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Performance of Nordic Sin Stocks

Master Thesis

by
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MSc in Business with Major Finance

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ABSTRACT

This thesis investigates the performance of Nordic sin stocks between 2005 and 2022. We study the risk adjusted returns of sin stocks and compare them against returns from comparable stocks. We apply various risk adjustment methods to the CAPM framework as well as the Fama Macbeth method in order to investigate the hypothesized existence of a sin stock premium. We conclude that there is no evidence of sin stocks having superior performance compared to its comparables in the Nordic stock markets.

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Table of Contents

List of tables and figures

Chapter 1 - Introduction

1.1. Background

This thesis aims to investigate the performance of Nordic sin stocks relative to comparable stocks and discover if a sin stock premium for taking on sinful investments exists or not. When researching sin stock performance we quickly come across a wide array of studies pertaining to the United States as well as on a global level, but research specifically aimed at the Nordic stock markets are scarce. Previous studies such as Hong & Kacperczyk (2009) and Blitz & Fabozzi (2017) provide ambiguous results regarding sin stock performance and researchers have failed to reach a uniform conclusion regarding the profitability of sin stocks compared to the broader market. For example Hong & Kacperczyk (2009) concluded that sin stocks generate abnormal returns whereas Blitz & Fabozzi (2017) drew the opposite conclusion following the introduction of the two new factors in the Fama-French five factor model (Fama & French, 2015). There are currently no published research papers that use the Nordic stock markets as a foundation for the analysis and we therefore hope that this thesis can serve as a contribution to the field and help shed light on the performance of Nordic sin industries.

In the broader context, the scope of this thesis is also relevant in the context of ongoing geopolitical occurrences with initiatives being proposed by the European Union (EU) to incentivize and facilitate sustainable investments and encourage financial institutions to allocate more capital towards ESG-friendly firms in line with the EU taxonomy (European Commission, 2023). This is applicable to our thesis since all Nordic countries either serve as member states of the EU or partake in the EEA agreement and a considerable amount of Nordic sin stocks are considered to be ESG-unfriendly. Our link to sustainability is through the petroleum sector studying how it affects the results by including and excluding it in various regressions. The petroleum sector has long played an important role particularly in the Norwegian stock market where the market capitalization of the largest petroleum company Equinor accounts for approximately 20% of the total market capitalization of the

Norwegian stock exchange alone according to data from Refinitiv Datastream. However, in recent years discussions about the petroleum sector being unsustainable due to it being a nonrenewable and depletable resource that pollutes the environment have been a common topic. We therefore might observe that these regulatory developments cause Nordic sin stocks to become increasingly subject to exclusion and shunned by investors in the upcoming years due to the EU Sustainable Finance Disclosure Regulation, where investment firms are placed within Article 6 (investments without restrictions), Article 8 (promote environmental/social characteristics, and may invest in sustainable investments, but do not have sustainable investment as a core objective), or Article 9 (products have a sustainable investment objective) (JPMorgan, 2023).

1.2. Research question, hypothesis and methodology

The research question of this thesis is as follows: Do Nordic sin-stocks outperform the Nordic market in terms of risk adjusted returns?

The economic argument that sin stocks outperform the market and provide higher risk adjusted returns is as follows: Sin stocks are in many instances unwanted in portfolios that wish or must exclude unethical stocks due to factors such as personal preferences or investing constraints. This causes sin stocks to be underinvested which might lead to higher returns for investors holding these stocks (Chen et. al, 2012). Under the assumption that the models being used capture and adjust for all risk factors appropriately this might suggest that markets are not fully efficient and that investors could exploit this information to obtain abnormal profits. Following this, we hypothesize that sin stocks provide higher risk adjusted returns compared to the broader market.

Available data on sin stocks and comparables will be used in our research to determine whether sin stocks generate abnormal returns or not. We study the returns of sin stocks and comparable stocks using the CAPM framework and adjust for risk using various methods. We also study the effect of various risk factors on returns using the Fama and MacBeth (1973) methodology.

Contrary to Hong & Kacperczyk (2009) who find solid evidence of a sin stock premium, our results find no evidence supporting that a sin stock premium exists in the Nordic markets.. However, it is worth noting that we work with a more recent and shorter timeframe than Hong & Kacperczyk (2009) as well as far fewer stocks.

The rest of this thesis proceeds as follows. In chapter 2, we provide a concise literature review. In chapter 3, we outline our hypothesis and methodology. In chapter 4, we present our dataset and preliminary analysis. In chapter 5, we report our empirical results with a subsequent discussion. In chapter 6, we conclude our thesis.

Chapter 2 – Literature review and theory

2.1. Traditional sin stocks

An investor researching sin stocks might find it difficult to come across a clear definition of what a sin stock actually is. The perception of unethical or immoral is highly subjective and previous studies on sin stocks fail to agree on one universal interpretation. Hong & Kacperczyk (2009) define the sin industry as being composed of the alcohol, tobacco and gaming sectors – the so-called “Triumvirate of sin”. The authors also argue that two other classes of stocks can be defined as sinful namely the defense industry and sex industry, albeit the first is strongly subject to investor sentiment in the US which the study focuses on and the latter is very limited or hard to track down. The definition from Hong & Kacperczyk (2009) is supported by several other studies such as Fabozzi et al. (2008), Blitz & Fabozzi (2017). However, there is a plethora of sin stock definitions and some studies such as Fabozzi, Ma & Oliphant (2008) even go as far as to mention more obscure industries such as biotech which we consider to lie outside the scope of this thesis.

2.2. A modern take on the sin industry

Over the past decade socially responsible investments (SRI) have evolved from being more of a niche to a widely popular investment approach amongst private investors as well as large institutional investors. Blitz & Fabozzi (2017) state that sin stocks can change over time due to shifts in the firm’s revenue sources or changing social norms. Following this Blitz & Swinkels (2021) introduce four new sin industries: coal, oil, utilities and transportation due to their high carbon footprints. The authors also argue that mining and gold could be considered sinful due to their environmental impact and that soda and fast-food restaurants may be in line due to their effects on health which draws parallels to the” classic gambling sin theme”. Sagbakken & Zhang (2021) also include other metals, mining and uranium as sin stocks. Lobe and Walkshäul

(2016) use the definition from Hong & Kacperczyk (2009), but offer a novel viewpoint by also including nuclear power as a sin stock.

In our thesis we take the traditional perspective of alcohol, tobacco, gambling and defense in line with Hong & Kacperczyk (2009) while leaving out the sex industry because it is not commercialized in the Nordics to such an extent that obtaining data is possible. We then add the modern view by including the petroleum sector which deviates slightly from Blitz & Swinkels (2021) who limited their research specifically to oil and not the petroleum sector as a whole. We also focus our thesis specifically on the Nordic countries which is a geographical area we fail to find much previous research on.

2.3. Sin stock performance – empirical results

The sin stock premium hypothesis states that some investors demand additional returns for holding sin stocks or that others sacrifice returns to avoid them meaning that sin can be considered a priced risk factor and the stocks should be trading at a discount. Assuming that the hypothesis holds, firms involved in controversial activities must provide extra financial performance in order to attract and attain investors. According to Fabozzi, Ma & Oliphant (2008) sin stocks deliver positive abnormal returns of 3% per year. Hong & Kacperczyk (2009) find robust evidence that a sin stock premium of approximately 3% per annum exists by extending the sample back to 1926. Trinks & Scholtens (2015) find that the Triumvirate of Sin provides economically significant positive abnormal returns along with other controversial investments. Statman & Glushkov (2008) find that shunning sin stocks brings a disadvantage in terms of returns to socially responsible investors.

On the other hand, comparing portfolios composed of sin stocks with corresponding portfolios made of socially responsible stocks Lobe and Walkshäul (2016) find no evidence that sin stocks either outperform or underperform. It is however worth noting that almost half the sin portfolio consists of stocks in nuclear power – a sin sector that no other studies previously discussed has included. Humphrey & Tan (2014) find no evidence that avoiding sin stocks has any effect on returns. Blitz & Fabozzi (2017) revisit the original study from Fabozzi, Ma & Oliphant (2008) and find that sin stocks exhibit a positive CAPM alpha with Fama-French three factor model and Carhart four factor model – consistent with previous results. However, the study also finds that the sin premium previously observed disappears when controlling for the two new Fama & French (2015) quality factors - profitability and investment - thus indicating no evidence of a sin premium. This would suggest that returns are not attributable to a sin premium, but rather to the profitability and investment levels of individual companies. Sagbakken & Zhang (2021) find results that align with Blitz & Fabozzi (2017) on European data.

From this we can see that previous studies provide contradicting results. As discussed previously researchers use different definitions of sin stocks and it is important to keep in mind that changing the definition may also change the empirical results.

2.4 Explanations of sin premium

Researchers who found evidence suggesting the possible presence of a sin premium have also come up with different explanations for why they observe such a premium. Below we will briefly summarize the most important explanations from previous literature.

In essence the discussion of a sin stock premium essentially revolves around whether social norms and values can have an effect on asset pricing. Using the CAPM model, asset prices are not dependent on investor sentiment, but rather attributable to the market risk premium (Sharpe, 1964). This is in stark contrast to the abovementioned claims made by Hong & Kacperczyk (2009) claiming that social norms have a direct effect on stock returns.

Social norms are thought by many social scientists such as Becker (1957), Arrow (1972), Akerlof (1980) and Romer (1984) to be an important constituent behind economic behavior, market movements and portfolio choice. However, these studies were all based off data from the labor market instead of stock market movements (Hong & Kacperczyk, 2009). Following this Hong & Kacperczyk (2009) hypothesized that this theory would hold true in a novel setting of the stock market finding robust evidence that a sin stock premium exists due to the “societal norms against funding operations that promote human vice” causing sin stocks to be “neglected by norm constrained investors and face greater litigation risks heightened by social norms”. With norm-constrained investors Hong & Kacperczyk (2009) refer to institutional investors such as pension plans, banks, insurance companies, employee stock ownership plans amongst others that typically face several restrictions and regulations regarding the investment choices compared to mutual or hedge funds that are considered to be natural arbitrageurs.

The work of Merton (1987) on neglected stocks has been an important precursor to research on sin stocks. Merton (1987) states that for neglected stocks a relative increase in the size of the investor base reduces the cost of capital leading to a subsequent increase in market value for firms and that equilibrium expected returns will outperform widely followed stocks due to the limited information available. Hong & Kacperczyk (2009) expanded on this theory identifying two main reasons as to why sin stocks should outperform comparable stocks (stocks with similar characteristics, but classified as non-sinful). The first being that the neglect from institutional investors will cause the stock prices to become depressed relative to their fundamental values as a result of limited risk sharing and the second being that the limited risk sharing from the reduced investor base will cause the CAPM to no longer hold and idiosyncratic risk to become a variable in pricing. The authors therefore argue that increased litigation risk magnified by social norms should result in higher expected returns.

Investors can choose to forego investments in certain sectors both due to legal obligations or personal convictions. When studying sin stocks, it is therefore also important to understand what effects imposing such constraints has on a portfolio. Any mean variance efficient portfolio obtained using the Markowitz (1952) framework that includes investing constraints is expected to underperform a portfolio with no constraints. This holds true for any type of constraint, not only the avoidance of sin stocks. Thus, investors excluding sin stocks are foregoing higher risk adjusted returns in order to conform to their personal values and beliefs. The opportunity cost of negative screening is studied by Trinks & Scholtens (2015) who conclude that US investors actively avoiding investments in the "Sextext of Sin" (Alcohol, tobacco, gambling, controversial weapons, adult entertainment and nuclear power) forego more than 6% of investment opportunities on a global basis in terms of market capitalization. The authors also find that a market portfolio including negative screening of controversial stocks significantly underperforms a non-screened portfolio. Humphrey & Tan (2014) on the other hand find no concluding evidence that an investor would neither gain nor lose from negatively screening a portfolio. Negative (positive) screening in this context can be defined as excluding (including) sin stocks in the portfolio. Hong & Kacperczyk (2009) conclude that norm constrained investors hold less sin stocks compared to mutual funds or hedge funds. Blitz and Swinkels (2021) also find indications that the number of norm constrained investors are increasing over time.

Whereas many studies on sin stocks such as Hong & Kacperczyk (2009), Statman & Glushkov (2009) and Fabozzi et al. (2008) assumed that the definition of a sin stock is the same across borders Fauver & McDonald (2013) amongst others argue that the perception of sin is relative and that cultural differences can affect equity valuation by as much as 8% in societies strongly against sinful industries and that sin stocks deliver excess returns of 1-2% that persist in countries with capital restrictions.

Chapter 3 - Research methodology & hypotheses

3.1. Research questions and hypotheses

In line with Hong & Kacperczyk (2009) we hypothesize that sin stocks will outperform comparable stocks in the Nordic countries and generate abnormal returns. This is based on the assumption that the Nordic markets exhibit similar patterns as the American and global markets. In other words, we hypothesize that a sin stock premium exists. Following this we develop the following hypothesis:

Hypothesis 1: Nordic sin stocks outperform comparable stocks using several risk adjustment methods from the CAPM framework including the Fama-French three-factor model and Carhart four-factor model.

Following the works of Blitz & Fabozzi (2017) we also hypothesize that sin stocks will fail to outperform comparable stocks in the Nordic countries when introduced to the two new Fama-French factors (2015) of profitability and investment. This would suggest that the premium we hypothesize exists in hypothesis 1 does in fact not stem from abnormal returns, but just a difference originating from different risk factor adjustments and failure to capture this in the model. Research by Frazzini & Pedersen (2014) shows that norm constrained investors have tendencies to overweight their portfolios in risky securities to compensate for leverage constraints in order to achieve higher expected returns. In line with their research we therefore hypothesize that this deviation from the CAPM can be captured using the BAB factor and form the following hypothesis:

Hypothesis 2: Abnormal returns can be explained by differences in profitability and investment and the BAB factor extension reduces the abnormal returns in the Fama-French three and five factor models.

Consistent with Hong & Kacperczyk (2009) we also study the returns while adjusting for risks associated with firm characteristics using the Fama Macbeth (1973) two step regression approach combining cross sectional and time series regressions in order to obtain a deeper understanding of the drivers behind sin stock returns. Based off the same argumentation used in hypothesis 1 we form the following hypothesis:

Hypothesis 3: Nordic sin stocks outperform comparable stocks while adjusting for firm characteristics including size, book value, returns and beta using the Fama & Macbeth (1973) method.

Research from Blitz & Swinkels (2021) and Sagbakken & Zhang (2021) introduced new definitions of sin stocks. Most of these newly introduced sin industries are not publicly traded in the Nordic countries meaning that we can only include the oil and gas sector as a modern sin industry which has a large presence in the Nordics. Following this we study differences and similarities between traditional and modern sin stocks and hypothesize that both the traditional and modern sin stock classifications yield abnormal returns with all the above mentioned models:

Hypothesis 4: Both traditional and modern sin stocks have a sin stock premium.

3.2. Time series regressions

To test our hypotheses, our methodical approach will consist of running time-series regressions on the monthly returns of the sin stock portfolio comparing them to the returns of the portfolio of comparable stocks. In line with previous studies such as Hong & Kacperczyk (2009) we use the capital asset pricing model (CAPM) framework including Fama-French three-factor model and the Carhart four-factor model to evaluate the portfolio performance. We did also expand our analysis to include the Fama-French five-factor model, momentum factor and betting against beta factor in line with Blitz & Fabozzi (2017).

3.2.1. Capital asset pricing model and Jensen's Alpha

Developed in the 1960's by Treynor (1962), Sharpe (1964), Lintner (1965a, b) and Mossin (1966) and then further developed by Black (1972) the CAPM model was built on the earlier works of Markowitz (1959). The model is widely used in asset pricing theory to evaluate portfolio performance due to its ease of use and capabilities of measuring the relationship between expected return and risk. The CAPM is a model consisting of one factor – the market factor $(R_{m,t} - R_{f,t})$, which tests the portfolio risk relative to the market and states that the main driver behind portfolio performance is the market performance. A positive and statistically significant value would indicate that the stock performs well during bullish market conditions, whereas a negative and statistically significant value would indicate the opposite. It is denoted as:

$$R_{i,t} = R_{f,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) \tag{3.1}$$

where:

$R_{i,t}$ = *The return of portfolio i at time t*

$R_{f,t}$ = *The risk free rate at time t*

β_{mkt} = *The market beta*

$R_{m,t} - R_{f,t}$ = *The market risk premium*

From the CAPM model, Jensen (1968) came up with what's known today as Jensen's Alpha (hereby alpha) which allows investors to obtain a risk adjusted measure of their portfolio performance. The alpha is the average return deviating from the predictions given by the CAPM model according to the portfolio's beta and average market return. The alpha is in other words a representation of the abnormal returns of a portfolio and should be zero if the CAPM holds. A positive (negative) alpha indicates higher (lower) returns than suggested by the presence of systematic risk:

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \epsilon_{i,t} \tag{3.2}$$

The interpretation of $\alpha_{i,t}$ is as follows: a positive and statistically significant value would imply that there are some positive excess returns which the CAPM fails to predict whereas a negative and statistically significant value would imply the opposite. This model builds on the assumptions that markets are efficient and that investors exhibit rational behavior. The latter assumption is conflicting with sin stock theory stating that investors irrationally shun certain stocks.

Although the CAPM holds a fundamental place in asset pricing theory the model has also been widely criticized due to its reliance on numerous simplifying assumptions and "difficulties in implementing valid tests of the model" (Fama & French, 2004). The authors even go as far as to argue that the model fails empirically to such an extent that its usage in applications should be invalidated. Due to the simplicity of the CAPM model we will proceed by introducing more advanced models which allow for various methods of risk adjustment.

3.2.2. Time series return regression

Following Hong & Kacperczyk (2009) we use the following model as our base for studying return differences in the time series regressions:

$$EXCOMP = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \epsilon_{i,t} \tag{3.3}$$

Where:

EXCOMP = (SINPt–COMPt) where EXCOMP is the monthly return of a portfolio of sin stocks in month t, net of the monthly return of a comparable portfolio in month t

$\alpha_{i,t}$ *= Jensen's Alpha (the excess returns of portfolio i at time t)*

β_{mkt} *= The market beta*

$R_{m,t} - R_{f,t}$ *= The market risk premium*

$\epsilon_{i,t}$ *= The measurement of error of portfolio i at time t.*

In accordance with Hong & Kacperczyk (2009) the EXCOMP variable is used to test whether we obtain abnormal returns by short selling the comparable portfolio and buying the sin stock portfolio in order to test our hypotheses. By examining the significance levels of the alpha from the regression, we can determine whether a sin stock premium exists or not. The comparable sample is used instead of the market portfolio because it is considered a "more subtle and potentially more conservative way" to assess the impact investing constraints and social norms have on sin stocks (Hong & Kacperczyk, 2009). We will run two separate regressions both for the market weighted and equal weighted portfolios. As our risk free rate we use the European dataset obtained from the Kenneth French Data Library. We then proceed by using the CAPM framework to expand on the model and adjust for various risk factors. EXCOMP will be used to test hypotheses 1, 2 and 4.

3.2.3. Fama French three-factor model

Due to the drawbacks of the CAPM, the Fama & French (1992) three factor model has risen to become a dominant asset pricing model. Expanding on the CAPM, Fama & French (1993) found that average returns on small and value stocks had tendencies to exceed the values predicted by the CAPM. They therefore argued that adding two more factors; size and value risk, to the market risk factor would better adjust for the outperforming tendency of small market capitalization and value stocks, thus making the model a more reliable tool for portfolio performance evaluation. The market risk factor remains the same as in the CAPM, whereas the two new factors are denoted as small minus big (SMB) and high minus low (HML). The SMB factor is the difference between the returns on a portfolio consisting of stocks in small firms and a portfolio consisting of stocks in large firms. The interpretation is that the size of a company has an effect on its returns. A positive and statistically significant SMB factor implies that small firms outperform large firms while a negative and statistically significant factor indicates the opposite. The HML factor is the difference between the returns of high book-to-market ratios such as value firms and low book-to-market rations such as growth firms. The interpretation is that a positive and statistically significant HML factor implies that value stocks outperform growth stocks whereas a negative and statistically significant factor suggests the opposite. The Fama French three-factor model is as follows:

(3.4)

$$EXCOMP = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \epsilon_{i,t}$$

where:

β_{SMB} = *Beta of size factor*

SMB_t = *Size factor (small minus big)*

β_{HML} = *Beta of value factor*

HML_t = *Value factor (high minus low)*

3.2.4. Carhart four-factor model

Carhart (1997) offers an extension to the Fama-French three-factor model through the introduction of the momentum factor with momentum being the acceleration or velocity of stock price changes. When studying mutual fund performance, Carhart (1997) found that the momentum factor augmented the explanatory capabilities of the multifactor model. The momentum factor is denoted as winners minus losers (WML) and is the difference between a portfolio of high historical returns and a portfolio of low historical returns. The interpretation is that a positive and statistically significant value suggests that the stock has had positive trends in the past that are expected to continue in the future whereas a negative and statistically significant value suggests a negative trend which is likely to persevere. The Carhart four-factor model is as follows:

(3.5)

$$EXCOMP = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{WML} * WML_t + \epsilon_{i,t}$$

where:

β_{WML} = *Beta of momentum factor*

WML_t = *Momentum factor (winners minus losers)*

3.2.5. Fama French five-factor model

Expanding on their previous work from the 1990s, Fama & French (2015) introduced two new factors to their model: profitability and investment, meant to improve the performance of the model. Despite its improvements one of the main flaws with the model is its “failure to capture the low average returns on small stocks whose returns behave like those of firms that invest a lot despite profitability” (Fama & French, 2015). The new factors are denoted by robust minus weak (RMW) and conservative minus aggressive (CMA) where the first is the difference between portfolios with strong and weak profitability and the latter is the difference between portfolios of firms with low and high investments. The interpretation is that a positive and statistically significant RMW factor suggests that high-profitability stocks outperform low-profitability stocks whereas a negative and statistically significant factor indicates the opposite. Similarly, a positive and statistically significant CMA factor suggests that firms with low investment policies outperform firms with high investment policies, whereas a negative and statistically significant factor indicates the opposite. The Fama French five-factor model is written as follows:

$$EXCOMP = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{RMW} * RMW_t + \beta_{CMA} * CMA_t + \epsilon_{i,t} \tag{3.6}$$

where:

β_{RMW} *= Beta of profitability factor*

RMW_t *= Profitability factor (robust minus weak)*

β_{CMA} *= Beta of investment factor*

CMA_t *= Investment factor (conservative minus aggressive)*

3.2.6. Betting against Beta

An important assumption of the CAPM is that investors seek to maximize the excess return and leverage or de-leverage the portfolio according to risk preferences (Frazzini & Pedersen, 2014). However, the authors argue that investors constrained in the amount of leverage they can take on tend to overweight risky securities in order to make up for the borrowing restrictions to achieve a higher expected return which is a clear deviation from the CAPM assumptions. Frazzini & Pedersen (2014) finds evidence that the introduction of the betting against beta (BAB) factor can capture this variation and serve as a useful variable in time series regressions on asset prices. The BAB factor is the difference between a low beta and high beta portfolio. The interpretation is that a positive and statistically significant BAB factor suggests that low-beta stocks outperform high-beta stocks, while the opposite holds true for a negative and statistically significant BAB factor. The BAB factor can be added to both the three-factor (equation 3.6) and five-factor model (equation 3.7):

(3.7)

$$EXCOMP = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{BAB} * BAB_t + \epsilon_{i,t}$$

(3.8)

$$EXCOMP = \alpha_{i,t} + \beta_{mkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{RMW} * RMW_t + \beta_{CMA} * CMA_t + \beta_{BAB} * BAB_t + \epsilon_{i,t}$$

where:

β_{BAB} *= Beta of BAB factor*

BAB_t *= Betting against beta factor (BAB)*

3.2.7. Factor construction

The Fama-French five factors are retrieved from the Kenneth French Data Library using datasets formed on the European market as a benchmark. Since all returns are denoted in USD and 1-month treasury bills are used as a proxy for the risk free rate and we follow the same methodology in our regressions. The five factors (2x3) are created with 6 portfolios constructed from market capitalization (size) and book-to-market, 6 portfolios constructed from market capitalization and operating profitability, and 6 portfolios constructed from market capitalization and investment which are all value-weighted (French, 2023). The construction of the SMB, HML, RMW and CMA factors is done by grouping stocks at the end of each month into two market cap and three corresponding book-to-market equity (B/M), operating profitability (OP), and investment (INV) brackets. Big stocks are classified as those residing the top 90% market capitalization at the end of each month and small stocks the bottom 10%, whereas the B/M, OP and INV factors have breakpoints at the 30th and 70th percentiles of the respective ratios for big stocks. (French, 2023).

SMB (Small Minus Big) is the average return on the nine small stock portfolios minus the average return on the nine big stock portfolios.

$$SMB_{(B/M)} = 1/3\,(Small\,value + Small\,neutral + Small\,growth) - 1/3\,(Big\,value + Big\,Neutral + Small\,weak)$$

$$SMB_{(OP)} = 1/3\,(Small\,Robust + Small\,neutral + Small\,Weak) - 1/3\,(Big\,Robust + Big\,Neutral + Big\,weak)$$

$$SMB_{(INV)} = 1/3\,(Small\,Conservative + Small\,Neutral + Small\,Aggressive) - 1/3\,(Big\,Conservative + Big\,Neutral + Small\,Aggressive)$$

$$SMB = 1/3\,(SMB_{(B/M)} + SMB_{(OP)} + SMB_{(INV)})$$

HML (High minus low) is the average return of the two high growth portfolios subtracted from the average of the two low growth portfolios.

$$HML = 1/2\ (Small\ value\ +\ Big\ value) - 1/2(Small\ growth\ +\ Big\ growth)$$

RMW (Robust minus weak) is the average of the weak portfolios subtracted from the average of the robust profitability portfolios.

$$RMW = 1/2\ (Small\ Conservative\ +\ Big\ Conservative)$$
$$- 1/2(Small\ Aggressive\ +\ Big\ Aggressive)$$

CMA (Conservative minus aggressive) is the average of the aggressive portfolios subtracted from the average of the conservative investment portfolios.

$$CMA = 1/2\ (Small\ Conservative\ +\ Big\ Conservative)$$
$$- 1/2(Small\ Aggressive\ +\ Big\ Aggressive),$$ (Fama & French, 2023).

The momentum factor WML (Winners minus losers) is calculated by the following formula:

$$WML = 1/2\ (Small\ High\ +\ Big\ High)$$
$$- 1/2(Small\ Low\ +\ Big\ Low),$$

where WML is the equal weighted average of the two loser portfolios subtracted from the average of the two winner portfolios. The portfolios within the equation are calculated by sorting the stocks based on the 30th and 70th percentile which results in three loser and three winner portfolios (French, 2023).

3.2.8. Portfolio construction

In order to obtain a clear view of what drives returns as well as for the sake of completeness we construct and model both value weighted and equally weighted portfolios. The value weighted portfolio is constructed by assigning weights to each security based on the firm's market capitalization whereas the equally weighted portfolio is constructed by assigning equal weights to each security in the portfolio ignoring any differences in market capitalization. Therefore the value weighted portfolio will have a larger exposure to firm's with a large market capitalization and lower exposure to firms with a low market capitalization. The equally weighted portfolio on the other hand provides equal exposure to all firms irrespective of their size. The different methods of constructing the portfolios may affect their return characteristics and in turn the results and it is therefore worthwhile to use both methods to ensure comprehensiveness.

3.3. Fama & Macbeth

In order to get a broader perspective on sin stock performance we will also study the returns according to the Fama Macbeth (1973) two-step procedure which consists of running a cross sectional regression for each time period before taking the time-series mean of the obtained estimates. This allows us to study the relationship between sin stock returns and firm characteristics as opposed to the risk factors used in the various time series regressions presented above.

3.3.1. Fama Macbeth two-step regression

To run the Fama Macbeth two-step regression we use the following return forecasting specification in line with the study from Hong & Kacperczyk (2009):

(3.9)

$$EXMRET_{it} = \alpha_0 + \beta_1 SINDUM_{it-1} + \beta_2 X_{it-1} + \epsilon_{it}, \quad i = 1,\dots, N.$$

where:

EXMRET = Return of stock i after subtracting the risk-free rate

SINDUM = A dummy variable that takes the value of one if the stock is a sin stock and the value of zero otherwise

X_{it-1} *= A vector of firm characteristics including various permutations of LOGSIZE, LOGMB, RET and BETA as defined above.*

β_1 *= A coefficient measuring whether sin stocks generate abnormal returns while controlling for the abovementioned firm characteristics.*

β_2 = A vector representing the loadings on the control variables.

Fama & Macbeth (1973) propose a methodology allowing us to measure to what extent firm characteristics explain portfolio returns and identify the presence of a risk premium associated with exposure to these factors. The model consists of running a two-step regression combining the use of time series and cross sectional regressions. The first step involves running a times series regression where asset returns are regressed against the market portfolio. This allows us to pinpoint the exposure to each factor with the betas which are often called factor loadings. Thereafter, the second step consists of regressing the asset returns against the factor loadings obtained in the first step using a cross-sectional approach to determine the risk premium associated with each risk factor. The anticipated premium for a unit of exposure to each risk factor over time is assessed by computing the average of the coefficients once for each element.

We proceed by taking the monthly estimates from these regressions and follow Fama and Macbeth's (1973) approach by obtaining the time-series mean and standard deviations of the estimates before applying Newey and West (1987) standard errors to assess the impact of sin stocks on return performance.

3.3.2. Definition of firm characteristics

Following Hong & Kacperczyk (2009) in order to use cross-sectional variation to study sin stock performance against comparable stocks we define

LOGSIZE, LOGMB, RET and BETA as our firm characteristics. LOGSIZE represents the natural logarithm of the firm's end-of-year market capitalization, LOGMB represents the natural logarithm of the firm's market capitalization divided by its end-of-year book value and RET represents the average monthly return of the stock. BETA represents the time-varying industry beta which fluctuates over time and is estimated based on the monthly returns from the past three years.

3.4 - Testing the models

In order to be able to draw a conclusion regarding our hypotheses we will, in line with (Hong & Kacperczyk, 2009), test the models with t-tests as well as with auxiliary regressions including the Breusch Godfrey and Breusch Pagan tests. The t-tests are conducted for all regression results using the following equation; $(\hat{\beta}_i - \beta_i)/se(\hat{\beta}_i) \sim t_{n-k-1} = t_{df}$, where k+1 is the number of unknown parameters in the ordinary least squares (OLS) model and n-k-1 is the degrees of freedom (Wooldridge, 2021, p. 120). The t-tests will be conducted on the most commonly used thresholds for statistical significance of 1%, 5% and 10%.

Chapter 4 - Data and preliminary analysis

4.1. Data sources

As previously stated this thesis will focus on listed companies on the Nordic stock exchanges: Norway, Sweden, Denmark, Finland and Iceland. We therefore start off by creating a list of all sin stocks and comparable stocks (see section 4.2 for a more thorough definition). Log returns and market capitalization were obtained from London Stock Exchange Group's financial database Refinitiv Datastream. All monetary data is retrieved solely in USD. Fama-French and momentum factors were obtained from Kenneth French's data library. The BAB factor is obtained from AQR Capital Management LLC which is a global investment management firm. They provide long/short BAB equity factors based on the paper written by Frazzin & Pedersen (2014) for the European equity market which are updated monthly (AQR, 2023).

4.2. Selection of sin stocks and comparables

In order to run the models presented in chapter 3 we will need a set of both sin stocks and comparables in line with Hong & Kacperczyk (2009). The SIC- and NAICS codes that have been used to retrieve relevant stocks within the countries that are being analyzed are presented in table 4.1 followed by a more thorough explanation of all sectors. Both classification systems are used to retrieve as many relevant stocks as possible as this gives us a wider selection of stocks to work with since not all stocks have both SIC and NAICS codes.

Table 4.1: Industry classification

Industry	SIC	NAICS
Sinstocks		
Tobacco	2110, 2111	312230, 424940, 453991,111910
Defense	3484, 3795, 3760, 2892, 3489	336992, 325920, 332994, 928110, 334511
Alcohol	2082, 2085, 5182, 5813	312120, 213140, 312130, 453920, 424820, 722410
Casino	7948, 7993	713210, 713290, 721120
Petroleum	1311, 1321, 1381, 1382, 1389, 2911 2990, 3533, 5171, 5172	446120, 211120 ,211112, 211111, 424720, 324110, 424510, 221210, 213112, 333415, 212210,
Comparables		
Tobacco peers	2033, 2015	311919, 311941, 311920, 722310, 311991, 311421, 311712, 446191, 311111, 311422, 311911
Defense peers	3541, 3550, 3559, 3560, 3823, 3825	333924, 334513, 333249, 333612, 333611, 333618
Alcohol peers	2080, 2086	312111, 311511, 312112
Casino Peers	4481, 4482, 7011, 7041	483114, 72111
Petroleum peers	5352, 4931, 4941, 4911	221114, 221111, 221115, 221118, 221116, 221117, 333414

Note: The table shows which codes have been used to screen stocks in Scandinavian markets. Both the Standard Industrial Classification (SIC) and North American Industry Classification System (NAICS) have been used to obtain relevant stocks.

4.2.1 Sin stock selection

Following the definition from Hong & Kacperczyk (2009) we define sin stocks as any stocks within any of the following industries: tobacco, alcohol, casino and defense (weapons). Furthermore, following the 2015 Paris agreement and Blitz & Swinkels (2021) we will also include the petroleum industry in the sin stock portfolio since there seems to be a global consensus to reduce the use of oil and gas significantly thus making petroleum a sin industry. Some pension funds for instance are already excluding stocks within the petroleum sector (Storebrand, 2022).

- **Alcohol.** The alcohol industry consists of the brewing industry, i.e. manufacturers and shippers of products used in the process, as well as the distiller and vinegar industry (Hong & Kacperczyk, 2009).
- **Casino**. The casino industry consists of casinos, providers of gambling and institutions that in general makes it possible to gamble (Hong & Kacperczyk, 2009).
- **Tobacco.** The tobacco industry includes manufacturers and distributors of tobacco products including tobacco plantations (Hong & Kacperczyk, 2009).
- **Defense.** The weapon industry consists of aerospace and defense stocks which consists of manufacturers, assemblers and distributors of aircrafts and producers of components for military usage. (Lobe, Walkschäusl, 2011).
- **Petroleum.** The petroleum industry consists of oil and gas producers and distributors. The petroleum industry is a modern-day exclusion target because of its high carbon footprint, which makes the sector unwanted by investors wishing to decarbonize their portfolios (Blitz & Swinkels, 2021).

4.2.2 Comparables selection

In line with Hong & Kacperczyk (2009), we evaluate sin stock performance against stocks with comparable characteristics instead of the market portfolio. The researchers argued that this a more nuanced and cautious approach to assess sin stock performance. They used the Fama French (1997) industry groups with soda as a comparable for alcohol, food as a comparable for tobacco and the categories fun and meals & hotels as comparable for casinos.

Following this the following stocks provide natural comparables for our selection of sin stocks:

- **Alcohol comparable.** Non alcoholic beverages including soda, milk and bottled water.
- **Casino comparable**. Hotels, cruises and other forms of lodging.
- **Tobacco comparable.** Food products, food manufacturing and food service contractors.

- **Defense comparable.** Industrial machinery and equipment such as vehicles, turbines, engines, generators, tools, instruments amongst others.
- **Petroleum comparable.** Other sources of energy including solar, hydro, wind, geothermal, and biomass energy as well as heating equipment manufacturing.

4.2.3 Selection of timeframe and geographical area

The Nordic countries consist of Norway, Sweden, Denmark, Finland and Iceland. With this we provide an extension to the preexisting literature that is largely centered around the US markets. The timeframe we work with is January 1st 2005 to December 31st 2022. As the world has undergone rapid change and the focus on sustainability is accelerating at unprecedented speeds, we believe it is essential to work with a timeframe that is relatively recent. As stated by Blitz & Fabozzi (2017) the perception of sin changes over time and it could therefore prove difficult to work with a timeframe that is too extensive. As pointed out by Hong & Kacperczyk (2009) the health consequences of tobacco usage were not widely known until the mid 1960s. Furthermore, the petroleum sector has only in recent years come under large scrutiny.

4.3. Screening process

In order to obtain the time series data we have used the equity screener in Refinitiv Datastream which enables us to filter equities based on what exchange they are traded on. From there we can use the equity screener to obtain stocks only in the specific sectors we are interested in that fit our sin stock and comparable classifications as per above. Working with stocks from different countries will naturally lead to the involvement of various currencies. In order to circumvent having to address foreign exchange rate changes and their implications we will work directly with log returns adjusted for spinoffs, stocksplits/consolidation, stock dividend/bonus, righters offerings/entitlement. All monetary data is downloaded in USD and we work with log returns.

4.4. Description of dataset

According to a search in the financial markets database Refinitiv Datastream as of December 31st 2022 there was a total of 367 stocks listed on the Norwegian stock exchange, 1037 stocks listed on the Swedish stock exchange, 185 stocks listed on the Finnish stock exchange, 28 stocks listed on the Icelandic stock exchange, and 170 stocks stocks listed on the Danish stock exchange. This amounts to 1787 listed Nordic companies in total.

After the screening process we obtain the following number of stocks in each sector across the different countries as illustrated in table 4.2. There are certain stocks that do not have any historical data within the timeframe that is analyzed which requires that those particular stocks are omitted from the dataset. This gives us a total of 157 stocks that we are analyzing which corresponds to 8.8% of the investable universe within the Nordic markets in terms of number of stocks. 93 of these stocks are sin stocks. In terms of total market capitalization our sin stocks and comparables account for 7.1% of the investable universe using numbers from the CEIC database.

Table 4.2: Distribution of stocks within sectors across countries

	Norway	Denmark	Sweden	Finland	Iceland
Alcohol	0	5	6	1	2
Alcohol - peer	0	0	0	1	0
Casino	0	0	4	0	1
Casino - peer	1	1	5	1	0
Defense	6	0	13	0	0
Defense - peer	1	2	7	3	0
Petroleum	41	5	5	0	1
Petroleum - peer	9	2	26	3	0
Tobacco	0	1	2	0	0
Tobacco - peer	1	0	1	0	0

Note: The table shows the number of listed stocks within the chosen sector in each country's respective stock exchange.

Both the sin stock and comparable datasets contain data from 01/01/2005 to 01/01/2023 and the long time interval should therefore not be biased by singular shocks to the economy or yield inconsistent results caused by the chosen timeframe.

Table 4.3 shows the average, median, maximum and minimum monthly return, volatility and cumulative return within each equal-, and market-weighted industry portfolio. Returns are winsorized at the 1% level in accordance with Hong & Kacperczyk (2009). We notice that the differences in the industry-based portfolios are higher in the value weighted portfolios, where the bigger stocks eminently are driving the results compared to the equal weighted portfolios. The sins tock industries have had a bigger total return within the analyzed time frame when looking at each sinstock industry compared with their peers. In the equal weighted case three of the sinstock industries have had a higher return than their peers, meanwhile two of the portfolios have had lower total returns. In the value weighted case, all sinstock portfolios have had higher cumulative returns than their peers except the petroleum industry, which also is the greatest industry in terms of market capitalization.

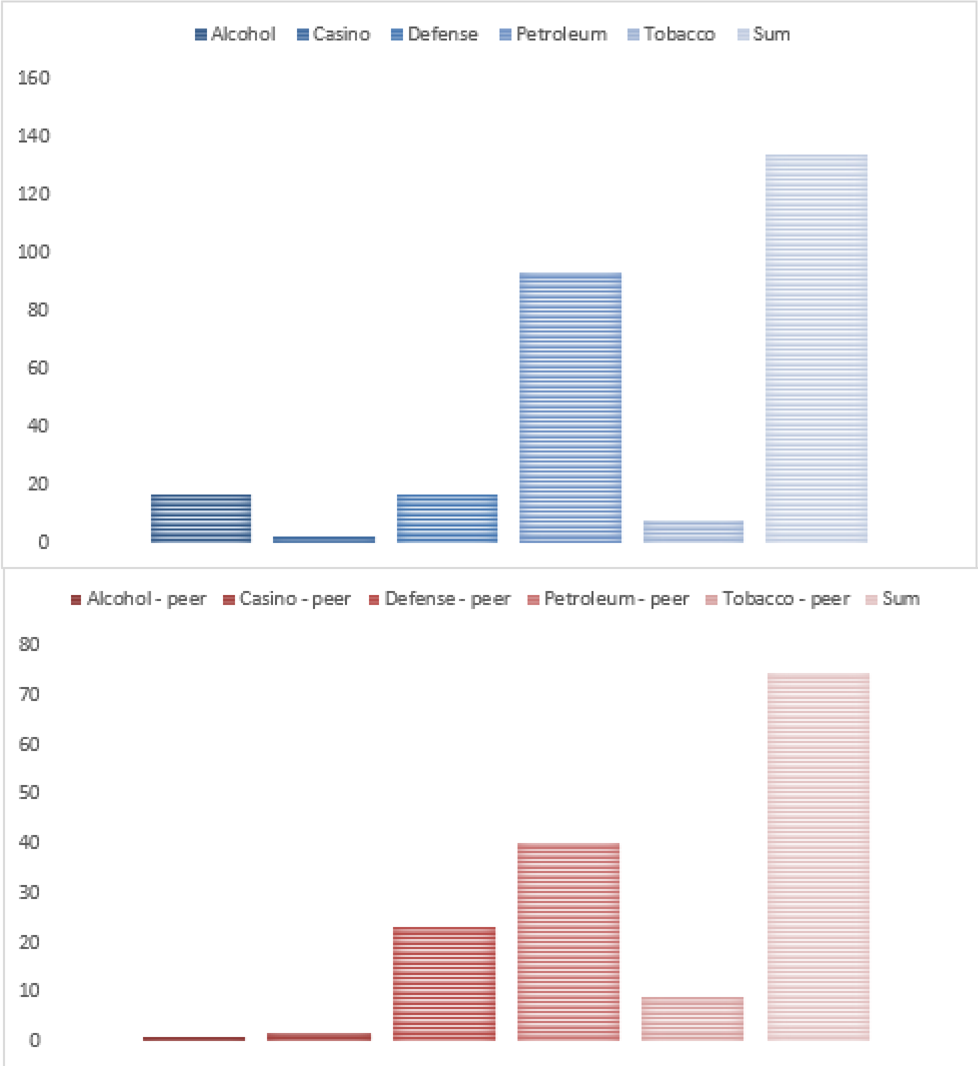
Table 4.3: Summary statistics

	Average	Median	Max	Min	Volatility	Cumulative return	Number of stocks
			Equal weighted return				
Alcohol	0.48 %	0.61 %	16.07 %	-12.51 %	4.46 %	128.49 %	14
Alcohol - peer	0.94 %	1.11 %	13.08 %	-14.74 %	5.84 %	391.41 %	1
Casino	0.72 %	0.45 %	44.40 %	-20.33 %	10.20 %	62.20 %	5
Casino - peer	-0.63 %	0.41 %	12.67 %	-17.94 %	5.17 %	-81.30 %	8
Defense	0.85 %	0.50 %	23.24 %	-15.15 %	6.15 %	317.10 %	19
Defense - peer	0.36 %	0.03 %	13.85 %	-19.81 %	6.12 %	44.38 %	13
Petroleum	-0.37 %	-0.16 %	15.23 %	-20.41 %	6.17 %	-70.95 %	52
Petroleum - peer	0.44 %	0.04 %	18.29 %	-13.63 %	4.87 %	99.04 %	40
Tobacco	1.43 %	1.69 %	12.09 %	-9.71 %	4.39 %	1510.72 %	3
Tobacco - peer	0.88 %	1.10 %	13.62 %	-12.48 %	5.41 %	363.67 %	2
			Market weighted return				
Alcohol	1.24 %	1.60 %	16.07 %	-14.37 %	5.65 %	921.98 %	14
Alcohol - peer	0.87 %	0.96 %	13.08 %	-14.74 %	5.80 %	351.27 %	1
Casino	1.94 %	1.85 %	44.40 %	-23.03 %	10.52 %	1975.95 %	5
Casino - peer	-0.13 %	-0.17 %	15.01 %	-16.40 %	5.42 %	-44.78 %	8
Defense	2.10 %	2.23 %	26.20 %	-17.76 %	7.53 %	4916.16 %	19
Defense - peer	1.66 %	1.98 %	17.32 %	-19.81 %	7.35 %	1910.67 %	13
Petroleum	1.23 %	0.85 %	19.63 %	-17.93 %	6.70 %	778.82 %	52
Petroleum - peer	2.04 %	2.02 %	22.84 %	-15.86 %	6.13 %	5323.94 %	40
Tobacco	1.56 %	1.69 %	12.09 %	-9.71 %	4.55 %	2230.68 %	3
Tobacco - peer	0.97 %	0.48 %	13.62 %	-12.48 %	5.69 %	476.37 %	2

Note: The table shows key statistics in the equal weighted portfolios above and market weighted portfolios below. The table operates with monthly figures. The average indicates what the average return has been in the timeframe between 2005 and 2023, the median excludes all returns except the one in the middle. Max shows the maximal monthly return each respective portfolio has reached, meanwhile Min shows the most substantial drawdown a portfolio has experienced within a month. The volatility measures the overall standard deviation in the portfolios. Cumulative return shows how profitable each portfolio has been from the beginning of 2005 until the first month of 2023.

Figure 4.1 shows the average total market capitalization across all periods being analyzed. The petroleum sector accounts for somewhat more than two thirds of the total market capitalization over time with regards to the sinstocks, whereas the petroleum peer industry accounts for approximately one half of the average total market capitalization of the sinstock peers. Since those two sectors will have a significant impact in terms of driving the results of the market weighted portfolios, we will conduct robustness tests where those two sectors will be omitted from the regressions discussed in chapter 3.

Figure 4.1: Market capitalization by industry (in billions USD)



Note: The figure shows the mean of the total market capitalization from 2005 until 2023. The market capitalization is measured in billions USD. The market capitalization within each industry is calculated by taking the sum of the market capitalization across all stocks within each sector, each month, and average out all months.

Chapter 5 - Results & main analysis

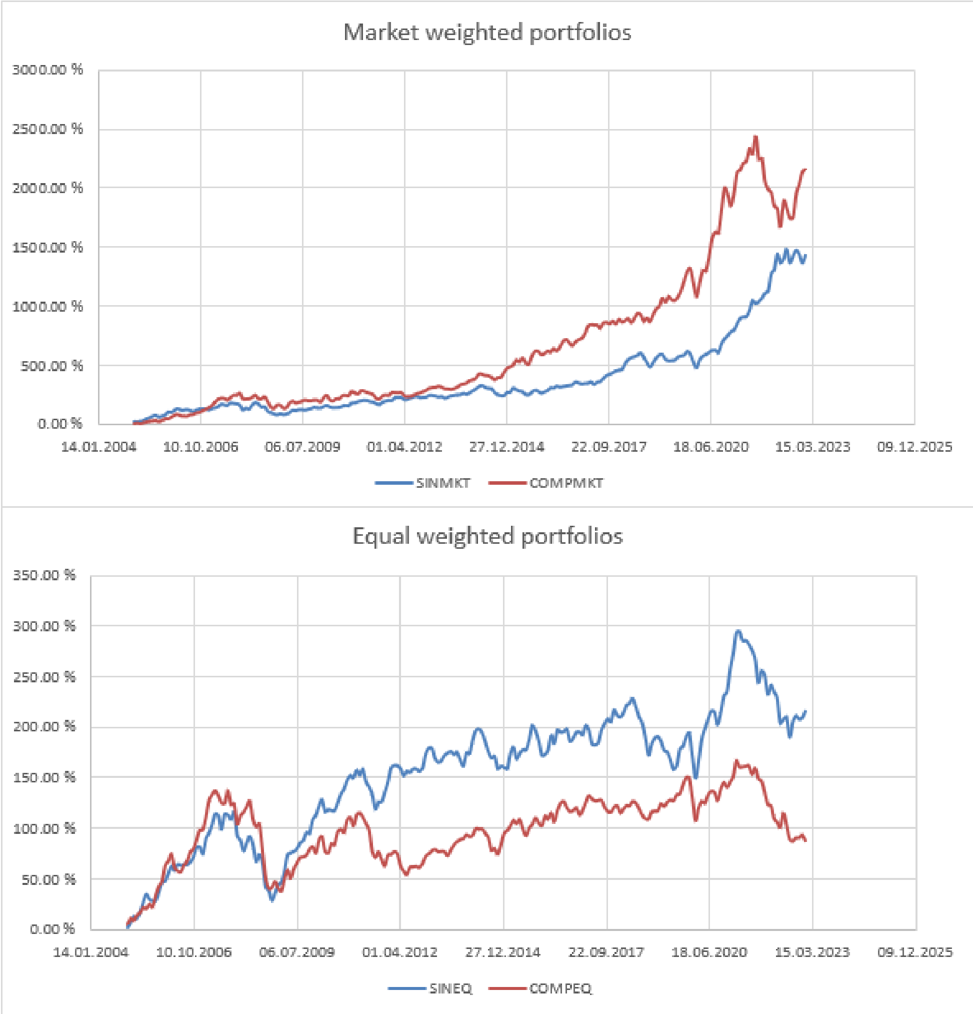
In the following chapter we will present and discuss our results with the objective of answering our hypotheses from chapter 3.1. Both the time series regressions and Fama & Macbeth two-step regressions will be subject to a comprehensive sector-wise analysis involving the use of central regression models presented earlier and employed throughout this chapter. Subsequently, we conduct various robustness tests to assess the results. Lastly we elaborate on the implications of our findings.

5.1. Descriptive statistics

Table (4.3) in the previous chapter visualized the performance of the various sectors. For the purpose of the analysis the sectors have been allocated into both equal weighted and market weighted sinstock- and comparable portfolios.

Below, we have graphed the accumulated returns of the sin stock and comparable portfolios. Looking at the cumulative returns, provides an illustration of the portfolio's performance over time from a long-term perspective while filtering out noise from short-term fluctuations. This allows us to observe the overall increase or decline in the portfolios while taking into consideration the magnitude and direction of returns. To some extent it also allows us to gauge how well sin stocks perform relative to the benchmark (in our case the comparable sample), but interpretation is limited since we do not yet adjust for risk factors.

Figure 5.1: Accumulated returns



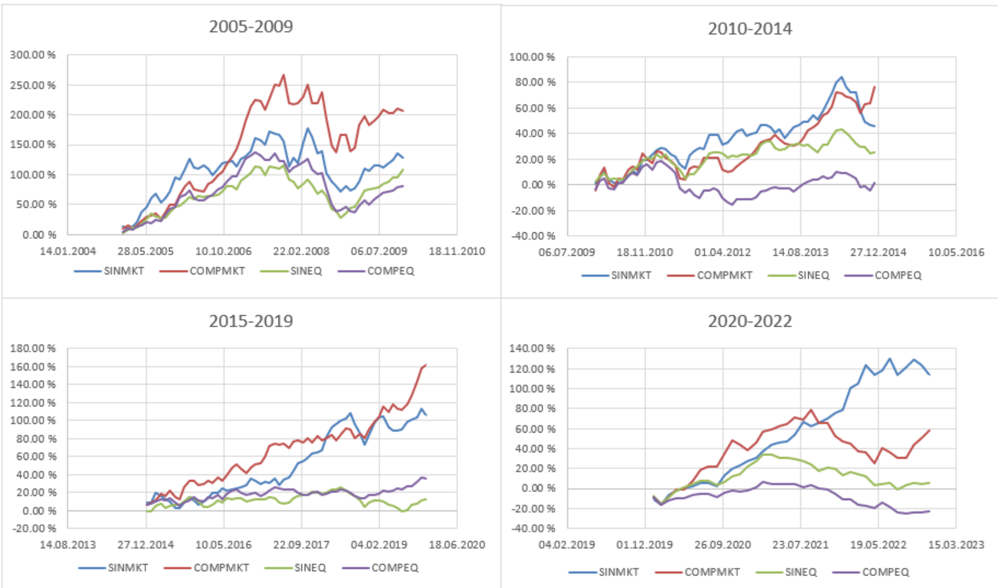
Note: The figure shows the total accumulated return in all portfolios that are analyzed. The graphs have the same color as the explanation in the graph.

Table 5.1: Performance of portfolios within different timeframes

Parameters	Average monthly return	Monthly standard deviation	Max monthly return	Min monthly return	t-statistic monthly return
2005-2009					
Market weighted sinstock portfolio	1.71 %	6.84 %	15.81 %	-16.90 %	3.68
Market weighted comparable portfolio	2.20 %	6.25 %	15.73 %	-15.46 %	5.19
Equal weighted sinstock portfolio	1.04 %	4.88 %	10.11 %	-12.04 %	3.14
Equal weighted comparable portfolio	1.13 %	4.89 %	10.44 %	-12.58 %	3.40
2010-2014					
Market weighted sinstock portfolio	0.66 %	3.86 %	10.32 %	-8.02 %	2.52
Market weighted comparable portfolio	1.06 %	4.21 %	12.42 %	-10.30 %	3.71
Equal weighted sinstock portfolio	0.48 %	3.16 %	7.45 %	-8.54 %	2.24
Equal weighted comparable portfolio	0.08 %	3.43 %	6.96 %	-10.34 %	0.34
2015-2019					
Market weighted sinstock portfolio	1.32 %	4.29 %	9.49 %	8.87 %	4.53
Market weighted comparable portfolio	1.79 %	3.74 %	11.06 %	-6.00 %	7.05
Equal weighted sinstock portfolio	0.11 %	4.87 %	10.11 %	-12.04 %	0.33
Equal weighted comparable portfolio	0.68 %	2.64 %	6.12 %	-7.42 %	3.79
2020-2022					
Market weighted sinstock portfolio	2.14 %	5.59 %	17.75 %	-11.27 %	5.64
Market weighted comparable portfolio	1.62 %	5.93 %	12.01 %	-9.15 %	4.02
Equal weighted sinstock portfolio	0.08 %	4.80 %	12.56 %	-10.32 %	0.25
Equal weighted comparable portfolio	-0.49 %	3.84 %	7.57 %	-9.06 % -	1.88

Note: Monthly return is the average return in each respective portfolio. Max/min is the highest/lowest return achieved in a single month during the whole period. The standard deviation shows the monthly volatility in each portfolio within the timeframe they are beneath. The table is split up into more time intervals and does measure the statistical figures within smaller timeframes.

Figure 5.2: Performance of portfolios within different timeframes



To better visualize how the portfolios have performed at different points in time we have split the timeframe into four increments. The first three increments contain five years worth of data whereas the last increment contains three years. As we can see from figure 5.2 and table 5.1, all portfolios experienced their largest drawdowns in the period spanning the financial crisis. We notice that without adjusting for any risk factors or taking statistical significance levels into account, the market weighted comparable portfolio outperformed the sinstock portfolio in every time period except 2020 - 2022 with a cumulative return of 2154%. This is largely driven by a 5324% return in the petroleum peer sector as table 4.3 illustrates. The equal weighted sinstock portfolio has a higher total return in every time period except between 2015 and 2019.

5.1.1. Capital asset pricing model and Jenssens' Alpha

On average the tobacco sector is the industry that has the smallest market beta, meanwhile the casino peer group is the highest market beta industry.

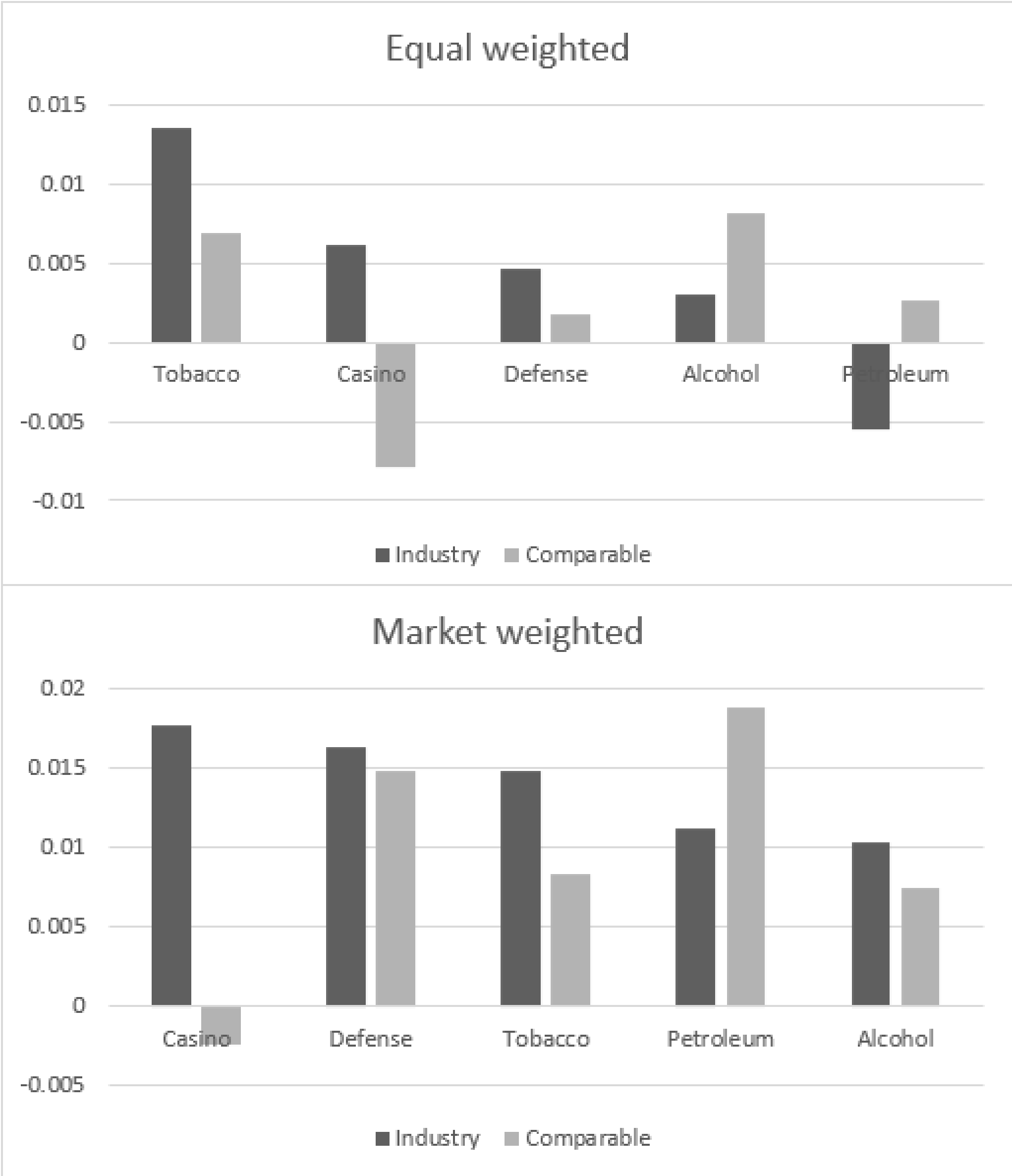
Table 5.2: Betas within the industries

Sectors	Average	Median	Min	Max
Alcohol	0.56	0.41	0.06	1.66
Alcohol - peer	0.44	0.44	0.39	0.49
Casino	0.51	0.54	0.32	0.68
Casino - peer	0.75	0.48	0.05	2.28
Defense	0.54	0.52	0.16	0.90
Defense - peer	0.61	0.57	0.01	1.57
Petroleum	0.43	0.55	-1.68	1.42
Petroleum - peer	0.53	0.51	-2.50	4.83
Tobacco	0.25	0.12	0.10	0.54
Tobacco - peer	0.22	0.22	0.18	0.26

Note: A beta value indicates how much a security moves relative to the market. The average shows the average beta value across all stocks within the industry marked under "Sectors", median shows the beta in the middle of all stocks, min (max) shows the smallest (biggest) beta value of a given stock within the dataset of a given industry.

It appears that all portfolios except the equal weighted petroleum and both the equal and market weighted casino comparable portfolio provide excess returns compared to the market according to figure 5.3. In other words the investment outperformed expectations and returns have exceeded the expected return adjusted for systematic risk.

Figure 5.3: Sector-based alphas



Note: Dark gray color illustrates the sin sectors, meanwhile the light gray color represents comparable sectors. Each sin industry stays beside their comparable industry. The y-axis shows the intercept within the different sectors according to the Jenssen's alpha model. The alpha measures the excess return each sector and comparable has compared to the market. The first graph is equal weighted, meanwhile the bottom graph shows market weighted sectors.

Table 5.3: Jensen's alpha on separate portfolios

	Alpha	MKT-RF
	Equal weighted	
SIN-RF	0.004	0.1802 ***
COMP-RF	0.0019	0.1426**
t-statistic	0.11	0.47
	Market weighted	
SIN-RF	0.0132***	0.1311*
COMP-RF	0.0141***	0.1449*
t-statistic	- 0.04	- 0.15

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile the beta describes the relative variation in the sinstock- portfolios compared to the comparable portfolios. MKT-RF is the relative variation in the returns compared to the underlying benchmark.

When running a Jensen's Alpha regression on the sin stock and comparable portfolios net of the risk free rate we obtain the output in table 5.3. We notice that the sinstock portfolio has a higher alpha in the equal weighted scenario meanwhile the opposite is true in the value weighted scenario. However, the t-statistic shows that there are no statistical significant differences between neither the value nor the equal weighted portfolio in terms of alpha.

5.2. Hypothesis 1: Sin stocks outperform the market with the three and four factor models.

Hypothesis 1: Nordic sin stocks outperform comparable stocks using several risk adjustment methods from the CAPM framework including the Fama-French three-factor model and Carhart four-factor model.

5.2.1. Jensen's Alpha

To be better equipped to draw a conclusion we have performed regressions on EXCOMP which corresponds to the returns of the comparable portfolio subtracted from the returns of the sinstock portfolio similarly like Hong & Kacperczyk did in their work where we have a long position in the sinstock portfolios and a short position in the comparable portfolios. The results are presented in table 5.3.

Table 5.4: Jenssens' Alpha on EXCOMP

	Alpha	MKT-RF
(1)	0.0021	0.0376
(2)	-0.0018	-0.0141

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile the beta describes the relative variation in the sinstock- portfolios compared to the comparable portfolios. (1) represents the EXCOMP in the equal weighted regression, meanwhile (2) represents EXCOMP in the market weighted regression, where EXCOMP is the sinstock return net of the comparable return, which the regression is run on.

When repeating the regression from table 5.3, but with EXCOMP as the dependent variable instead, we see that neither the Alpha in the equal or the value weighted portfolio is statistically significantly different from zero in the CAPM regression (table 5.4). Jenssens' alpha is positive in the equal weighted regression, meanwhile the opposite is true for the value weighted regression.

5.2.1. Fama French three factor model

Using equation 3.4 we run regression for the Fama-French 3-factor for both the equal weighted portfolio (1) and the market weighted portfolio (2) as presented in the table below.

Table 5.5: Fama French three factor model

	Alpha	MKT-RF	SMB	HML
(1)	0.0020	0.0400	0.0670	-0.0227
(2)	-0.0019	-0.0311	0.1631	0.0673

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha is a measure of the abnormal returns the portfolios get compared to the benchmark. Beta Market is the relative variation in the returns compared to the underlying benchmark. Beta SMB is a measure of the increase in return based on the increase in market capitalization of the portfolio. Beta HML is the increase in return relative to the increase in price to book multiple. (1) represents the EXCOMP in the equal weighted regression, meanwhile (2) represents EXCOMP in the market weighted regression,

None of the parameters are statistically significant in the Fama French three factor model. The equal weighted portfolio suffers from heteroskedasticity, and the OLS regression is changed with a robust regression instead which in fact does not change the parameters. Surprisingly the alpha differs from positive in the equal weighted portfolio to negative in the value weighted portfolio, which indicates that the industries with higher market capitalization are driving the value weighted portfolio negatively.

We observe that the alpha in the equal weighted time series regression was positive, but negative in the value weighted time series regression. An industry that has a high market capitalization and many stocks which would affect the panel data regression is the oil and gas industry. For that reason, it might be interesting to look at how the regression results do change if the oil & gas sector together with its comparable industry is omitted from the regression.

5.2.2. Carhart four factor model

The Carhart four-factor model is an extension of the Fama French three-factor model where the momentum factor is added to the regression as illustrated in equation 3.6. It appears that the regression results do not really change with this added momentum factor. As presented in table 5.6 the momentum factor in the equal weighted portfolio is the only one that is statistically significant.

Table 5.6: Carhart 4 factor model regression on EXCOMP

	Alpha	MKT-RF	SMB	HML	WML
(1)	0.0031	0.0114	0.0689	-0.0935	-0.1289 .
(2)	-0.0012	-0.0494	0.1643	0.0220	-0.0826

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile MKT-RF describes the relative variation in the long-short- portfolios compared to the market returns net of the risk free rate. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT-RF is the market beta, HML is beta depending on market capitalization, SMB is market price relative to book value, WML is a momentum factor that measures the performance of stocks the last 12 months. (1) is the equal weighted portfolio regression, (2) is the value weighted regression.

5.3. Hypothesis 2: Introducing the investment and profitability factors.

Hypothesis 2: Abnormal returns can be explained by differences in profitability and investment and the BAB factor extension reduces the abnormal returns in the Fama-French three and five factor models. This would suggest that the premium we hypothesize exists in hypothesis 1 does in fact not stem from abnormal returns, but just a difference originating from different risk factor adjustments and failure to capture this in the model.

5.3.1 Fama French five-factor model

Table 5.7: Fama French 5 factor model regression on EXCOMP

	Alpha	MKT-RF	SMB	HML	RMW	CMA
(1)	0.0006	0.0295	0.0834	0.2025	0.4399 .	-0.0421
(2)	-0.0032	-0.0158	0.2068	0.1821	0.35972	0.1445

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile MKT-RF describes the relative variation in the long-short- portfolios compared to the market returns net of the risk free rate. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT-RF is the market beta, HML is beta depending on market capitalization, SMB is market price relative to book value, RMW is a measure of profitability and CMA is the measure of investments. (1) is the equal weighted portfolio regression including all industries, (2) is the value weighted regression.

It appears that EXCOMP under the Fama French five factor equal weighted model yet again is positive, but very close to zero and still statistically insignificant. In this portfolio, the only statistically significant parameter is the RMW factor which is significant at a 10% level. In the value weighted Fama French 5 factor time series regression, none of the parameters are statistically significant and the alpha is also in this regression negative but also close to zero (Table 5.7).

5.4.1. Introducing the BAB factor

The BAB factor can in some instances capture variation in asset prices in regressions (Frazzini & Pedersen, 2014). In this section the BAB factor will be used in both time series and panel data regression in line with the analyses conducted in the previous analyses to complement the Fama French three and five factor model.

Table 5.8: Fama French 3 & 5 factor model regression on EXCOMP with BAB extension

Alpha	MKT-RF	SMB	HML	BAB	RMW	CMA
Equal weighted portfolios						
0.0023	0.0403	0.0622	-0.0229	-0.0365		
0.0009	0.0290	0.0761	0.2140	-0.0564	0.4602 .	-0.0478
Market weighted portfolios						
-0.0023	-0.0317	0.1717	0.0677	0.0654		
-0.0035	-0.0153	0.2137	0.1712	0.0536	0.3404	0.1499

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile MKT-RF describes the relative variation in the long-short- portfolios compared to the market returns net of the risk free rate. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT-RF is the market beta, HML is beta depending on market capitalization, SMB is market price relative to book value, RMW is a measure of profitability and CMA is the measure of investments. The BAB factor captures the variation in the betas that the stocks have.

It appears that the BAB does not have that big of an effect on the models. The three factor models do not change in terms of signs. The five factor models do also remain similar before the BAB factor was included.

5.5. Industry divided portfolios

In this subchapter we aim to identify which industries that are affected by which risk factors in the three and five factor models. We study which industries have abnormal returns and are statistically significant to provide a deeper understanding of the underlying drivers of the portfolios. The left hand side variables in the regressions are log returns net of the risk free rate.

Table 5.9: Industry divided Fama French regressions

	Alcohol	Alcohol - peer	Casino	Casino - peer	Defense	Defense - peer	Petroleum	Petroleum - peer	Tobacco	Tobacco - peer
3-factor model										
Equal weighted portfolios										
Intercept	0.0032	0.0085*	0.0059	-0.0082*	0.0040	0.0017	-0.0053	0.0025	0.0134***	0.0073 .
Mkt-RF	0.1766**	0.0458	0.0522	0.10203	0.5602***	0.1569 .	0.1096	0.1378*	-0.0208	0.1377 .
SMB	-0.20973	-0.1404	0.0349	0.25529	0.4730*	-0.0101	0.0810	0.0955	0.0720	-0.2206
HML	-0.09261	0.0104	-0.1685	-0.0121	-0.0809	-0.0233	0.2488	-0.0190	-0.0276	0.0743
R^2	0.0441	0.0034	0.0019	0.0205	0.2650	0.0178	0.0299	0.0249	0.0021	0.0286
Value weighted portfolios										
	Alcohol	Alcohol - peer	Casino	Casino - peer	Defense	Defense - peer	Petroleum	Petroleum - peer	Tobacco	Tobacco - peer
Intercept	0.0107**	0.0076 .	0.0177*	-0.00257	0.0151***	0.0149***	0.0115*	0.0189***	0.0147***	0.0089*
Mkt-RF	0.2032**	0.04632	0.1501	0.03287	0.8240***	0.1726 .	-0.0157	0.1230	-0.0291	0.0539
SMB	-0.29309	-0.1259	-0.09125	0.13938	0.3685	-0.1207	-0.0178	-0.0810	0.0360	-0.2975
HML	-0.03735	0.02645	-0.16861	0.02966	-0.5548**	-0.0927	0.1865	-0.1340	-0.0469	0.2113
R^2	0.0414	0.0037	0.0054	0.0040	0.3230	0.0145	0.0051	0.0106	0.0028	0.0250
5-factor model										
Equal weighted portfolios										
	Alcohol	Alcohol - peer	Casino	Casino - peer	Defense	Defense - peer	Petroleum	Petroleum - peer	Tobacco	Tobacco - peer
Intercept	0.0032	0.0109*	0.0054	-0.0091*	0.0022	0.0025	-0.0052	0.0039	0.0125***	0.0074 .
Mkt-RF	0.0902	0.0023	0.0005	0.1007	0.4815***	0.1429	0.1023	0.0782	-0.0665	0.0940
SMB	-0.3093*	-0.2357	-0.0109	0.2729	0.4208*	-0.0427	0.0695	0.0017	0.0431	-0.2727
HML	0.2183	-0.1375	0.0875	0.1188	0.4553 .	0.0795	0.2548	0.0290	0.2585	0.2228
RMW	0.1381	-0.6905	0.2412	0.2867	0.6970 .	0.2219	-0.0341	0.2798	0.3216	0.0375
CMA	-0.6330*	-0.4663	-0.3630	0.0135	-0.5298	0.1294	-0.0573	0.4667	-0.3369	-0.3409
R^2	0.0671	0.0216	0.0038	0.0233	0.2850	0.0194	0.0300	0.0375	0.0133	0.0330
Value weighted portfolios										
	Alcohol	Alcohol - peer	Casino	Casino - peer	Defense	Defense - peer	Petroleum	Petroleum - peer	Tobacco	Tobacco - peer
Intercept	0.0113**	0.0102*	0.0185*	-0.0046	0.0116*	0.0161**	0.0114*	0.0197***	0.0136***	0.0093*
Mkt-RF	0.1051	0.0036	0.1302	0.0456	0.7905***	0.1770	-0.0763	0.0250	-0.0930	-0.0234
SMB	-0.4159 .	-0.2254	-0.1285	0.1940	0.4024	-0.1402	-0.0859	-0.2090	-0.0127	-0.3936 .
HML	0.2511	-0.1504	-0.1915	0.2472	0.0433	-0.2705	0.4159	0.1188	0.3470	0.4422
RMW	0.0110	-0.6780	-0.1813	0.5741	1.1312*	-0.3728	0.1226	-0.0683	0.4722	0.0174
CMA	-0.7309*	-0.3746	-0.1630	0.1421	-0.1574	0.0022	-0.4417	0.7361 .	-0.4378	-0.5745
R^2	0.0597	0.0199	0.0059	0.0146	0.3440	0.0168	0.0102	0.0264	0.0232	0.0362

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha is the intercept of the returns in the sector in the columns and may be interpreted as excess return of portfolio, MKT-RF is market beta, HML is beta depending on market capitalization, SMB is market price relative to book value. RMW is a measure of profitability and CMA is the measure of investments.

The alcohol industry has a higher alpha than its comparable if the value weighted portfolios are compared, meanwhile the opposite is true for the equal weighted portfolios. The stocks within the gambling industry have a higher alpha than its comparable in both the Fama French three-factor and five-factor model regression regardless of whether the portfolio that is compared is equally weighted or value weighted. The defense sector has a higher alpha in the Fama French three-factor model, meanwhile the opposite is true for the Fama French five-factor model. Furthermore, the defense industry has the highest market beta in the dataset (Table 5.9), and has the highest R^2 as well, which indicates that the returns within the defense industry are better explained by the Fama French models than any of the other industries. Overall, it seems that the sin stocks generally have higher alphas with respect to the risk factors. The sin-industries that have higher alphas than their comparables do also have higher absolute returns (as presented in table 4.3 in

Chapter 4). Since the alpha captures returns that exceed the systematic risk this would suggest that higher alphas are accompanied by higher absolute returns.

5.7. Time series regressions summary

Below is a brief summary of the conclusions from the time series regressions so far. Due to the lack of statistical significance only the CAPM, Carhart four-factor model and three-factor with BAB extension in the equal weighted regressions excluding oil and gas have statistically significant positive alphas. The MKT-RF factor is positive in the three-factor, four-factor, five-factor and both models with BAB factor extension in the value weighted regressions excluding oil and gas. In the other regressions we do not have enough statistical significance to draw a conclusion. The SMB factor is statistically insignificant in all time series regressions. The HML factor is positive in the three-factor models with and without the BAB factor extension and the Carhart four-factor model in the value weighted regressions excluding oil and gas. The WML factor is negative in the equal weighted regression excluding oil and gas. The RMW factor is positive in all equal weighted regressions, but statistically insignificant in the market weighted regressions. The CMA and BAB factors are statistically insignificant in all time series regressions. A complete summary of all regression results pooled together can be found in appendix C.

Due to the lack of statistically significant results we therefore reject both hypotheses 1 and 2 contrary to findings from Hong & Kacperczyk (2009) and Blitz & Fabozzi (2017) respectively.

5.8. Hypothesis 3: Fama Macbeth

Hypothesis 3: Nordic sin stocks outperform comparable stocks while adjusting for firm characteristics including size, book value, returns and beta using the Fama & Macbeth (1973) method.

5.8.1 Fama Macbeth two-step regression

In this section the focus will be directed towards the stocks' firm characteristics and the performance of sinstocks will be better highlighted based on the SINDUM variable.

Similarly to Hong and Kacperczyk (2009) this thesis makes use of the Fama-MacBeth regression as well in the same manner. The included variables are SINDUM, LOGSIZE, LOGMB, RET, and BETA1.

Table 5.10: Fama Macbeth regressions: 2008-2022

	(1)	(2)	(3)	(4)
Intercept	-0.1082***	-0.0957***	-0.0905***	-0.0909***
SINDUM	-0.0048 .	-0.0007	-0.0011	-0.0017
LOGSIZE	0.0056***	0.0046***	0.0044***	0.0044***
LOGMB		0.0048***	0.0046***	0.0046***
RET			0.0566	0.0380
BETA1				0.2924
R^2	0.1760	0.2068	0.2237	0.2419

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. SINDUM is a dummy variable measuring the return of sinstocks excess of the comparable returns. LOGSIZE is the natural logarithm of firm i's market capitalization. LOGBM is the natural logarithm of firm i's market capitalization divided by its book value at end of year t. RET is the average monthly return of stock i during year t. BETA is the time varying beta of firm i calculated over the past three years. R squared captures the fit of the model (Hong & Kacperczyk, 2009).

The SINDUM variable which is a dummy variable for sinstocks is negative in all regressions, but only statistically significant (at a 10% level) in regression (1) (Table 5.10). Both LOGSIZE and LOGMB are statistically significant at all conventional levels, meanwhile RET and BETA1 are not statistically significant in any regressions. All variables included except for the SINDUM variable have a positive sign which indicates that higher market capitalization, market-to-book value, past returns and betas have a positive impact on stock returns. This is surprising since the results by Hong and Kacperczyk (2009) indicate that both higher market capitalization but also higher market-to-book ratio have a statistically negative impact on company returns. The multiple R squared increases with added variables and indicates that the variables explain a fifth/forth of the stock returns. Due to the lack of statistically significant results we therefore reject hypothesis 3 contrary to findings from Hong & Kacperczyk (2009).

5.8. Hypothesis 4: Modern sin stocks

Hypothesis 4: Both traditional and modern sin stocks have a sin stock premium.

Table 5.11: Fama French three factor model (excluding oil & gas)

Alpha	MKT-RF	SMB	HML
	Equal weighted portfolios		
0.0048 .	0.0405		
0.0047 .	0.0382	0.0824	
0.0046	0.0547	0.0745	-0.0883
	Market weighted portfolios		
0.0015	0.1079		
0.0013	0.1016	0.2229	
0.0010	0.1498 *	0.2002	-0.2571 .

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Beta Market is the relative variation in the returns compared to the underlying benchmark. Beta SMB is a measure of the increase in return based on the increase in market capitalization of the portfolio. Beta HML is the increase in return relative to the increase in price to book multiple. This regression excludes the Petroleum industry and its comparable industry.

In the table above, the oil and gas industry is omitted from the regression results together with its comparable industry. The alpha increases in the equal weighted regressions. Jenssen's alpha becomes statistically significant, meanwhile the alpha in the three factor model still is not statistically significant. The market weighted portfolios excluding oil and gas have positive alphas which contradicts the results from the results including all industries where the alphas are negative. MKT-RF is only statistically significant in the Fama French 3 factor model excluding oil and gas and we notice that the sign in front of MKT-RF is linked to the sign in front of the intercept. The HML factor in the market weighted Fama French 3 factor model regression excluding oil and gas becomes negative opposite to the case in the regressions including all industries. It appears that both the equal and value weighted sinstock portfolios perform better when the oil and gas industry is omitted from the regressions. However, the HML factor seems to capture some of the returns making the equal weighted regression alpha statistically insignificantly different from zero.

Table 5.12: Carhart 4 factor model regression on EXCOMP excluding Petroleum

	Alpha	MKT-RF	SMB	HML	WML
(1)	0.0062 *	0.0133	0.0773	-0.1911	-0.1871 *
(2)	0.0013	0.1408 .	0.2008	-0.2793 .	-0.0404

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile MKT-RF describes the relative variation in the long-short- portfolios excluding the oil and gas industry together with the renewable energy sector compared to the market returns net of the risk free rate. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT-RF is the market beta, HML is beta depending on market capitalization, SMB is market price relative to book value, WML is a momentum factor that measures the performance of stocks the last 12 months. (1) is the equal weighted portfolio regression, (2) is the value weighted regression.

When excluding the petroleum sector in the Carhart four factor model, the excess returns compared to the market (alpha) becomes even more positive and statistically significant at a 5% level within the equal weighted regression (table 5.12). It remains statistically insignificant in the value weighted regression. The added WML factor is like in the all industry regression statistically significant but at a 5% level within the regression excluding petroleum. This may imply that petroleum is potentially not priced as a sin stock.

Table 5.13: Fama French 5 factor model regression on EXCOMP excluding Petroleum

	Alpha	MKT-RF	SMB	HML	RMW	CMA
(1)	0.0031	0.0291	0.0761	0.2079	0.5017 .	-0.1498
(2)	-0.0010	0.1772 *	0.2704	-0.1023	0.5286	0.2481

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile MKT-RF describes the relative variation in the long-short- portfolios excluding the oil and gas industry together with the renewable energy sector compared to the market returns net of the risk free rate. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT-RF is the market beta, HML is beta depending on market capitalization, SMB is market price relative to book value, RMW is a measure of profitability and CMA is the measure of investments. (1) is the equal weighted portfolio regression including all industries, (2) is the value weighted regression.

Surprisingly, the time series regressions where the oil and gas sector is excluded is affected by the investment and profitability factor extension. The alpha in the equal weighted portfolio is no longer statistically significant, and the value weighted portfolio has a negative alpha very close to zero (Table 5.13).

Table 5.14: Fama French five factor model with and without BAB extension excluding oil and gas

Alpha	MKT-RF	SMB	HML	RMW	CMA	BAB
			Equal weighted regressions			
0.0031	0.0291	0.0761	0.2079	0.5017 .	-0.1498	
0.0036	0.0283	0.0636	0.2274	0.5362 .	-0.1594	-0.0959
			Value weighted regressions			
-0.0010	0.1772 *	0.2704	-0.1023	0.5286	0.2481	
-0.0007	0.1769 *	0.2639	-0.0921	0.5465	0.2430	-0.0499

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return relative to the market, meanwhile MKT-RF describes the relative variation in the long-short- portfolios compared to the market returns net of the risk free rate. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT-RF is the market beta, HML is beta depending on market capitalization, SMB is market price relative to book value, RMW is a measure of profitability and CMA is the measure of investments. The BAB factor captures the variation in the betas that the stocks have.

The alphas are not statistically significant in any of the time series regression including the BAB factor and excluding the oil and gas sector (table 5.14) similarly to the findings in the all-industry time series regression. The only statistically significant variables are MKT-RF in the value weighted regressions at a 5% significance level and RMW in the equal weighted regressions at a 10% significance level.

Table 5.15: Fama MacBeth regressions excluding oil and gas: 2008-2022

	(1)	(2)	(3)	(4)
Intercept	-0.0784***	-0.0711**	-0.0697	-0.0758***
SINDUM	0.0060 .	0.0051	0.0045	0.0041
LOGSIZE	0.0039***	0.0034***	0.0034***	0.0036***
LOGMB		0.0040**	0.0053**	0.0040*
RET			0.3023 .	
BETA1				0.7375 .
R^2	0.2077	0.2657	0.3023	0.3128

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. SINDUM is a dummy variable measuring the return of sinstocks excess of the comparable returns. LOGSIZE is the natural logarithm of firm i's market capitalization. LOGBM is the natural logarithm of firm i's market capitalization divided by its book value at end of year t. RET is the average monthly return of stock i during year t. BETA is the time varying beta of firm i calculated over the past three years. R squared captures the fit of the model (Hong & Kacperczyk, 2009).

The regression on traditional sinstocks when excluding oil and gas, is conducted in the same manner as in the regressions for all sinstocks. Due to insufficient number of observations in the dataset containing traditional sinstocks relative to risk factors included, the variable RET is excluded in the last regression. The sign on the intercept and the various variables remain the same when the regressions are conducted on the "traditional" dataset. BETA1 and RET become statistically significant at a 10% level meanwhile the intercept and LOGMB no longer are statistically significant at the same level as they were in the dataset including all industries. The most important change in the regression including only sinstocks is that the variable of interest (SINDUM) becomes positive. However, it is only statistically significant at a 10% level in the first regression and not in the other three. Adjusting for only LOGSIZE provides a positive alpha in the regression excluding oil and gas.

The alpha is statistically insignificant in all regressions including more firm characteristics.

Although some of the regressions exhibit statistically significant results we overall do not find enough evidence to conclude that excluding oil and gas changes the results notably and we therefore reject hypothesis 4.

5.9 Robustness and validity of model

The econometric approach used in the regressions is the Ordinary Least Squares (OLS) method. According to the Gauss-Markov theorem the following five assumptions must hold true in order for the OLS estimator to be considered the best linear unbiased estimator: I) Linear in Parameters, II) Random Sampling, III) No Perfect Collinearity, IV) Zero Conditional Mean, V) Homoscedasticity (Woolridge, 2021, p. 40-45).

Assumption I) is met as all the models are linear in the parameters and assumption IV) is met as the residuals are approximately normal. The latter is necessary to assume because exogenous explanatory variables are a critical criteria for the OLS estimator to be considered an unbiased estimator. As long as the sample size is large enough OLS will on average yield correct results although single iterations can deviate significantly from the true parameter (Woolridge, 2021, p. 82-83) and we can therefore say that assumption IV is met. We will now proceed with a selection of tests to check the remaining assumptions.

5.9.1 Heteroskedasticity and autocorrelation

The presence of autocorrelation entails that the error term has a degree of correlation with previous error terms. In order to test for this we run a Breusch-Godfrey test which tests the serial correlation in an autoregressive (AR(q)) model (Wooldridge, 2021, p. 406). Heteroskedasticity on the other hand entails that the variance of the error term is non constant and can be tested for by using a Breusch-Pagan test. The test here is H: ${\sigma^2}_a = 0$, where this result indicated no unobserved effect, in which case we should just use the OLS (Wooldridge, 2021, p. 473).

Autocorrelation is not present in any of the time series regressions. However, heteroskedasticity is present in most of both the equal weighted time series regressions and all the market weighted time series regressions containing traditional sin stocks only. The market weighted time series regressions containing all sin stocks have no heteroskedasticity except in those where the BAB-factor is introduced.

The issue with heteroskedasticity in the time series models (table 5.16 & table 5.17) has been handled by conducting robust time series regressions resulting in the same beta coefficients. It appears that heteroskedasticity does not affect our results and we do therefore disregard heteroskedasticity as an issue for our analysis.

Table 5.16: Autocorrelation and heteroskedasticity test for equal weighted regressions

	Equal weighted time series regressions			
	Autocorrelation		Heteroskedasticity	
	p-value <	Autocorrelation?	p-value <	Heteroskedasticity?
(1)	0.70	No	0.02	Yes
(2)	0.70	No	0.04	Yes
(3)	0.70	No	0.02	Yes
(4)	0.70	No	0.02	Yes
(5)	0.90	No	0.05	No
(6)	0.80	No	0.02	Yes
(7)	0.90	No	0.06	No
	Regressions on traditional sinstocks only			
(1)	0.60	No	0.01	Yes
(2)	0.60	No	0.01	Yes
(3)	0.70	No	0.01	Yes
(4)	0.70	No	0.06	No
(5)	0.70	No	0.06	No
(6)	0.70	No	0.01	Yes
(7)	0.80	No	0.05	No

Note: P-value below 0.05 suggests that either autocorrelation or heteroskedasticity is present in the regression. The numbers 1-7 indicate which regression model is being analyzed in table 5.18.

Table 5.17: Autocorrelation and heteroskedasticity test for market weighted regressions

	Market weighted time series regressions			
	Autocorrelation		Heteroskedasticity	
	p-value <	Autocorrelation?	p-value <	Heteroskedasticity?
(1)	0.60	No	0.40	No
(2)	0.60	No	0.80	No
(3)	0.40	No	0.70	No
(4)	0.50	No	0.80	No
(5)	0.40	No	0.50	No
(6)	0.50	No	0.01	Yes
(7)	0.40	No	0.03	Yes
	Regressions on traditional sinstocks only			
(1)	0.30	No	0.00	Yes
(2)	0.40	No	0.01	Yes
(3)	0.50	No	0.00	Yes
(4)	0.50	No	0.01	Yes
(5)	0.40	No	0.01	Yes
(6)	0.50	No	0.00	Yes
(7)	0.40	No	0.01	Yes

Note: P-value below 0.05 suggests that either autocorrelation or heteroskedasticity is present in the regression. The numbers 1-7 indicate which regression model is being analyzed in table 5.18.

Similarly we run Breusch-Godfrey and Breusch-Pagan tests for the Fama-Macbeth regression and observe that they are subject to both autocorrelation and heteroskedasticity (table 5.18). Autocorrelation implies that there is a degree of correlation between the residuals which in the context of Fama-Macbeth regressions suggests that the error terms are correlated across time. Heteroskedasticity on the other hand implies that the residuals are not constant which in the context of Fama-Macbeth causes the variance to change over time.

Table 5.18: Autocorrelation and heteroskedasticity test for Fama MacBeth regressions

	Fama-MacBeth regressions			
	Autocorrelation		Heteroskedasticity	
	p-value <	Autocorrelation?	p-value <	Heteroskedasticity?
(1)	2.20E-16	Yes	2.20E-16	Yes
(2)	2.20E-16	Yes	2.20E-16	Yes
(3)	2.20E-16	Yes	2.20E-16	Yes
(4)	2.20E-16	Yes	2.20E-16	Yes
	Regressions on traditional sinstocks only			
(1)	2.01E-06	Yes	2.20E-16	Yes
(2)	7.44E-06	Yes	2.20E-16	Yes
(3)	9.16E-06	Yes	2.20E-16	Yes
(4)	8.98E-06	Yes	2.20E-16	Yes

Note: P-value below 0.05 suggests that either autocorrelation or heteroskedasticity is present in the regression. The numbers 1-4 correspond to the numbers 1-4 in table 5.20.

5.9.2 Multicollinearity

Multicollinearity is the presence of severe correlation between independent variables in the regression. Although imperfect multicollinearity is not a direct violation of assumption III) it can make it difficult for the OLS estimator to distinguish between the effects from the different explanatory variables (Wooldridge, 2021, p. 313). In order to evaluate the correlation we will calculate the Pearson correlation coefficients.

Table 5.19: Pearson correlation coefficients for time series regressions

	MKT-RF	SMB	HML	RMW	CMA	BAB	WML
MKT-RF	1.00	0.09	0.38	-0.27	-0.24	0.01	-0.47
SMB	0.09	1.00	-0.03	-0.04	-0.26	-0.08	-0.01
HML	0.38	-0.03	1.00	-0.80	0.51	0.00	-0.51
RMW	-0.27	-0.04	-0.80	1.00	-0.42	0.08	0.38
CMA	-0.24	-0.26	0.51	-0.42	1.00	-0.01	0.02
BAB	0.01	-0.08	0.00	0.08	-0.01	1.00	0.08
WML	-0.47	-0.01	-0.51	0.38	0.02	0.08	1.00

Note: The table shows the correlation between the factors used in the conducted time series regressions.

The definition of what is considered a too high absolute value for the coefficients has no uniform definition and researchers use different thresholds. However, according to Kumari (2008), a correlation between two regressors is considered to be high when it exceeds |0.8| and multicollinearity may affect the statistical power of the regression models in a problematic way at this point. In absolute values we find the highest correlation coefficient between the Fama French factors HML and RMW with a value of -0.8 which indicates the presence of a strong negative linear relationship which may cause a problem with multicollinearity. The correlation coefficient between the HML and CMA factors have the second highest absolute value of 0.51 which indicates a moderate positive linear relationship. This is in line with the research from Fama & French (2015) stating that growth firms typically tend to have more aggressive investment profiles, whereas value firms usually tend to follow more conservative investment strategies. The remaining coefficients all have weak or weak to moderate linear relationships.

Chapter 6 - Conclusion

This thesis has focused on uncovering whether there is a sin stock premium present in the Nordic markets or not. Before conducting any risk adjustments we find that the value weighted comparable portfolio has outperformed the value weighted sin stock portfolio in terms of total return due to a substantial return which the petroleum peer sector provides in combination with its high market capitalization. Meanwhile, the equal weighted sin stock portfolio has outperformed the comparable portfolio when looking at accumulated returns across the entire time period.

Contrary to the findings of Hong & Kacperczyk (2009), we find no statistical evidence of the existence of a sin stock premium when adjusting for risk with the Fama-French three-factor model and the Carhart four-factor model due to the lack of statistically significant alphas in the results. This applies to both the equal and value weighted models and we therefore reject hypothesis 1 on all the significance levels we have used (1%, 5% and 10%).

Whereas Blitz & Fabozzi (2017) found that the new Fama French factors of investment and profitability explain abnormal returns, our findings do not align due to the lack of statistical significance in our results. Furthermore, for the same reasons we fail to conclude that the BAB factor extension helps to capture some of the variation in the model in contrast to the research from Frazzini & Pedersen (2014). This applies to both the equal and value weighted models and subsequently we reject hypothesis 2 on all significance levels.

Contrary to Hong & Kacperczyk (2009), the SINDUM variable is only statistically significant at the 10% level in the Fama-Macbeth regression when the regression is conducted with the LOGSIZE variable. Furthermore, the SINDUM variable is negative. When additional variables are included, the SINDUM variable is no longer statistically significant. Following this we reject hypothesis 3 on all significance levels.

When excluding the oil and gas sector along with the comparable sector we observe some changes in the results. The equal weighted time series regressions consisting of the Carhart four-factor model and the Fama French three-factor model with the BAB factor extension have statistically significant alphas at the 5% and 10% levels respectively. Furthermore, the Fama Macbeth regression excluding oil and gas together with its comparable sector exhibits similar results to the model including all sectors and the SINDUM variable is statistically significant at the 10% level when LOGSIZE is included, however with a positive sign this time. As with the model in hypothesis 3 the statistical significance of the SINDUM variable disappears when additional variables are included. However the changes are minor and do not alter our previous conclusions, leading us to reject hypothesis 4 on all significance levels.

In summary, due to a lack of statistical significance across all models, we find no statistical evidence supporting the existence of a sin stock premium in the Nordic stock markets with the risk adjustment models used in this thesis.

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Appendices

Appendix A. Overview of stocks

Below is an extensive list of all sin stocks and comparable stocks used in this master thesis.

Alcohol	Alcohol - peer	Casino	Casino - peer	Defense	Defense - peer	Petroleum (1)	Petroleum (2)	Petroleum - peer	Petroleum - peer (2)	Tobacco	Tobacco - peer
RBREW.CO	OTLY.OQ	ACROUD.ST	HKY.OL	AACM.ST	CGCBV.HE	ABL.OL	MAHAa.ST	ABSO.ST	SAXGR.ST	HAYPP.ST	ORK.OL
CARLb.CO	OLVAS.HE	ANGLR.TE	PANDXb.ST	ASTRO.OL	HEXI.ST	AKER.OL	MASIb.BQB	ASAB.ST	SCATC.OL	STORG..CO	PREU.ST
HARBb.CO		BLICK.TE	PARKEN.CO	AVTCHb.ST	INSPL.ST	AKRBP.OL	NORAM.OL	AEGA.OL	SUST.NGM	SWMA.ST	
ALEFRM.CO		KINDsdb.ST	REATO.ST	FINGb.ST	MBRS.NGM	AKSOA.OL	NORDIC.CO	ALFA.ST	STRLNG.ST		
ANORA.HE			GOTLb.ST	GOMX.ST	NORSEI.TE	ARCHA.OL	NORTH.OL	ALTA.OL	SYSR.ST		
OLGERD.IC			SHOTE.ST	GUGEO.ST	OX2SE.ST	ATLA.CO	NOL.OL	ARISE.ST	TULAV.HE		
KOBR.NGM			VIK1V.HE	HEXAb.ST	OXEMA.ST	AVENIR.NFF	NOR.OL	ASTK.OL	WMA.CO		
UMIDAb.TE				IDEX.OL	PON1V.HE	BORR.OL	OTS.OL	BEIJb.ST	ZAZZb.ST		
MACKb.ST				KOG.OL	SCAPE.CO	BWE.OL	OKEA.OL	CLOUD.OL			
VIVA.ST				NEXT.OL	STWA.ST	BWIDL.OL	OET.OL	CAPSL.OL			
HIGHCOb.ST				NORBT.OL	SEAW7.OL	BWO.OL	ONOF.NFF	EASYb.TE			
ARCTIC.ST				ASTOR.TE	VWS.CO	COOL.OL	PENR.OL	ECCb.ST			
				SEYE.ST	WRT1V.HE	CRWEN.NGM	PSE.OL	ECOM.TE			
				TEQ.ST		DNO.OL	PNO.NFF	ENRAD.TE			
				TOBII.ST		DOF.OL	PNOR.OL	ESGRb.TE			
				UNIBAP.ST		DOFI.NFF	PSIBb.BQB	LIFA.HE			
				ZWIPEZ.OL		ECOT.NFF	PGS.OL	LAIR.NGM			
						EIOF.OL	PRSO.OL	LIAB.ST			
						EMGS.OL	REACH.OL	MINEST.ST			
						EQNR.OL	SBX.OL	MPCES.OL			
						RISH.OL	SEAPT.OL	MTRS.ST			
						GEOS.OL	SDRL.OL	NMAN.ST			
						HAVI.OL	SHLF.OL	NIBEb.ST			
						HRGI.OL	SIOFF.OL	NSOL.OL			
						ABIG.TE	SOFF.OL	OSUN.OL			
						IOTA.NFF	SUBC.OL	ORRON.ST			
						IPCOR.ST	TETY.ST	PURMO.HE			
						IOX.OL	TRMDa.CO	QAIR.ST			
						JACK.NFF	VAR.OL	SALTb.ST			

Note: The table shows the companies referred to by tickers that are included in this master thesis. They are categorized within their industry.

Appendix B. Correlation matrices

The table below illustrates the correlation between all the different sectors.

	Alcohol	Alcohol - peer	Casino	Casino - peer	Defense	Defense - peer	Petroleum	Petroleum - peer	Tobacco	Tobacco - peer
					Equal-weighted sectors					
Alcohol	1.0000									
Alcohol - peer	0.3075	1.0000								
Casino	0.1987	0.1620	1.0000							
Casino - peer	0.2269	0.1602	0.1854	1.0000						
Defense	0.3452	0.3110	0.1546	0.1387	1.0000					
Defense - peer	0.4720	0.3579	0.2496	0.3469	0.5115	1.0000				
Petroleum	0.4048	0.2405	0.2647	0.2807	0.4095	0.5067	1.0000			
Petroleum - peer	0.4869	0.4300	0.2308	0.3780	0.5146	0.7034	0.5953	1.0000		
Tobacco	0.2694	0.1663	0.1205	0.0244	0.1265	0.0888	0.1667	0.1843	1.0000	
Tobacco - peer	0.2848	0.2079	0.1069	0.0201	0.3606	0.3153	0.3002	0.3457	0.1202	1.0000
					Market-weighted sectors					
Alcohol	1.0000									
Alcohol - peer	0.2202	1.0000								
Casino	0.1921	0.0561	1.0000							
Casino - peer	0.3118	0.1650	0.1847	1.0000						
Defense	0.4257	0.3255	0.2112	0.2411	1.0000					
Defense - peer	0.3510	0.3569	0.2341	0.3011	0.5496	1.0000				
Petroleum	0.3255	0.1849	0.2195	0.1669	0.3458	0.3024	1.0000			
Petroleum - peer	0.4422	0.3101	0.2714	0.3840	0.5330	0.5109	0.4754	1.0000		
Tobacco	0.2056	0.1299	0.1085	0.1301	0.1749	0.0598	0.1032	0.1929	1.0000	
Tobacco - peer	0.2708	0.1709	0.0484	0.0749	0.2209	0.2769	0.1366	0.1992	0.0339	1.0000

Note: The table shows how the equal weighted and market weighted sectors correlate with each other.

Appendix C. Time series regression results

The tables below pools together all time series regression results to facilitate comparison.

Alpha	MKT-RF	SMB	HML	WML	RMW	CMA	BAB
Equal weighted regressions (all industries)							
0.0021	0.0376						
0.0020	0.0357	0.0690					
0.0020	0.0400	0.0670	-0.0227				
0.0031	0.0114	0.0689	-0.0935	-0.1289			
0.0006	0.0295	0.0834	0.2025		0.4399 .	-0.0421	
0.0023	0.0403	0.0622	-0.0229				-0.0365
0.0009	0.0290	0.0761	0.2140		0.4602 .	-0.0478	-0.0564
Equal weighted regressions (excluding oil and gas)							
0.0048 .	0.0405						
0.0047 .	0.0382	0.0824					
0.0046	0.0547	0.0745	-0.0883				
0.0062 *	0.0133	0.0773	-0.1911	-0.1871 *			
0.0031	0.0291	0.0761	0.2079		0.5017 .	-0.1498	
0.0051 .	0.0553	0.0652	-0.0888				-0.0711
0.0036	0.0283	0.0636	0.2274		0.5362 .	-0.1594	-0.0959
Value weighted regressions (all industries)							
-0.0018	-0.0141						
-0.0020	-0.0185	0.1571					
-0.0019	-0.0311	0.1631	0.0673				
-0.0012	-0.0494	0.1643	0.0219	-0.0825			
-0.0032	-0.0158	0.2068	0.1821		0.35972	0.1445	
-0.0023	-0.0317	0.1717	0.0677				0.0654
-0.0035	-0.0153	0.2137	0.1712		0.3404	0.1499	0.0536
Value weighted regressions (excluding oil and gas)							
0.0015	0.1079						
0.0013	0.1016	0.2229					
0.0010	0.1498 *	0.2002	-0.2571 .				
0.0013	0.1408 .	0.2008	-0.2793 .	-0.0404			
-0.0010	0.1772 *	0.2704	-0.1023		0.5286	0.2481	
0.0011	0.1501 *	0.1962	-0.2573 .				-0.0309
-0.0007	0.1769 *	0.2639	-0.0921		0.5465	0.2430	-0.0499

Note: Significance levels: . > p < 0.1 * > p < 0.05; ** > p < 0.01; *** > p < 0. Alpha measures the monthly excess return on EXCOMP relative to the market, meanwhile the beta describes the relative variation in the sinstock- portfolios compared to the comparable portfolios. Alpha is the intercept of the model and may be interpreted as excess return of portfolio, MKT is market beta, HML is beta depending on market capitalization, WML is a momentum factor that measures the performance of stocks the last 12 months, SMB is market price relative to book value. RMW is a measure of profitability and CMA is the measure of investments. The BAB factor captures the variation in the betas that the stocks have.

Appendix D. Factor statistics

The table below contains descriptive values for each of the factors used in the time series regressions.

Factors	Average	Median	Max	Min
MKT-RF	0.0051	0.0077	0.1660	-0.2200
SMB	0.0013	0.0014	0.0472	-0.0506
HML	-0.0003	-0.0011	0.1209	-0.1130
WML	0.0074	0.0098	0.1014	-0.2609
RMW	0.0034	0.0038	0.0409	-0.0540
CMA	-0.0002	-0.0003	0.0543	-0.0439
BAB	0.0066	0.0067	0.0807	-0.1028

Note: The table shows the average, median, maximal and minimal value of each factor used in the time series regressions.