indices can at least partly be seen reflecting the outlook of investors. Both of these approaches can give us a framework to try to understand the connections between the existing behavioral and neoclassical theories and results of the empirical part of this thesis. Tetlock, who studied the effects of sentiment in the media to stock returns, summarized that if interpreted as a proxy for investor confidence high pessimism can be assumed to have negative effect on the future returns in the short term but ultimately predicts higher future returns at longer time horizons (Tetlock, 2007). He further noted that a key difference with this sentiment theory in relation to “information theory”, where one assumes pessimism or optimism reflect exogenous new information, is that in the sentiment theory short-term returns will be reversed in the longer run whereas in the “information theory” effects on the short-term returns can be assumed to persist over time (Tetlock, 2007).

The second hypothesis of this study relies on assumption that phenomena drawn from the theoretical framework play differently for sustainable assets than regular ones. Particularly such phenomena might be e.g., loss aversion by Kahneman and Tversky (1986) as well as negativity bias documented by Chen (2011) and Akhtar et al. (2011) in their empirical findings. This second hypothesis presumes that turns in overall economic sentiment affect investor confidence which in turn has a stronger explanatory power for sustainable asset returns than returns in traditional asset classes. This hypothesis is only limited to the short term because we assume that the findings made among other Schmeling (2009), which state that the predictive power of the consumer sentiment declines over-time, holds true in Finnish and Swedish markets. This sub-research question relies more on the latter of the two aforementioned interpretations, that is treating sentiment as endogenous property.

However if one ought to be inclined to interpret the results more from the point-of-view where sentiment is treated akin to the news, second sub-research question and acceptance or rejection of corresponding second hypothesis would give an indication about the uneven incorporation of news with positive and negative sentiment into stock prices, if accepted this result would be broadly be in-line with for example a study by Heston and Sinha, which might provide one possible explanations for observed patterns (Heston, Sinha, 2017).

H2: The relationship between relationship between sentiment and stock returns is stronger for sustainability related stocks

5. Data and Methodology

In order to study rationality in the sustainable asset pricing in the longer timeframe, we rely on datasets about individual perceptions that are the most readily available and which generally have been the main focus of attention among economic actors and media. Those are consumer confidence indicators published by national statistics offices and the Economic Sentiment Indicator published by the European Commission. As these indicators are decidedly measurements of individuals perceptions, they should give some indication about the accuracy of one of the key tenants of neo-classical finance, rational expectations of market participants. This can be achieved by trying to decouple the values of sentiment from the values of major macroeconomic and financial variables at the corresponding time periods. The variation in these sentiment indices that cannot be explained by the changes in the macroeconomy, and financial environment can be assumed to be reflect the magnitude of individuals perceptions that are not fully justified by real world developments.

When this “underlying value” in these indices is assigned into a separate variable this can be used as proxy for irrational sentiment as it represents divergence from a degree of “optimism” or “pessimism” that would be reasonable conclusion when taking account major factors in the economy. If this irrational sentiment is subsequently found to hold an explanatory power over the returns on sustainable assets, we can see this as deviation from expected utility maximation as outlined by Von Morgenstern-Neuman utility theory which is a key underpinning of efficient markets hypothesis. It would in that case seem that rational expectations do not fully materialize and indicate that there are arbitrage opportunities that are not immediately and fully realized, it would be reasonable therefore to assume that a combination of prevalent biases and noise trading has an effect of some magnitude on pricing of these assets, this would be a result of investors irrational risk appetite (risk aversion, or risk-seeking behavior) or investors failing in perception or accounting of economic trends (e.g. mental accounting, cognitive dissonance etc.).

This research format and methodology is carefully drawn from previous studies conducted by academics like Lemmon and Portniaguina (2006) Møller, Nørholm and Rangvid (2014), Akhtar, Faff, Oliver and Subrahmanyam (2011) as well as Bathia, Bredin, Nitzsche (2016) and Sum (2014) which were detailed among others in previous chapter. Essentially this study contains two regression analyses regarding both datasets one in which changes in sentiment indices are controlled against changes in macroenvironment and another in which

these controlled sentiment values are used as explanatory variables against sustainable stock returns.

Methodology this study uses in order to answer the aforementioned research questions and confirm the hypothesis of this work is ordinary least squared regression (OLS) regression coupled with all the necessary test for ensuring it to be the best linear unbiased estimator (BLUE), meaning it has the lowest sampling variance among set of possible linear estimators (Brooks, 2019). In order to establish this, a set of four assumption must be proven to hold for the model (Brooks, 2019). These assumptions will be tested for every regression of this study and as they will hold, we can conclude in accordance with Gauss-Markov theorem that OLS is the best unbiased linear estimator for the dataset (Brooks, 2019).

Before applying the regression model over the time-series dataset several preliminary tests are to be done including the ones in which necessary descriptive statistics from the chosen variables are obtained, crucially the correlations within independent variables are also checked in order to determine the relevancy of each variable for the analysis and to avoid overfitting the model. Furthermore, Augmented Dickey-Fuller (ADF) is applied to test the data for stationarity, as it is desirable property for variables included in OLS regression. Mutual correlations of independent and control variables are also evaluated in order to gain preliminary understanding about their relationships.

5.1. Variable selection

Selecting of independent variables should always be done with great care. Selection of survey-based consumer confidence indices published by national statics offices is justified by the fact that these are widely considered to be the most reliable and comprehensive indicators published in regular intervals for Finnish and Swedish markets. Furthermore, survey-based consumer confidence indices are regularly used both as a measurement for consumer confidence and as proxies for investor sentiment in similar studies made in American markets where University of Michigan and Conference Board indices are the most popular consumer confidence indicators. Inclusion of the Economic Sentiment Index (ESI) published by European Commission (an organ of European Union) is important as this variable can be thought to be more indicative about the expectations regarding future business conditions (Wang et al. 2021). Møller et al. in fact found that consumer confidence

included in ESI is highly correlated with business cycle to a point where it cannot be said to contain independent information compared to output gap (Møller, Nørholm and Rangvid, 2014). Nevertheless, inclusion of ESI which contains confidence indicators from different sectors in the economy offers us a convenient variable that captures also other aspects of overall economic sentiment than just consumer confidence, and as its consumer confidence survey differs that of Finnish national statistics offices' it could potentially capture other aspects of a variable that can fundamentally be considered somewhat subjective. Moreover, ESI as a whole contains five confidence indices, in addition to consumer confidence those are industry, retail trade, services and construction confidences, all based harmonized surveys conducted in monthly basis in all EU countries (Directorate General for Economic and Financial Affairs, 2022). Generally, those five had the same overall trend in the last ten years, but there are significant differences between these individual indicators (Directorate General for Economic and Financial Affairs, 2022). In addition to business cycle there can of course be other explanatory factors included in consumer confidence and ESI numbers and in following chapters some steps are taken in order to distinguish those. However, this paper is going to simply talk about "business cycle related sentiment" and "irrational sentiment" and there will not be efforts to explain the possible existence of "irrational sentiment" in demographic, social-psychological etc. factors.

5.1.1 Independent variables

Consumer Confidence indicator, henceforth referred as CCI, is indicator based on qualitative consumer survey aiming to express the expectations and views of Finnish consumers regarding economic development, it contains four different components: own economy now, own economy in one years' time, economy of Finland in one year's time, and consumer's spending on major purchases within one year. Gross size of monthly sample of 2350 consumers selected in the basis of systematic random sampling (SYS) ranging in terms of age from 15-years-old to 84-years-old and proportionally representing the population of Finland as whole in terms of age, gender, region and native language. In total the survey includes 17 questions harmonized in accordance with EU framework. In addition to these there are 11 additional Statistics Finland's own questions that are made monthly or quarterly. Index based on all questions can range between 100 and -100 with greater value representing greater confidence. In most Survey questions consumers are presented with an option of five alternate responses, which can be roughly described to represent the perceived happened or expected change: a lot better, little better, same, little worse, much

worse (++, +, =, -, --). In items measuring opinion a characteristic value index is then derived from the percentage distribution of the responses. The balance figure is then calculated by weighing the percentages of shares of the different responses by +1, +0.5, 0, -0.5 and -1, according to the answers. In items measuring the intentions to save, consume, or borrow the values are calculated by summing up the percentages of those households that either certainly or possibly do the given action. The CCI itself however is calculated as an arithmetic mean of four the four most important opinion questions, these are spelled out below as given by Statistics Finland. (Statistics Finland, 2022)

1. What will your own economic situation be like in 12 months' time compared to present?
2. What will Finland's economic situation be like in 12 months' time compared to present?
3. What will be the number of the unemployed in Finland in 12 months' time compared to present?
4. How likely are you able to save money within the next 12 months?

Consumer tendency indicator, henceforth CTI, is also an indicator based on qualitative survey, this conducted by Swedish National Institute of Economic Research. It is also harmonized in accordance with EU framework, on which ESI is based, but doesn't take same values as ESI consumer confidence indicator is defined differently and different seasonal adjustment method is used. Consumer tendency survey is conducted monthly using 1500 Swedish households as sample size with respondents age varying between 18 and 84 and sample as whole selected so that age, gender and regional variation is in accordance with Swedish population as a whole. The questions of the survey cover: consumers' assessments of their personal finances, assessments about the Swedish economy as a whole, their expectations for interest rates and for inflation, and their plans for major future purchases and savings. Like in the Finnish consumer survey answers contain five options regarding change: much better, little better, same, little worse, much worse (++, +, =, -, --). Answers net balances are then seasonally adjusted and standardized so that mean is set to zero and standard deviation to one. (National Institute of Economic Research, 2022)

Like stated above both Finnish and Swedish consumer surveys are harmonized in according to program managed by Directorate-General for Economic and Financial Affairs (DG-

ECFIN), the main indicator published by this organization under the European Commission is our second independent variable: Economic Sentiment Indicator, henceforth always referred as ESI, which is also published monthly both for each member and candidate state of European Union as well as for EU and for eurozone as a whole, latter two of which are weighted averages. Indices are collected based on wide sample that consists of interviews of approximately 135 000 firms and 40 000 individuals for the block as a whole. Finnish sample size being 990 consumers, 800 industrial companies, 820 service businesses, 240 retail trade enterprises and 210 companies in the construction field, similar numbers for Sweden are 1500 consumers, 3070 services, 1700 in industry, 1090 in retail trade and 540 in construction. Questions of the surveys for industry cover areas like order books, predictability of business situation, production of past and coming 3 months, expectations of selling prices and employment as well as stocks of finished products. For construction businesses the questions focused on factors limiting the building activity as well as order books, expectations about selling prices and employment, predictability of business situation, as well as building activity of past 3 months. Similarly for retail traders the questionnaire composes of orders placed with suppliers, predictability of business situation, business activity of past and coming 3 months, expectations of selling prices and employment as well as stocks of goods. Questions presented for services include past and expected future demand and employment, past business situation, and expected future selling prices, as well as predictability of future situation. Like in the two previous indicators, answers of ESI questionnaires are options describing respondents' perceptions, future expectation or past experiences, for most questions there are actually three categories to choose from, signaling: increase, staying the same, decrease; or positive, neutral, negative, respectively. Some questions of the surveys however have six options described above forming categories: ++,+,=,-,--, and also "don't know"-category as a sixth option. Confidence indicators are then calculated as arithmetic means of seasonally adjusted balances of answers to the questions of the survey, balances being the differences between positive and negative answers measured as percentage points of total answers. (DG-ECFIN, 2022)

From below boxplots of Figure 1 and Figure 2 we can see the distributions of Finnish and Swedish consumer confidence indicators and economic sentiment indicators over the observation periods. Markedly only Swedish ESI has a median above (101,2) the neutral value (100 for both ESI and CTI and 0 for CCI), although its mean (100.1) is only barely above it. Also, it is notable that ESI tends to take higher values for both countries compared

to the pure consumer confidence in both countries which is possible indication that consumers tend to hold more pessimistic views about the economic outlook over the observation period than businesses do as business sentiment on different sectors is included only to the ESI.

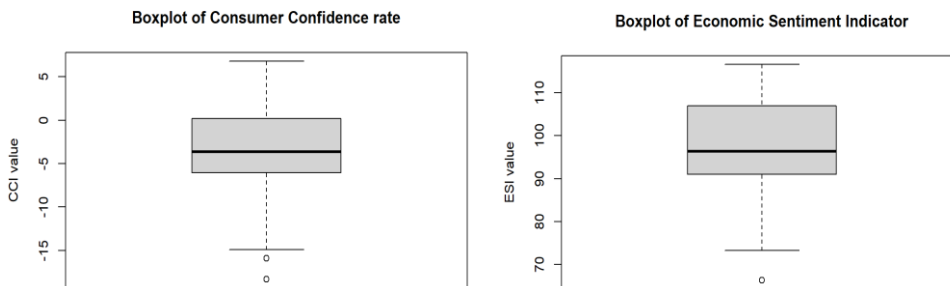


Figure 1: Boxplots of Finnish CCI and ESI

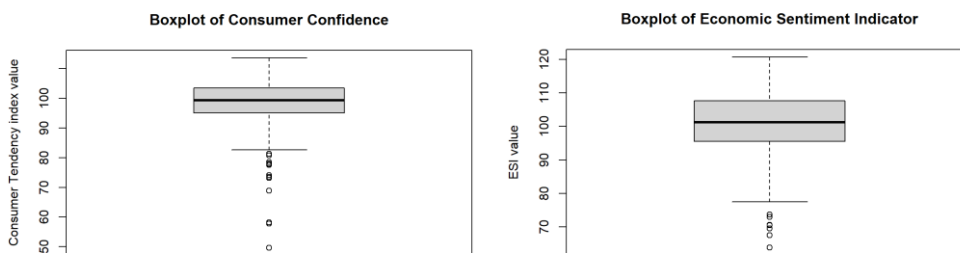


Figure 2: Boxplots of Swedish CTI and ESI

5.1.2. Dependent variables

The dependent variables of this study are the main sustainability related indices of Helsinki and Stockholm stock exchanges. Both indices are being kept up by Nasdaq, and historical price data for this analysis is obtained from Nasdaq Nordic.

Dependent variable for Finnish markets part of analysis is Nasdaq's OMX Sustainability Finland GI index (gross index) which is created for sustainable investing purposes. Going forward this paper shortens the name of this index as OMXSUSTAINFIGI. NASDAQ OMX calculates this index in cooperation with ISS which is a provider of research and service for responsible investments. The indexes are comprising of top companies in terms of sustainability and selection of companies is based on how well they meet the criteria for environmental, social and governance (ESG) issues. The criteria used in selection are based upon international guidelines for ESG issues and are designed to support

considerations of the UN Principles for Responsible Investments. ISS sustainability assessment is conducted by rating the companies according to their model *ISS oekom Corporate Rating*. The top-ranking companies in this model are included in the indexes. In addition to this, the indexes are also free float adjusted and liquidity screened in order to ensure ability to invest. (Nasdaq, 2022)

Dependent variable for model regarding the Swedish markets is OMX Stockholm 30 ESG the leading share index of Stockholm Stock Exchange's. This index consists of the thirty most actively traded stocks on the Stockholm Stock Exchange combined with a systematic ESG screening based on specific criteria and securities that doesn't meet the criteria are excluded. Index is market cap weighted and its composition is revised twice a year in July and January. In subsequent graphs and analysis this variable is referred as OMXS30ESG. Composition of OMX30ESG at the time of writing this thesis is very similar to main index of Stockholm stock exchange OMXS30, however the two indices are not taking precisely similar values for example closing price closing prices of the two indices tend to vary as can be seen in picture 4 (Nasdaq, 2022)

This study examines the average daily returns per month of these two indices as average monthly returns will give us a convenient measure of overall performance throughout the month. As sentiment data indices which will form the independent variables of this study are published in monthly basis it is convenient to measure the overall monthly performance of said stock indices against the overall sentiment in each given month. Boxplots of these are presented in the figure 3. Mean of average daily return per month for OMXS30ETHIC throughout the observation period was 0,03736% whereas for OMXSUSTAINFIGI mean of average daily return per month was throughout the observation period 0,03679%, maximum average daily return per month during the observation period for OMXS30ETHIC was 1,06% and for OMXSUSTAINFIGI it was 0,61189%. These statistics reveal that over all development in both indexes throughout the observation period has been positive, although negative returns haven't been uncommon. Performance of these indexes has been very similar compared to each other which is something that can be expected from indexes with roughly composition similar (in relative terms) in neighboring markets.

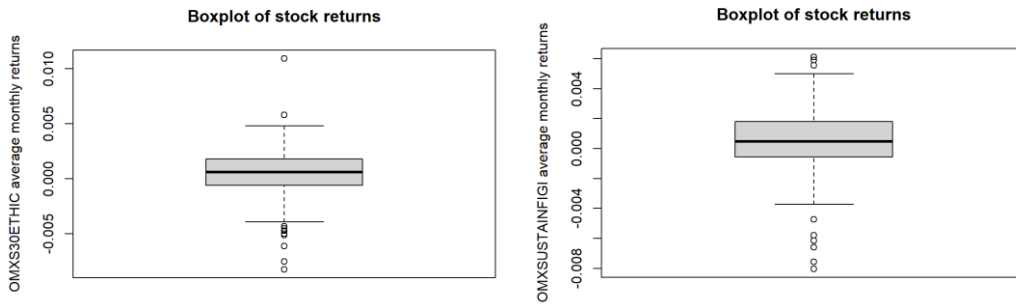


Figure 3: Boxplots of stock returns

As mentioned, this study uses these indices instead relevant main indices of Helsinki and Stockholm stock exchanges because as sustainable and ESG-related investing has been growing in recent decade it is relevant to ask how vulnerable precisely the indices, constructed in accordance with sustainable investment principals and taking ESG-issues into account are for changes in economic sentiments. Even though both of these sustainable indices are constructed on the basis of the main index on each stock exchange that doesn't mean that returns are necessarily similar to those of the main index, for example in Figure 4 we can see that the returns for both the main index of Stockholm stock exchange OMXS30 and ethical index OMXS30ETHICAL constructed on basis of it from June to October 2022, and it is visible that the returns in any given day do not fully align (Nasdaq, 2022).

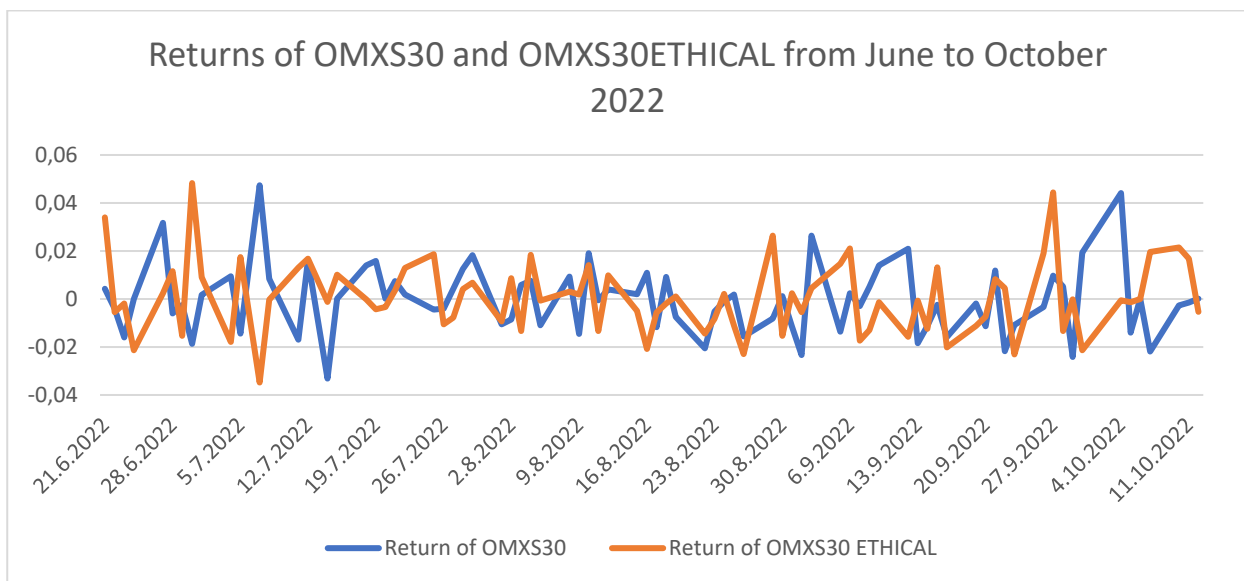


Figure 4: Returns of OMXS30 and OMXS30ETHICAL (Nasdaq, 2022)

Overall, the sustainability related indices in both markets OMXSUSTAINFIGI and OMXS30 ETHICAL in Finland and Sweden respectively exhibit same trends but also these two cannot be said to move in lockstep as can be seen in Figure 5 which exhibits the average monthly returns for both of these indices. Indeed, it seems that returns of Finnish index OMXSUSTAINFIGI peaks higher in both upturns and downturns than Swedish OMXS30ETHIC index.

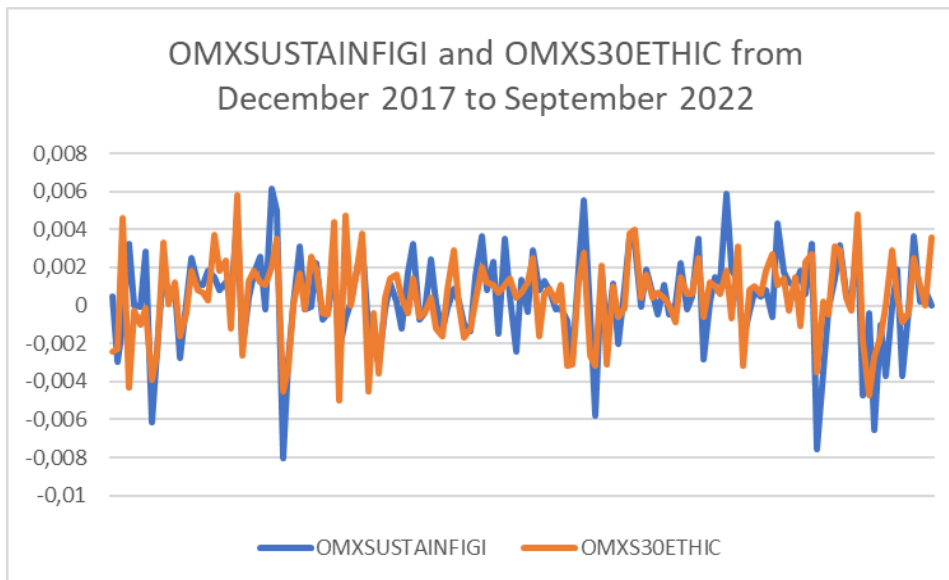


Figure 5: OMXSUSTAINFIGI and OMXS30ETHICAL monthly average returns

The main reason for choosing environmental indices that have been constructed on the basis of the main indices of the given stock exchanges as opposed to other possible sustainable stock exchanges is the fact that as those are composed of stocks that widely reflect the stock exchange at large which therefore minimizes the possibility that difference between the aggregate asset prices and direction of independent variables is not dictated by the additional risk-reward considerations associated with the composition of the index in question but instead is reflective of the asset prices in the whole market and its composition is dictated by the industries which are the most significant in the market, e.g., index is not composed and thus reflective of small business in niche industries of green solution. Such as index would likely be highly volatile with respect to firm and sector specific factors such as developments in one or another technology, particular regulation or some other hard to quantify factor that is not suitable for robust statistical analysis framework of this study. For example, so far, no sustainable investing index which is diversified enough with respect to sectors, firm sizes, growth and market cap doesn't exist in these markets, that would enable comparison better than indices chosen for this study. Indeed, these indices chosen for this

study are adjusting the main indices of Helsinki and Stockholm stock exchanges to the sustainable investing factors rather well. This “adjustment” is large enough to justify the hypothesis that impact the sentiment variables and irrational sentiment variables in particular have on stock returns differs between sustainability related indices and the main indices of Helsinki and Stockholm stock exchanges, indeed from the Picture 4 one can see that even though there are naturally same trends present in sustainability index and regular index, values they take are not exactly corresponding with each other. This also justifies the second research question of this study and related second hypothesis, that the impact of the sentiment indices is greater for stocks classified as sustainable investments than for those which are not. This difference being attributed to various reasons described in Chapter 4 above.

5.1.3. Control variables

Several of previous studies that have dealt with the relationships between similar indices and stock returns have used several macroeconomic and financial indicators as control variables in order to disentangle the simple business cycle effects from the sentiment-return relationship. For this paper the selected set of control variables reflects those most often used in similar research projects, particular reference points for this study have been studies done by Chen (2011), Wenzhao, Chen, Duxburry (2021), Lemmon and Portiniaguina (2006), Schmeling (2009) as well as Concetto and Ravazzolo (2019). Broadly speaking these are relating to two larger themes: overall macroeconomic activity and interest rate level, these can be assumed to be correlating at least to some extent with both economic sentiment and stock returns and thus valid and reliable modelling of causal sentiment-stock return relationship must control against these factors. Complete list of used control variables, their short descriptions, source where data is obtained. GDP growth rate, industrial production growth rate and unemployment rate indicate the overall level of macroeconomic activity whereas CPI inflation, 3-month Euribor rate, detrended 6-month government bond rate are signaling the state of wider financial environment which is sure to have an effect on prevailing sentiment. Importantly these control variables can be expected according to simple economic intuition to vary with business cycle and thus rational investor would take their variation into account in his or her investment decisions. Historical data regarding each variable can be deemed reliable as they are obtained either from trusted national statistics authorities in Finland and Sweden, widely respected international organizations like World

Bank, or relevant central banks. As the table 1. below shows control variables for both Finnish and Swedish models are the same. Growth rate of gross domestic product (GDP) is perhaps the most widely followed of all macroeconomic indicators and for this study I use quarterly moving average of GDP growth rate, meaning that each observation of dependent variable is measured against the average GDP growth of the four last quarters, as this will conveniently adjust the variation against seasonal changes. For interest rate related control variables, we use three-month Euribor rate and six-month government bond yield rate as those will give us convenient view into interest rate level and crucially into level of risk-free rate. Both Finland and Sweden can be considered stable enough states for their short-term government bonds to be regarded as risk-free assets especially in the point-of-view of their domestic markets.

Variable	Name	Description	Source of data
GDP-growth rate	GDP	Quarterly moving average growth rate	national statistics agencies
industrial production growth rate	INDPRO	Monthly index with 100=2015	World Bank and national agencies
unemployment rate	UNEMP	Share of workers in the labor force without job but who are currently actively looking for one.	national statistics agencies
CPI inflation	INFL	average change in consumer prices	national statistics agencies
3M-Euribor	EURIBOR	interest rate proxy	Bank of Finland
6M-government bond yield	GOVBY	interest rate proxy	Riksbank

Table 1: Control variables

As can be seen from the table 1, correlations between control variables vary greatly. In the terms of directions of correlation coefficients all variables tend to be in line with basic economic assumptions about their behavior. Strongest positive correlation is between quarterly moving average of GDP and CPI inflation (0.63) which is line with basic assumption that economic growth can increase inflationary pressure, whereas strongest negative correlation (-0.51) is between unemployment rate and industrial production growth rate

which is also in-line with basic economic intuition. There are also significant positive correlation between the rate of industrial production and GDP (0,47) and rate of inflation and rate of industrial production (0,46) which further points to the basic economic notion about the link between economic growth, growth in industrial production and rise in prices, although it is notable that the correlation between industrial production and inflation is lower than between GDP and inflation pointing perhaps to the fact that both Finland and Sweden are to significant degree service based economies nowadays even though especially manufacturing to export is not insignificant part of the national economies. The second highest negative correlation in this set of control variables can be found between the rate of three-month Euribor and industrial production (-0.37), and what is particularly notable in this is that it is much larger than the correlation between same Euribor rate and GDP which is almost non-existent (0,06). Relationship between the Euribor and GDP doubtlessly reflects the broader economic development throughout the observation period, as during the latter half 2010s the overall interest rate level remained very low in Europe despite that there were GDP growth to some extent, it is however doubtful whether higher correlation between Euribor and industrial production growth can only be explained by higher capital intensity in manufacturing compared to service sectors. Euribor and inflation have mutual positive correlation of 0.39 which might be less than expected by popular simplistic assumption regarding monetary policy and its effect on inflation and interest rates.

In the point of view of further research, the most important thing is that correlation between any of the control variables is not too strong, so all of the selected control variables can be included as independent variables in control regression in the first phase of this analysis as the risk of multicollinearity is not too great. Even the highest correlation of 0.63 between CPI inflation and quarterly moving average of GDP is low enough that both variables can be said to sufficiently capture independent aspects in order to justify inclusion of both of them into further analysis.

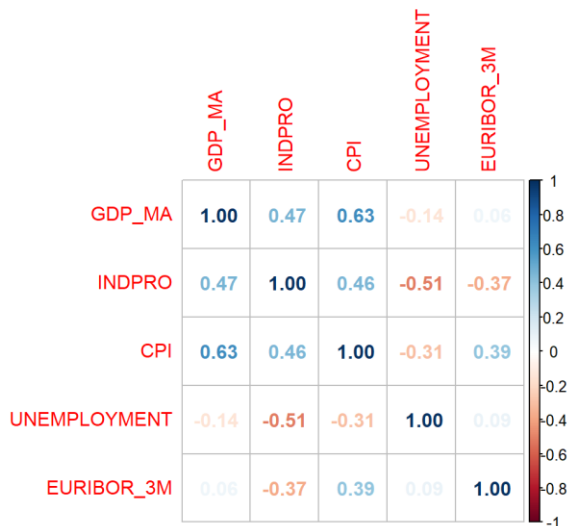


Figure 6:: Pearson correlation coefficients for control variables in Finnish sample

In Swedish sample correlation coefficients between the control variables have roughly the same pattern as same variables have in Finnish sample, though it is notable that strengths of correlation are not exactly the same, in fact in most cases they seem to be slightly weaker in Swedish sample than in Finnish sample (see figure 6). Markedly the highest correlation in Swedish case is between CPI inflation rate and industrial production rate (0,51), whereas the highest is between CPI inflation rate and unemployment rate (-0,28) which are much lower than the highest correlation in Finnish set, and also lower than the correlation between the same two variables was in the Finnish set (-0,31). There was also significant positive correlation between the quarterly moving average GDP growth rate and CPI inflation rate (0.47). CPI inflation rate has also positive correlation of 0,34 with 6-month Swedish government treasury bill rate, and there is also positive correlation of 0.27 between industrial production rate and GDP, which again is much lower than in the Finnish set. Like in the Finnish set majority of correlation between the variables are broadly in line with common knowledge about economics. That said, too much emphasize should not be attributed on these correlations as Pearson correlation is inadequate way of describing the most financial returns (Lee, Lee, 2015).

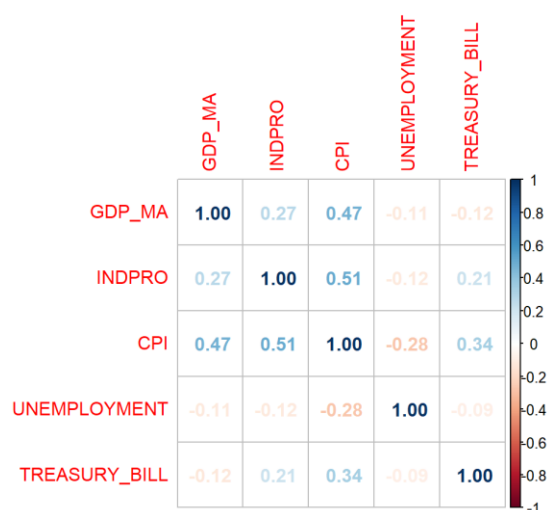


Figure 7: Pearson correlation coefficients of control variables in Swedish sample

Control variables are used to differentiate the irrational and rational components of the sentiment indicators by regressing the sentiment indicators against control variables and their lagged values. Adding also the lagged values of these macroeconomic and financial indicators as independent variables for this regression allows for taking into account the fact that several economic variables can have also significant latent impact on sentiment. Residual term of this regression is subsequently used as a measure irrational economic sentiment as it composes of the variation in sentiment indices that is unexplainable by chosen macroeconomics and financial factors. It is possible that even after this controlling our new measure of irrational sentiment contains some rational considerations, but this measure is at least purer measure of irrational sentiment as it is disentangled from the most widely followed business cycle related variables and by default contains larger percentage of variation unexplained by rational thinking than original sentiment indicators would. In the other words, this study does not claim that only the included five variables fully represent rational component in the sentiment indices, but selection was limited to these seven in effort keep the dimensionality reasonably limited and correspondingly a risk of overfitting the model suitably low. This controlling regression to differentiate the business cycle related rational component from the residual component is done to both sentiment indicators in both countries i.e., CCI and ESI in Finnish case and CTI and ESI in Swedish case.

5.2. Research design

This study uses ordinary least squared technique as basis for all time-series regressions done in this study. This technique aims to find a line that best characterizes the patterns found in time series data of observations by aiming to minimize the total sum of squared distances of each observation point to the regression line (Brooks, 2019). The below formula illustrates the fitted line of simple OLS regression with one independent variable.

$$(1) \hat{y} = \hat{\alpha} + \hat{\beta}x_t$$

Mathematically the equation on the basis of which this fitted line, where values of intercept α and regression coefficient β are selected by minimizing the residual sum of squares over all the observations, can be illustrated by formula 2 below. In Formula X residual sum of squares, known also as loss function, is denoted by L and number of total observations is denoted by T .

$$(2) L = \sum_{t=1}^T (y - \hat{y}_t)^2 = \sum_{t=1}^T (y - \hat{\alpha} - \hat{\beta} x_t)^2$$

This is perhaps best illustrated graphically in Figure 8 below. The figure describes a regression line that best fits the data i.e., the sum of squared distances from each of the green observation points to the red line are at a minimum all points considered. Distances from each observation point to the fitted values form the residual term of regression equation, simple interpretation for residual term is that it includes all the time series variation in the dependent variable which cannot be explained by intercept and independent variables with best fitting coefficients (Brooks, 2019).

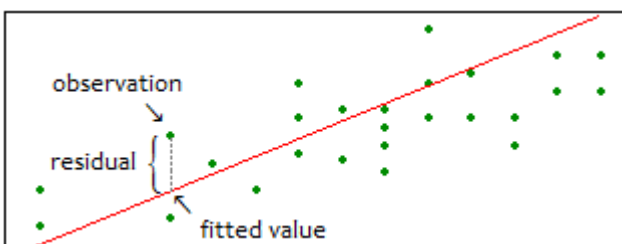


Figure 8: Regression line fitted to observation data.

In order for us to conclude that models based on aforementioned equations give us the best possible unbiased linear estimators for given data as suggested by Gauss-Markov theorem the following four conditions regarding the equations error term u^t have to be met:

- The errors have to have zero mean: $E(u_t) = 0$.

- The variance of the errors has to be constant and finite over all values of independent variable: $var(u_t) = \sigma^2 < \infty$, in the other words residuals are homoscedastic.
- The errors have to be linearly independent of one another: $cov(u_i, u_j) = 0$, in the other words residuals are not autocorrelated with is other.
- There cannot be relationship between the error and corresponding variate of independent variable: $cov(u_i, x_j) = 0$.

In addition to these four conditions, there is also fifth assumption regarding the disturbance (error) term which should be always checked when running an OLS regression namely that the error term is normally distributed: $u_t \sim N(0, \sigma^2)$. After these five conditions are proven to hold for the created model, we can assume that on average values of the intercept and regression coefficients given by the model equal to their true values and that regression coefficients given by OLS have the minimum variance among the class of unbiased estimators (Brooks, 2019). In order to verify this by testing the five conditions stated above we must apply several statistical tests to determine the nature of regression equations error term. Mean of the regression can be obtained by simple calculation but for second and third condition we must apply more complex statistical methods, namely Breusch-Pagan test for constancy and finiteness of variance and Durbin-Watson for autocorrelation. Independence of the error term from corresponding independent variable can be determined by calculating a measure for linear dependence and in this case, we use linear correlation to achieve this. There would be also several ways to check the error terms distribution but, in this case, we opt for Jarque-Bera test as well as graphical observation of the distribution.

Following this outline our regression formulas goes as follows for datasets from both countries. First regression uses control variables (macroeconomic and financial indicators) as independent variables and sentiment index as dependent variable. As mentioned above the residual of this regression is subsequently used as a proxy variable for irrational sentiment which forms an independent variable in the following second regression analysis. Below regression is for one consumer confidence index, but a separate regression taking the same form is conducted also for Economic Sentiment Index.

$$\hat{y}_{CTI} = \hat{\alpha} + \hat{\beta}x_{GDP} + \hat{\beta}x_{INDPRO} + \hat{\beta}x_{CPI} + \hat{\beta}x_{UNEMPLOY} + \hat{\beta}x_{interst} + \varepsilon_{irrational\ sentiment\ residual}$$

Second regression analysis can be described by following formula. Both above and below equations describe Swedish markets dataset but regression formulas naturally take also the same form in Finnish markets dataset.

$$\hat{Y}_{OMXS30ETHIC} = \hat{\alpha} + \hat{\beta}x_{irrational\ CTI} + \hat{\beta}x_{irrational\ ESI} + \varepsilon$$

5.3. Preliminary analysis.

Before conducting the regressions some graphical observations about the variables are done in order to see if any interesting patterns about their mutual relationships can be found. Firstly, average daily stock returns per month are plotted against the corresponding values of sentiment indices in for both countries, at this point “original” values of the indices are still used as residual component of “irrational” sentiment hasn’t distinguished as a sperate variable yet. Graphical illustrations can be seen in figure 9 where blue dot signals the mean value.

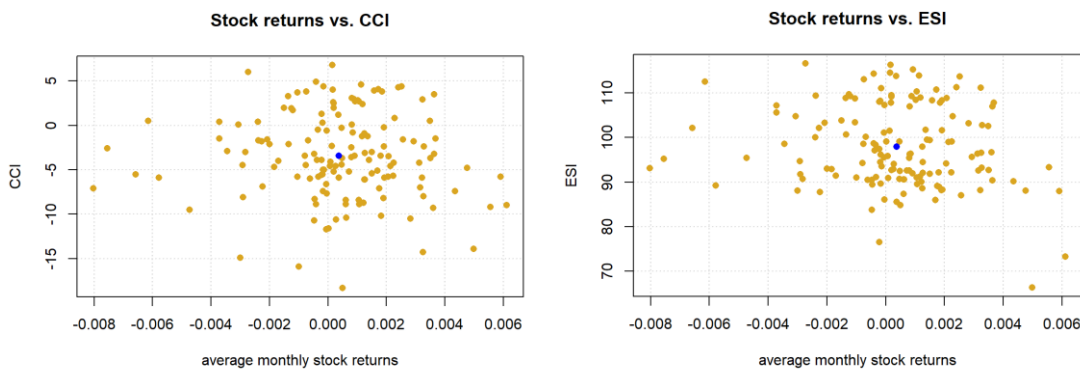


Figure 9: CCI, ESI and average daily stock returns per month for Finland

From the picture 7 above we can see definitely some concentration indicating that certain values of ESI and CCI tend to appear more often along with certain stock returns than others. On the other hand, correlation between both the CCI and ESI in one hand and the stock returns on the other is relatively low: -0.07110447 and -0.1613233 with CCI and ESI respectively. It cannot be said only based on graphical observations whether there exists linear relationship between these variables, but there is at least an indication that certain range of sentiment index values corresponds to certain range of stock returns.

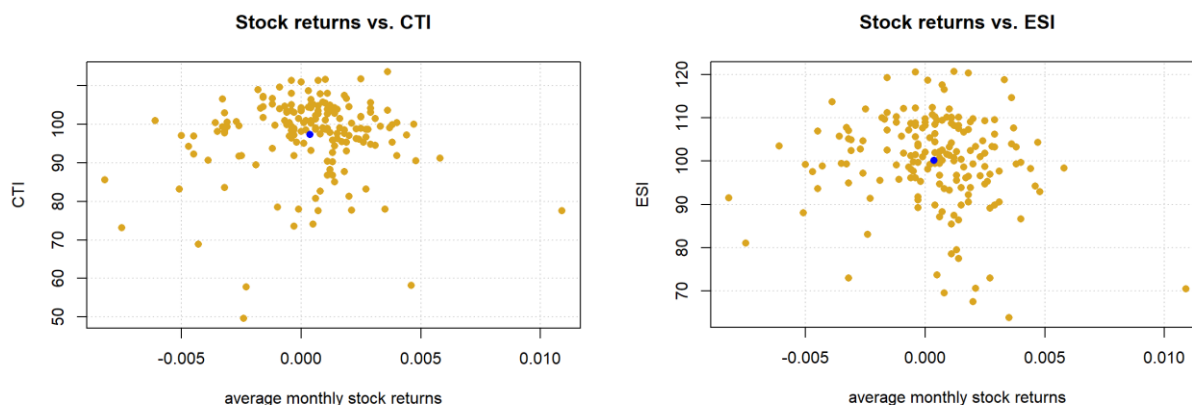


Figure 10: CTI, ESI and average daily stock returns per month for Sweden

Same graphical illustrations yield same results also regarding Swedish markets (see figure 10). The most notable difference compared to the Finnish market is however the fact that concentration of CTI values in relation to stock returns is much tighter than with Finnish CCI and stock returns. Also, ESI values are bit more concentrated on certain stock returns in Sweden than in Finland though the difference between the countries is smaller than with CCI and CTI. Correlations between variables are also small in Swedish case, 0.05788462 and -0.1180556 for CTI and ESI respectively, markedly between the CTI and stock returns correlation is weakly positive, even though in the case of other sentiment variables in both markets it is weakly negative.

Initial analysis therefore suggests that there seems not to be intuitively recognizable statistical link between stock returns on sustainability related indices and sentiment, even in the case where sentiment can be assumed to include also rational considerations and reactions with regard to macroeconomic and financial fundamentals. This is however based on only superficial analysis, and in any case one cannot draw definite conclusions based on graphical analysis and correlations of independent and dependent variables of this study. To gain more insight in the next section, “irrational component” of the sentiment indexes is distinguished by regressing control variables against them and is then used to explain the variation in stock returns.

6. Empirical analysis

As explained in more detail above, empirical part of this thesis contains essentially four phases, first we test the time series of all sets of variables used as independent variables in regressions for stationarity. Second, the control regression using our control variables as independent variables and sentiment indexes as dependent variables is performed, the residuals of both indexes are obtained, and these are assigned as proxy variables for irrational sentiment, residuals of this regression are subsequently analyzed in order to determine whether regression can be defined as best linear unbiased estimator. In phase three these newly obtained variables for irrational sentiment are used as independent variables for regression where returns on sustainability related indexes are used as dependent variables, for this regression too similar residuals analysis is done as for the regression in previous phase so it can be determined that this regression too is the best unbiased linear estimator. The last phase in this analysis to make one more set of regressions but this time to use average monthly returns on OMXH25 and OMXS30 indexes as dependent variables and compare the results of these regressions to the results of the previous phase where OMXSUSTAINFIGI and OMXS30ETHIC were independent variables.

6.1. Testing for stationarity

Each time-series set included in any regression as independent variable is tested for stationarity using Augmented Dickey-Fuller test. Stationarity can be defined as a property of time series where time series has a constant variance over time. Non-stationarity is relatively common in financial time series and running a time series regression with two or more non-stationary variables may result a spurious regression where slope estimates may falsely appear significant in statistical test and even have very significant t-ratios even though such a significant relationship might not exist in reality (Brooks, 2019). Therefore, first difference is taken of each variable whose time series are found to be stationary are in order to reduce stationarity (Brooks, 2019).

Augmented Dickey-Fuller test has null hypothesis that the time series is non-stationary, in the other words it contains at least one unit root, whereas in the alternative hypothesis is that the time series has been generated by stationary process (Das, 2019). The basic idea Augmented Dickey-Fuller test (henceforth ADF-test) is the same as in original Dickey-Fuller test where objective is to determine if Φ – coefficient in following equation 3. equals

one, whereupon the null hypothesis accepted or whether it is lower whereupon alternative hypothesis is accepted (Brooks, 2019).

$$(3.) \quad y_t = \Phi y_{t-1} + u_t$$

Practically this is achieved by solving the following regressions. As in the following regression $\Phi-1=\Psi$, null hypothesis is proven to hold if Ψ equals zero (Brooks, 2019).

$$(4.) \quad \Delta y_t = \Psi y_{t-1} + u_t$$

ADF-test is, as name suggests, augmented version of this basic version of unit root test, where a p number of lags of the dependent variable is also used in the regression of the test, thus the test is capable of detecting any dynamic structures present in dependent variable through its lagged term (Brooks, 2019). Determining the right number lags in a given situation may sometimes prove difficult but in this thesis a heuristic offered by Brooks (2019) is used: as these observations are on monthly basis twelve lags for each variable are used (Brooks, 2019). Mathematical presentation of ADF-test is below on the below equation.

$$(5.) \quad \Delta y_t = \psi y_{t-1} + \sum_{i=1}^p \alpha \Delta y_{t-i} + u_t$$

As this test is conducted to the control variables of this study, only variable that could be accepted as stationary was unemployment rate in both Finnish and Swedish sets, all other displayed non-stationarity. Therefore, before going forward first difference of each observation in all these variables is taken and this is used in subsequent analysis inducing thus stationary into the dataset and avoiding the possibility of spurious regression. Exceptions is made with quarterly moving average of GDP which is kept as problems start arising when more than one (non-)stationary variable are included in the regression and fact that quarterly moving average taken out of the GDP growth should already smooth seasonality out of the straight measure of quarterly growth.

6.2. Control regression

After controlling the set of control variables against stationarity these control variables are then used as independent variables in regressions where sentiment indexes are assigned as dependent variables. As there are four sentiment variables used in this thesis in total four regressions are run. Mathematical representation of control regression for CCI can be seen below in the equation 6, where α is the intercept of regression and β :s are the regression coefficients. Mathematically the regression formula is essentially same for three other regressions, only swapping CCI for CTI or Finnish or Swedish ESI.

$$(6.) \quad y_{CCI} = \hat{\alpha} + \hat{\beta}x_{GDP} + \hat{\beta}x_{INDPRO} + \hat{\beta}x_{CPI} + \hat{\beta}x_{UNEMP} + \hat{\beta}x_{EURIBOR} + \varepsilon_{residual}$$

Detailed results of all four regressions, including the estimates, standard errors and p-values of regression coefficients, and p-values and goodness-of-fit statistics are presented in the Appendices 1 to 4. What seems to be common trend for all sentiment indicators is that with five percent significance level GDP has by clear margin largest impact on every sentiment indicator., this might be because of GDP is so well known widely followed indicator, literally the predominant measurement of economic growth. In addition, to GDP growth in Finnish sample industrial production growth rate seem to have statistically significant impact on both CCI and ESI in the five percent significance level and unemployment rate has statistically significant negative impact on ESI on ten percent significance level. In Swedish case, interest rates, denoted here as 6-month government treasury bill yield rate, seem to have statistically significant impact on both CTI and ESI. What is the most important is that all four models can be said to be overall statistically significant as all their p-values were well below the five percent significance level. Impact of interest rate level on sentiment is also in-line with theory but magnitude of that impact might be moderated in these results by the sample size as during the 2010s which form a greatest part of this time series the interest rates were on a fairly low level for historically long period of time.

A goodness-of-fit statistic worth paying attention to at this point. This study uses adjusted R^2 which gives a measure how well does the model fit into the data, in the other words how much of the variation in the dependent variable is explainable by independent variables included in the model (Brooks, 2019). This measure has also then been adjusted from traditional R^2 so that it also penalizes for including additional variables if they don't increase the explainable variance in dependent variable sufficiently (Brooks, 2019). This helps to avoid overparameterization. R^2 can easily be defined as one minus residual sum of squares divided by total sum of squares, or even more simply explained sum of squares divided by total sum of squares. In its adjusted form, this simple equation is complemented so that adding more independent variables doesn't automatically increase the statistic even though it would at least marginally increase the explained sum of squares, so that one is able to get an indication whether for example particular variable should be included in or discarded from the model (Brooks, 2019). Mathematical illustration of adjusted R^2 is below on the below equation, where T is the total sample size and k is the number of independent variables in the model.

$$(7.) \quad \overline{R_2} = 1 - \left[\frac{T-1}{T-k} (1 - R^2) \right]$$

In the four control regression models, it is notable that the adjusted R^2 measurements are much higher when ESI is as dependent variable in both Finnish and Swedish cases, indicating that ESI is better explained by the set of control variables. One possibility of this might be the fact that ESI includes also confidence metrics obtained from businesses on different fields which at least according to conventional wisdom are more capable of and willing to follow macroeconomic and financial indicators in order to adjust their decision-making accordingly, in short businesses are said to be more rational actors than consumers. As this regression is done on the purposes for controlling the main part of this analysis and as we assign residuals of each of these four regressions as new variables, great goodness-of-fit is not necessary, but this gives a valuable point of information about the control model, nonetheless.

More important than goodness-of-fit is the statistical significance of our control models, and fortunately in addition to p-value also the F-test statistic proves statistical significance of the model with the given degrees of freedom. F-test is made for testing multiple hypothesis simultaneously and thus it can include for example all the coefficients of regression model at the same time unlike for example t-test. F-test evolves two regressions one restricted and one unrestricted, to obtain the test statistic residual sums of squares of those two regressions are then compared. Mathematically this can be written as presented in the below equation in which RRSS is the residual sum of squares in the restricted regression, URSS is the residual sum squares in the unrestricted regression, T is the number of observations and k is the number of regressors in the unrestricted regression including the constant and m is the number of restrictions. Value given by this test statistic should then be compared to the critical value given by F-distribution table with given degrees of freedom and if test statistic were above the critical value null hypothesis, which would state that all the coefficients except that of intercept are zero, can be rejected. (Brooks, 2019)

$$(8.) \quad \text{test statistic} = \frac{RRSS - URSS}{URSS} \times \frac{T-k}{m}$$

6.3. Regression analysis of stock returns and sentiment

Now that statistical significance of control regressions is established and their residuals assigned into new variables, two regressions that contain the core of this thesis can be run. One in Finnish dataset which uses monthly average of daily returns for OMXSUSTAINFIGI index as dependent variable and residual components of CCI and of Finnish ESI (called

here irrational CCI and irrational ESI) as independent variables, and another in Swedish dataset which uses monthly average of daily returns for OMXS30ETHIC index as dependent variable and residual components of CTI and of Swedish ESI (called here irrational CTI and irrational ESI) as independent variables.

After running these two regressions several interesting observations can be made. First of all, it seems that in Finnish dataset coefficient of neither independent variable can be found to be statistically significant, even if one would use 10% confidence level. What is more p-value and F-statistic for the Finnish model as a whole are indicating that this regression could not produce statistically significant results.

Similar regression model done on the Swedish sample however yielded statistically significant coefficients on both measures of irrational sentiment CTI and ESI, although coefficients estimated to them are markedly low, indeed adjusted R^2 suggest that only 2,65% of the variations in the monthly average of daily returns on the index can be explained by variation in the irrational components in the sentiment variables. Such a low value is not entirely unexpected; indeed, it has unlikely never been suggested that fluctuations in irrational economic sentiment would by a major factor determining the stock returns, but it is interesting to know that there are indications that at least in Swedish markets those fluctuations in irrational sentiment reverberate into the returns of sustainable stock indices in however small amounts. Before drawing too many conclusions about the results we must establish statistically significant of overall model should be analyzed and fortunately F-statistic suggests that we establish the statistical significance of the model with 4,21% confidence level, given the 2 degrees of freedom for the numerator and 175 degrees of freedom for the denominator.

6.4. Analysis of the residuals

When evaluating these two regressions in the terms of five conditions on its residuals which determine whether the chosen model can be said to be best unbiased linear estimator according to the Gauss-Markov theorem we can right away conclude that the first condition is fulfilled as the mean of the residuals in both regressions is very close to the zero. Means are $4.01e-20$ and $2.92e-20$ for Finland and Sweden respectively.

The second assumption for residuals of OLS-regression was that residuals ought to have a variance that is constant finite over time, if this is not true residuals are said to be heteroscedastic. Convenient test for heteroscedasticity is Breusch-Pagan test. It utilizes

Lagrangian multiplier statistic for testing the null hypothesis that residual terms are homoscedastic. Calculating the test statistic evolves decomposing the variance into function h of two elements in the terms presented in two below equation where α is a vector consisting of unrestricted parameters unrelated to coefficients of regressions independent variables, and further it assumed that the first term in z_t is one (unity). Thus, null hypothesis of homoscedasticity can be written as every other element in vector α to equal zero except the first, whereupon the below equations would hold true the meaning that variance of error term would indeed be constant. Proving this is achieved by creating auxiliary regression upon z^t and Lagrangian test statistic can be found as one half the explained sum of squares in that regression. Test statistic should follow the χ^2 distribution with $p-1$ degrees of freedom (where p is the length of the vector α). (Breusch, Pagan, 1979)

$$(9.) \quad \sigma_t^2 = h(z_t' \alpha)$$

$$(10.) \quad \sigma_t^2 = h(\alpha_1) = \sigma^2$$

Breusch-Pagan test was conducted to the regressions of both Finnish and Swedish sample and the results were mixed. In Finnish sample the test indicated that heteroscedasticity of residuals could not be ruled out with any sensible confidence level, whereas for Swedish sample we can conclude that variance of residuals constant and finite over time with the confidence level of under two percent.

In order for us to determine whether residuals are linearly independent from one another Durbin-Watson test is conducted for residual values of both regressions. This possible feature of a time series where values of a given variable correlate with their previous values is also called autocorrelation and when it is present in the residual values of OLS regression it means that model isn't capable of capturing some significant patterns in the data and thus the chosen methodology wouldn't necessarily be the best possible. Durbin-Watson test focuses on first order autocorrelation meaning that it measures the correlation between a given variable and its immediately previous value (Brooks, 2019). In the context of time series regression formula of Durbin-Watson test can be written as presented in equation 11. Where u denotes the residual term of the regression and where $v_t \sim N(0, \sigma_v^2)$. Under the null hypothesis of Durbin-Watson test ρ is zero and rejecting it would mean that there are indications about a relationship between successive residuals i.e., first order autocorrelation (Brooks, 2019).

$$(11.) \quad u_t = \rho u_{t-1} + v_t$$

Durbin-Watson test conducted for regression models for Finnish sample had a p-value above the five percent significance level meaning that we cannot rule out autocorrelation in the residuals of regression. For Swedish sample however the p-value of test statistic was above the 5-percent-level, and we can reject the null hypothesis and conclude that there seems not be autocorrelation present in residuals. We can also observe residuals in graphical plot of the residuals does not indicate a presence of clearly observable pattern of autocorrelation (Figure 11 and 12).

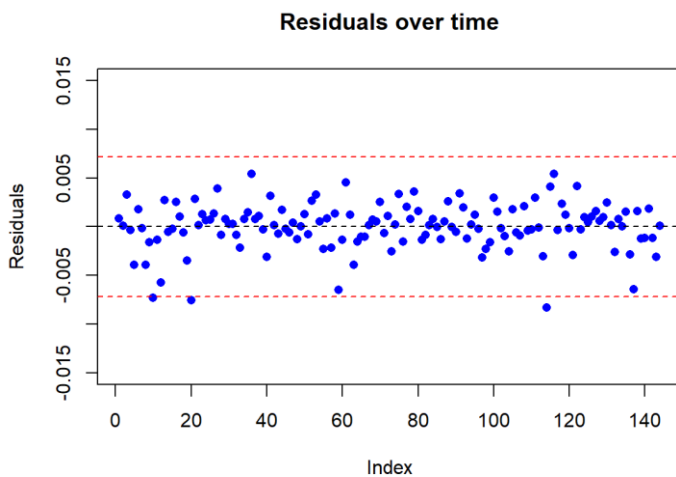


Figure 11: Residuals over time in regression on Finnish sample

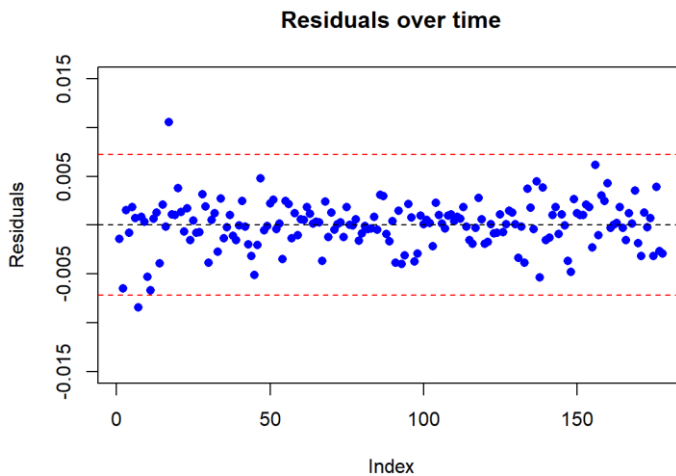


Figure 12: Residuals over time in regression of Swedish sample

Even as the results regarding residuals autocorrelation are not encouraging for Finnish sample, we can still establish that the fourth assumption regarding linear independence of residuals from the independent variables of the regression. Correlations between residuals in Finnish sample are $-1.385447e-17$ in relation to CCI and $-2.625733e-17$ in relation ESI,

and similarly in Swedish sample residuals correlate with CTI with the coefficient of -5.987114e-17 and with ESI 1.552625e-17, in short there is practically no correlation with residuals and independent variables in both regressions.

The fifth assumption that residuals are normally distributed is not necessary for model to be considered BLUE, but it is nevertheless desirable property. Checking this assumption is done by Bera-Jarque test. This is fairly simple statistic test that is based on two properties of normal distribution namely that its skewedness and excess kurtosis is zero. This in mind, Bera-Jarque test counts coefficients (b_1 and b_2) for skewedness and kurtosis which are presented in equation 12 respectively, where u denotes the residuals and σ^2 denotes their variance.

$$(12.) \quad b_1 = \frac{E[u^3]}{(\sigma^2)^{\frac{3}{2}}} \text{ and } b_2 = \frac{E[u^4]}{(\sigma^2)^2}$$

These coefficients can then be used to calculate the test statistic of Bera-Jarque test statistic, presented in equation 13 where T is the sample size. As the kurtosis of normal distribution is 3 therefore the numerator in right-hand side fraction is b_2-3 .

$$(13.) \quad W = T \left[\frac{b_1^2}{6} + \frac{(b_2-3)^2}{24} \right]$$

The test statistic follows asymptotically χ^2 distribution under null hypothesis which is that distribution of the tested series is mesokurtic and symmetric, in the other words normally distributed. If null hypothesis is rejected that would mean that distribution would either be significantly skewed or platy- or leptokurtic or even both.

When residuals of the two regressions of this thesis were tested for normality using Bera-Jarque test results were again somewhat mixed. Regression of the Finnish sample showed no signs of either skewedness or excess kurtosis meaning that null hypothesis about normal distribution from its part could be accepted. Swedish sample however showed significant skewedness, although its distribution was still mesokurtic, which means that null hypothesis for its part cannot be accepted. To gain further insight into the distribution of residuals for Swedish sample regression, those residuals are plotted in figure 13 where both traditional density distribution line graph and qq-graph, presenting actual quantiles against expected quantiles of normal distribution, are shown.

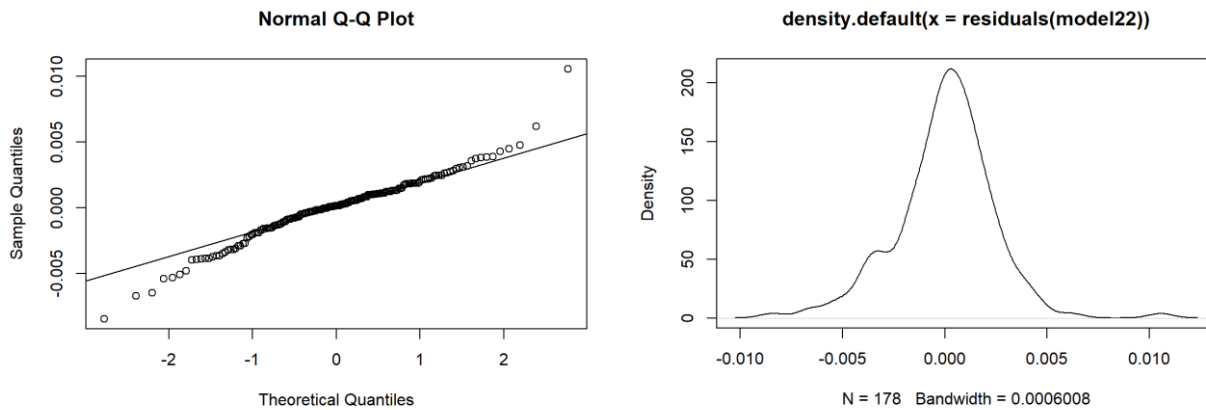


Figure 13: Distribution of residuals in regression of Swedish time series

In the end one can draw a conclusion based on these diagnostical analyses about the model that at least the model on Finnish sample should be rejected as based on the first-degree autocorrelation and heteroscedasticity present in residuals it can be concluded that the model is not capable of capturing all the dynamic changes in the data. Diagnostical analysis on the Finnish sample regression hence points to the conclusion as do the estimated coefficients of its regressors; no causal relationship between CCI and ESI in the one hand and monthly averages of daily returns on OMXSUSTAINFIGI index on the other throughout the given observation period.

Drawing conclusions on diagnostical tests of the Swedish sample regression is slightly more complicated. As the normal distribution of residuals is not necessary property for OLS regression model to be considered best linear biased estimator. What is more, the estimated coefficients in Swedish case were found to be statistically significant both individually as suggested by their p-values and together as suggested by the F-test of multiple hypothesis. Therefore, drawing conclusive observation about the sentiment-stock return relationship in Swedish markets would be possible, however the explanatory power of the coefficients is so small as also suggested by adjusted R-squared that the practical significance of the results is debatable .

6.5. Regular main indexes as dependent variables

After conducting the analysis regarding the main research question of this study, another set of two regressions is conducted using regular main indexes of Helsinki and Stockholm stock exchanges (OMXH25 and OMXS30) as dependent variables and the same irrational components of sentiment indexes as independent variables as was used in two regressions regarding sustainability related stocks. This is done in order to compare the difference in

impact of irrational sentiment on main indexes versus those indexes constructed on the basis of sustainable investment. Statistics of these regressions can be seen appendices 7 and 8.

What is remarkable in both of these regressions is that neither of them actually shows statistically significant results. In Finnish sample this seems to be in-line with regression of sustainability related stock indices, whereas particularly notable is that there seems not be statistically significant link between Stockholm main index OMXS30 and irrational sentiment even though there seems to be one between OMXS30ETHIC and those same sentiment variables. This would go on to indicate that we could accept the second research hypothesis of this thesis, namely that sentiment has stronger impact on returns of sustainability related indices than on regular ones, in this case sentiment seems to have a statistically significant impact on former but not on latter.

Final statistics of both regressions for countries can be seen in below tables 2 and 3. Like stated above these indicate weak but statistically significant relationship for Sweden and statistically insignificant relationship for Finland.

	OMXSUSTAINFIGI	OMXH25
Intercept	3,709e-04 (0.067)	3,084-e04 (0,118)
CCI coefficient	-7.983e-05 (0.2735)	1.200e-04 (0.237)
ESI coefficient	-4.988e-06 (0.9710)	-5.836e-05 (0.388)
regression p-value	0.3284	0.4744
regression f-statistic	1.308(on 2 and 141)	0.7497 (on 2 and 141)
regression adjusted R-squared	0.004295	-0.003513

Table 2: Regression results Finland

	OMXS30ETHIC	OMXS30
Intercept	3,709e-04 (0.0423)	2,355-e04 (0,162)
CTI coefficient	8.713e-05 (0.0147)	2,355e-05 (0.363)
ESI coefficient	-9,355e-05 (0.0293)	4,025e-05 (0.308)
regression p-value	0.0421	0.0255
regression f-statistic	3.226 (on 2 and 175)	3.316 (on 2 and 175)
regression adjusted R-squared	0.001708	0,0255

Table 3: Regression results Sweden

7. Conclusions

In order to derive empirical results, we have to first think about financial markets and actors that operate on those, chiefly the traders whose actions ultimately determine the asset prices according to the laws of supply and demand. Authors like Black (1980) have sometimes implied that there are at least two “groups” of traders present in the markets (Black, 1980). One group is formed of rational traders that trade according to the fundamentals, aim to the diversification of the risk and maximization of expected value of their investment, and who evaluate the asset values largely in accordance with pricing models like CAPM, its extensions and Fama and French multi-factor models. Another group is formed of so-called noise traders who trade based on noise, are largely irrational and who often can be assumed to form counterparts of value-maximizing rational traders (Black, 1980). In these presentations actions of rational traders largely determine assets’ market prices. One can introduce the key concepts of behavioral finance into this description by assuming that biases and heuristics effect all kinds of traders but to different extents, some traders might be greatly influenced by for example risk aversion, overconfidence or cognitive dissonance but impact of those on other traders might be negligible. By grossly simplifying it can be assumed that subsequently three groups of traders are formed, in addition to aforementioned rational traders and noise traders there can be assumed to be a third group of traders who share the ambitions of rational traders but whose rationality is “skewed” or “constrained” by various biases and consequently end-up in decisions and outcomes that differ those reached by fully rational traders. Naturally this third group is not homogenous but consists itself of several groups of traders characterized by various different biases to different extents, some of the biases might be even somewhat antithetical like for example overconfidence and loss aversion. Slightly more granular but overall, still fairly simplistic view would be to split the “third group” of biased traders into two with respect to the perhaps the most important factor, risk. Drawing from the prospect theory of Kahneman and Tversky there could be assumed to be risk-seeking and risk-averse group of traders whose utility curves are concave and convex respectively, that said it is worth noting that especially these two groups of risk-seekers and risk averse investors are not fixed but individuals can move between depending, among other things, choices they face as pointed out by Kahneman and Tversky (Kahneman, Tversky, 1979). Interaction between all these groups of traders ultimately determines the market efficiency and balance price for each asset. Generally, it is assumed that closer the traders are of full rationality, closer the markets are of efficiency frontier *ceteris paribus*. This interpretation also leaves room for adaptive market hypothesis

proposed by Lo (2004), where market actors can be assumed to be on almost constant state of evolution in order to adapt to the changing environment (Lo, 2004). This interpretation is highly attractive when considering impact of external shocks or periods of rapid change have on investors' confidence, sentiment and even perceived rationality. Still more complexity is introduced into this interpretation as markets of sustainable assets are observed as in those asset classes the motivation of investors, even if still assumed to be primarily about expected utility maximation, can be assumed to include wider variety of considerations than only financial gains incurring to the investor, or it potentially could call even the concept of expected utility maximation itself into question.

Finding that individuals perceptions alone hold explanatory power over asset valuations independent of changes in surrounding environment would suggest presence of certain bias in the markets and given that sentiment indices are mainly formed about expectations of future economic development such a bias would likely be a mix of overreaction, loss aversion, miscalculation of probabilities, overconfidence on the part of economic actors, and perhaps mental accounting. According to this assumption individuals react to developments in the wider economic environment but their expectations while based on these developments are not exactly rational, exact bias at play depends on the given situation and cannot be inferred from the empirical result of this study alone. We might expect that for example negative developments might induce loss aversion that's reflected on explanatory power of excess sentiment over stock returns, while positive developments might exacerbate overconfidence among markets players. Mental accounting as well as heuristics relating miscalibration of probabilities can be assumed to be constantly at play distorting expectations and therefore their decision-making. It is nevertheless obvious that at any given moment there is several biases at play at the same time and identifying precisely the impact of these biases at one or another moment is to be left for future research.

This basic implication of existence of heuristics and biases would in one interpretation lend a credence on prospect theory and on concave or convex utility curves that are essential part of it. This is unless one would interpret the sentiment indices as completely exogenous economic variables like interest rates for example. One shouldn't however necessarily take this as disapproval of whole premise of efficient market hypothesis at least in its weak form as although it seems that effects of heuristics and biases are not fully and instantaneously canceled out by rational arbitrageurs or traders who have opposite biases and heuristics this doesn't necessarily mean that at in longer-term markets might still be moving toward

supposed equilibrium of efficient market hypothesis and degree of inefficiency would be reducing. Such notion would be in line with Lo's adaptive markets hypothesis which states that rapid changes in the environment tend to render heuristics developed in past context suboptimal which makes those look like biases impeding rationality in the present context but as long as environment remains sufficiently stable those heuristics evolve leading to eventually choices that come closer to what might be called rational optima (Lo, 2004).

Rather than attributing the statistically significant impact of sentiment in Swedish markets on stock prices solely on presence of biases in the markets, it can also be assumed to be a result of interaction between noise traders and prevailing biases as outlined by Yan (2010) among others (Yan, 2010). The impact of biases and composition of noise traders in Swedish markets can be assumed to be such that noise traders do not "cancel out each other" as assumed in traditional neoclassical models.

While evidence pointing to independent explanatory power of the sentiment was found in the Swedish markets same cannot of course be said about Finnish markets. Therefore, contrary of above remarks could be argued to hold true in Finnish market. That is that there is no evidence about irrational perceptions, irrelevant of their cause, having impact on stock pricing and subsequently returns. There is no reason based on this research to assume that efficient market hypothesis would not hold true in some form in Finnish markets, although from theoretical point-of-view this doesn't necessarily mean that markets would follow the random walk hypothesis as further analysis has indicated that there seems to be statistically significant relationship between GDP and said stock indices. However, it should be noted that results this study can be generalized only to an extent of those variables precisely reflected in sentiment indices (namely individuals' and to some extent companies perceptions regarding present and expected near future economic environment in the terms of individual's economic standing, business condition, and economic growth) hold explanatory in given time period, this importantly is not to say whether biases and heuristics in general could hold any explanatory power in the wider marketplace, determining such a conclusion would likely require also experimental studies in addition to simple quantitative analysis. However, we can conclude that there is no evidence to that effect in aggregate level on sustainable stocks in Finland, unlike in Sweden. Therefore, we can conclude that traditional view of neoclassical finance and asset pricing models associated with that view probably are rather accurate descriptions on Finnish markets' asset pricing mechanisms, there is no evidence that irrational sentiment as major factor in asset pricing which would

discredit Von Neuman-Morgenstern utility theory and expected utility maximation as its core (Von-Neuman-Morgenstern, 2007).

One possible reason for weak observable link between the sentiment and stock returns could also be as Akhtar et al. have been theorizing consumer sentiment might be thought as indicator of either optimism or pessimism, and it could be that good sentiment news in upmarket is not seen as news at all and vice versa (Akhtar, et al. 2011). Also, throughout the observation period there has been greater periods of bull rather than bear markets and as Chen and Shiu-Sheng have been noting the impact of sentiment impact is greater in bear markets, this might help to partly explain why there is a statistical link Swedish markets as Swedish index has been launched in 2007 just before major global economic downturn (Chen, Shiu-Sheng, 2011).

In any case, regression analysis and adjusted R^2 show that the sentiment is neither strong nor likely one of the main indicators explaining the returns of sustainable stocks. This is very much in-line basic intuition, as not only does irrational sentiment expressed in the indices used in this research is incomplete measurement not taking into account all possible biases and heuristics that could affect to economic actors decision making, but also it is never suggested that irrational sentiment produced by such biases and heuristics would be the one major factor explaining variation of returns in any stock market.

To conclude, since there is evidence on sentiment holding some explanatory power with respect to sustainability related index in Swedish markets but none with respect to regular index, one can also accept the second research hypothesis with some reservation. Namely that the impact of the sentiment seems to be stronger for sustainable assets than to “regular one”, main reservation being that the impact is still considerably low. This difference between the sustainable index and the regular one might at least partly be attributable to higher degree of biases and heuristics among the investors who invest into this index compared to investors on the regular index.

8. Discussion

In the end it can be said that the relationship between the sentiment measured by consumer confidence and economic sentiment indices and stock returns remains, at the best, ambiguous. From control regressions we can see that these indices definitely are affected by real world quantifiable changes in the economy that have a direct impact on the prospects of many companies. Therefore, one can say that both economic sentiment and stock returns are affected by an overlapping set of underlying variables, most notably by the growth of gross domestic product, but what is interesting is that variation in neither sentiment index is fully reflected by changes in most widely followed economic indicators. This thesis aimed, in one way, to answer the questions whether fluctuations in sentiment that are not directly attributable to fluctuations of corresponding magnitude in the most widely followed economic variables carry explanatory power over stock returns which would indicate the possibility that investors are not completely rational in their calculations and whether properties like optimism and pessimism based on considerations not entirely founded on changes in real world economic and financial variables could have an aggregate level impact on how assets are priced on capital markets. As investors who expect return from their investments are fundamentally interested in future profits, there would at least theoretically be room for such considerations to affect the decision making as there is always a degree of uncertainty present in predicting the future and behavioral finance theory has laid out several ways these individual potentially irrational considerations can manifest even in aggregate market level. Much like previous research in this field, results of this thesis proved to be inconclusive.

That is not to say that shifts in the sentiment controlled against major economic variables would necessarily have to have an impact of notably great magnitude on the stock returns, after all it is common knowledge that stocks are priced according to the expectations of the future returns on investment and thus at the index level price is formed as an aggregate of all those numerous factors that affect the profit making capacity and/or growth potential of every single company that is included in the index. Therefore, macro-level indicators are generally assumed to hold explanatory power as they either signal changes in companies' business environment that affect their growth potential and profit capacity or for example by raising the risk-free level of interest that investors use as a benchmark while pricing risk. This is why it is unreasonable to assume that sentiment diverged from economic developments would form a large part of that *basis* on which investors root their decisions. Instead, a more reasonable assumption would be that sentiment affects investors' *perceptions, reactions,*

and their *interpretation* on all the changes in all the factors that affect or can be assumed to affect future prospects of any given company and to risk level, thus sentiment could lead over-, or undervaluation of investment compared to valuation made by entirely rational *homo economicus*. However, this thesis couldn't find any conclusive evidence of such a phenomenon in Finnish markets while findings in Swedish markets depend on to what conclusion one comes regarding the low R-squared value of the regression. In this chapter discussions about few key parameters of the model are presented along with the final comparison of empirical findings in relations to previous research.

8.1. Role of economic growth

This thesis found economic growth as measured by growth in GDP to be the major factor in explaining variation in the sentiment indices in both markets. GDP growth in any given area can also assumed, according to the common knowledge, to be linked to stock returns of companies in that area at least in medium- to long-term. However, the linkage between these three variables may not be quite as simple. This is especially so regarding the consumer confidence which wholly formed another of the two sentiment variables of this thesis and was also included as a one factor in the other one of them. It was suggested already by Keynes in 1936 that what he dubbed as "animal spirit" can drive economic activity (Keynes, 2008). Since then, especially after consumer surveys started to be regularly published, there has been batch of research trying to determine whether consumer confidence can be considered independent factor underlying consumer spending which thus can drive economic growth in accordance with basic demand-side theory of growth (Ludvigson, 2004). This has certainly been hinted at by prominent figures such as former Federal Reserve chair Alan Greenspan (Greenspan, 2002). For example, Guo and He (2020) have found that confidence has significant positive impact on economic growth, especially during recessions (Guo, He, 2020). Much however depends on profound question whether measures of consumer confidence can be considered to capture information truly independent from any other economic indicator (more on this chapter 8.3.) (Ludvigson, 2004). For purposes of interpreting the result of this thesis it is however sufficient for one to keep in mind that as suggested by Ludvigson there is possibly more complex and perhaps non-linear relationship between economic growth and consumer confidence than just one way effect of GDP growth explaining part of the variation in consumer confidence indicators (Ludvigson, 2004).

8.2. The sustainability-dimension

Like the relationships between economic output and consumer confidence the relationship between returns on stocks classified as sustainable investments and “regular” stocks or sustainable-investment indices and stock markets at large form nowadays separate ever-growing batch of research. Focus of this thesis to sustainability related indices was partly motivated by practical considerations as the growth of investment in this class of assets has grown remarkably in recent years, but in addition one of the main reasons to focus on sustainable investment was the notion that at least on intuitive level one would consider that at least part of investors choice to put their money on these assets have at least partly been motivated by other factors than pure profit-seeking. It would thus be reasonable to assume that changes in irrational sentiment on the economy-wide level would have a differing effect on those assets. Moreover, developments in sustainable finance largely depends to what degree financial markets are capable of integrating the benefits for market participants associated with taking sustainability into account in decision-making as well as exposure of those market participants to ESG risks into valuations of economic activities and financial assets (Guagliano et al. 2020). It could therefore be understood that if markets are effective at incorporating the sustainability related information including so-called transition risk and physical risk, there would be clear difference in pricing of assets classified sustainable and those which are not, as by default an asset performing well in sustainability dimension would then have a different risk-return profile than otherwise comparable asset that performs less well in sustainability dimensions because sustainability dimension are related to the business prospects of each company even though nature of that relationships differs greatly between sectors and even individual companies.

As already stated, what this thesis refers as “sustainability related stocks” is somewhat umbrella term and in the literature variety of terms including sustainable investment, ethical investment, ESG-investment, and CSR-based investment are used sometimes somewhat interchangeably. Regardless of the name what is the most interesting is whether the forces affecting this class of assets differs from those what might be traditionally expected to affect in stock markets. If investors motivation is more varied to invest in stocks or indexes that fill certain standard regarding sustainability it opens a door for possibility that returns for these assets are affected by prevailing sentiment more or possibly less than stock markets at large. Indeed, in this thesis, it was found that sentiment which affects to returns of sustainable OMXS30ETHIC index doesn't seem to have a similar impact on otherwise fairly

comparable OMXS30 index. This points to aforementioned difference in pricing between sustainable asset classes and regular ones and their differing sensitivity to sentiment which might be attributable to

However, like in the context of economic growth, there are evidence that causal relationships might be more complex. Indeed, it has been shown that ESG-performance itself may affect stock returns in certain cases, for example La Torre, Mango, Cafaro and Leo found using Eurostoxx50 index that evidence about this varying from company to company and to small extent in market level (La Torre, Mango, Cafaro, Leo, 2020). While Kruger found that negative CSR-news regarding a given company tend to trigger strong negative reaction in investors (Kruger, 2015). It would be interesting path of future research to try to find out more clearly whether factors like ESG-performance or CSR-news hold more explanatory power during low or high irrational economic sentiment, or whether such factors are as suggested by Kruger mostly driven by rational considerations about the future profits and thus largely in line with neo-classical assumptions (Kruger, 2015).

8.3. Efficacy of sentiment indices

Indices measuring economic sentiment, and consumer sentiment indices in particular, are relatively well followed economic indicators in many countries. As these indices are based on surveys conducted on individuals about their own opinions and assessments, it could be assumed that there is certain level subjectivity reflected in indexes on aggregate level. It could be further assumed that at the certain level things like news coverage of different events and developments would be reflected in the sentiment indices, for example high news coverage of certain event could induce bias among individuals' perception that this event would have higher (or lower) real-world impact than rational assessments would suggest, for example Greenspan noted that September 11, 2001, terror attacks were deep shock to the consumer confidence (Greenspan, 2002). It is hard to see that a drop in consumer confidence resulting from such an event would be result of aggregate effect of thousands of rational re-evaluations of the prevailing and expected near future economic conditions in individual and economy-wide level. This assumption of subjectivity forms the basis why, among others, this thesis considers it viable to use sentiment and confidence indicators to deduct a proxy for irrational sentiment. Regardless, it should be noted that it has sometimes been questioned whether these indices can capture truly independent information unrelated to any other economic indicator, like for example by Ludvigson (Ludvigson, 2004).

Moreover, from the nature of the questionnaires it can be concluded that there are at least two perspectives respondents would evaluate economic conditions, one is through personal finance, and another is through expectations on economy-level development. To this effect one can conclude that were to negative development in sentiment index led to decline of stock returns, it could in individual level be driven to rational or irrational expectation of decline in ability to invest or even need to divest due to worsening personal financial situation and/or expectation of losses on investment due to declining overall economic outlook.

8.4. Empirical findings

Although there haven't been a lot of research of this matter focusing on Finnish and Swedish markets, results in these markets do not seem to differ much from the picture in another European markets. Findings of this thesis of at best fairly weak explanatory power of sentiment in Swedish markets is largely in-line with previous empirical findings about the explanatory power of sentiment on European stock returns which have found shifts of sentiment to be either minor or practically non-existent factor in explaining the returns, although interestingly it seems to hold better predictive power in American markets. Previous studies on European markets have included variety of sentiment indicators as explanatory variables but almost always ESI is among them. In this thesis it can be concluded that domestic consumer confidence indicators in Finland and Sweden are not much better predictors, thus it cannot be said that those indicators that measure only the consumer confidence would give radically different picture about the impact of irrational sentiment than ESI which also includes sentiment measures from business side.

8.5. Future research suggestions

Even though this thesis proves that irrational sentiment is not a statistically significant factor in explaining the developments in stock returns in Finnish and Swedish markets that doesn't necessarily mean that there is no validity to an assumption that biases and heuristics could yield market reactions unjustified by rational analysis. One potentially interesting future line of inquiry would be to conduct an event study on major news stories of Finnish and Swedish media impact on stock returns in these markets. It would also be interesting to run longer time-series analysis with regular stock returns on major indices in both markets and do more profound comparison between the two markets using its results.

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Appendices

Appendix 1. Statistics of control regression for CCI.

```
Residuals:
  Min       1Q   Median       3Q      Max
-12.4825 -1.9508  0.4396  2.7172  8.2939

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    -6.9628     2.2485  -3.097  0.00238 **
`FIGDPQ[84:224, 5]` 140.0057    61.3544   2.282  0.02406 *
DiffIND         6.1850     1.1319   5.464  2.17e-07 ***
DiffCPI        -0.9259     1.0917  -0.848  0.39786
`UEMPFI[10:152, 1]`  0.2725     0.2609   1.044  0.29817
DiffEUR        -4.4044     6.3931  -0.689  0.49205
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.873 on 135 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared:  0.2912,    Adjusted R-squared:  0.2649
F-statistic: 11.09 on 5 and 135 DF,  p-value: 5.802e-09
```

Appendix 2: Statistics of control regression for ESI (Finland).

```
Residuals:
  Min       1Q   Median       3Q      Max
-15.337 -3.912 -0.377  3.974 15.487

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    96.0415     3.3783  28.429 < 2e-16 ***
`FIGDPQ[84:224, 5]` 945.7200    92.1854  10.259 < 2e-16 ***
DiffIND         7.4069     1.7006   4.355  2.61e-05 ***
DiffCPI        -0.8609     1.6403  -0.525  0.601
`UEMPFI[10:152, 1]` -0.7085     0.3921  -1.807  0.073 .
DiffEUR       -10.3694     9.6057  -1.080  0.282
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.819 on 135 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared:  0.6144,    Adjusted R-squared:  0.6002
F-statistic: 43.03 on 5 and 135 DF,  p-value: < 2.2e-16
```

Appendix 3: Statistics of control regression for CTI.

Residuals:

	Min	1Q	Median	3Q	Max
	-36.316	-2.852	1.981	4.578	10.662

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	89.66408	4.62994	19.366	< 2e-16 ***
`SWEGDPQ[50:230, 5]`	381.43649	73.00248	5.225	5.08e-07 ***
DiffIND	0.04626	0.04298	1.076	0.2833
DiffCPI	-0.80793	1.48812	-0.543	0.5879
`UEMPSE[33:209,]`	0.53492	0.56184	0.952	0.3424
Diff6MTB	7.50695	3.73582	2.009	0.0461 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.542 on 169 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared: 0.2044, Adjusted R-squared: 0.1808
F-statistic: 8.681 on 5 and 169 DF, p-value: 2.409e-07

Appendix 4: Statistics of control regression for ESI (Sweden).

Residuals:

	Min	1Q	Median	3Q	Max
	-17.9159	-3.4370	0.7482	4.5043	12.8338

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	90.74181	3.85132	23.561	<2e-16 ***
`SWEGDPQ[50:230, 5]`	922.29181	60.72566	15.188	<2e-16 ***
DiffIND	0.02851	0.03575	0.797	0.4263
DiffCPI	0.69760	1.23786	0.564	0.5738
`UEMPSE[33:209,]`	-0.12820	0.46735	-0.274	0.7842
Diff6MTB	8.07591	3.10757	2.599	0.0102 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.274 on 169 degrees of freedom
(3 observations deleted due to missingness)
Multiple R-squared: 0.6541, Adjusted R-squared: 0.6438
F-statistic: 63.9 on 5 and 169 DF, p-value: < 2.2e-16

Appendix 5: Statistics of main regression (Sweden)

Residuals:

	Min	1Q	Median	3Q	Max
	-0.0084348	-0.0012396	0.0001448	0.0012820	0.0105356

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	3.709e-04	1.813e-04	2.045	0.0423 *
IrrationalCTI	8.713e-05	3.536e-05	2.464	0.0147 *
IrrationalESI	-9.355e-05	4.256e-05	-2.198	0.0293 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.002419 on 175 degrees of freedom
Multiple R-squared: 0.03556, Adjusted R-squared: 0.02453
F-statistic: 3.226 on 2 and 175 DF, p-value: 0.0421

Appendix 6: Statistic of main regression (Finland)

```

Residuals:
      Min       1Q   Median       3Q      Max
-0.0083395 -0.0010889  0.0001288  0.0013436  0.0054228

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.709e-04  2.009e-04   1.846  0.067 .
IrrationalCCI -7.983e-05  1.035e-04  -0.772  0.442
IrrationalESI -4.988e-06  6.912e-05  -0.072  0.943
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.00241 on 141 degrees of freedom
Multiple R-squared:  0.01822, Adjusted R-squared:  0.004295
F-statistic: 1.308 on 2 and 141 DF, p-value: 0.2735

```

Appendix 7: Statistics of regression on OMXS30, main stock index Stockholm stock exchange

```

Call:
lm(formula = `OMXS30X[1:178, ]` ~ IrrationalCTI + IrrationalESI,
    data = SWEDENComp)

Residuals:
      Min       1Q   Median       3Q      Max
-0.007268 -0.001161  0.000229  0.001329  0.007824

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.355e-04  1.678e-04   1.403  0.162
IrrationalCTI 2.986e-05  3.273e-05   0.912  0.363
IrrationalESI 4.025e-05  3.940e-05   1.022  0.308

Residual standard error: 0.002239 on 175 degrees of freedom
Multiple R-squared:  0.03651, Adjusted R-squared:  0.0255
F-statistic: 3.316 on 2 and 175 DF, p-value: 0.0386

```

Appendix 8: Statistics of regression on OMXH25, main stock index of Helsinki stock exchange

```

Call:
lm(formula = `OMXH25X[1:144, ]` ~ IrrationalCCI + IrrationalESI,
    data = FINLANDComp)

Residuals:
      Min       1Q   Median       3Q      Max
-0.0091349 -0.0012532  0.0000585  0.0014653  0.0054804

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.084e-04  1.960e-04   1.573  0.118
IrrationalCCI 1.200e-04  1.010e-04   1.188  0.237
IrrationalESI -5.836e-05  6.744e-05  -0.865  0.388

Residual standard error: 0.002352 on 141 degrees of freedom
Multiple R-squared:  0.01052, Adjusted R-squared: -0.003513
F-statistic: 0.7497 on 2 and 141 DF, p-value: 0.4744

```