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Why Does It Feel So Good To Be Bad?

An empirical analysis of traditional and modern sin stock returns in developed countries from January 2000 to August 2022

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Executive Summary

This study aims to give managers and investors a better financial basis to assess whether they should be exposed to sinful companies. Accordingly, this thesis examines the presence of alpha for sin stocks in developed countries between January 2000 to August 2022. The study expands on previous research and applies a contemporary definition of the sin industry that considers oil and gas companies. Additionally, the study expands the observation period and the geographical area beyond what has already been done and includes stricter stock criteria. With 412 identified stocks for developed countries, this thesis has one of the most extensive sin stock samples to be analysed to date.

Multi-factor models are applied to control for risk exposure variations between different value-weighted portfolios. We estimate alphas by exploiting a long-short investment strategy by which we are long sin and 1) short in the market and then 2) short in the comparable portfolio.

Our results demonstrate an economically large and statistically significant alpha for both the traditional and modern sin portfolio in excess of the market. The market risk-, profitability, and investment factors explain the abnormal returns to some extent. Among the traditional sin industries, gambling offers the highest alpha. However, the other industries also outperform the market. For modern sin stocks, the value factor is crucial in explaining abnormal returns over the entire period. Results detect an increase in modern sin stock alpha ex-post the divestment movement, where the profitability factor explains some of the return premium. When we apply the second long-short investment strategy for both traditional and modern sin stocks we find no evidence of alpha. Thus, investors might earn a similar risk-adjusted return if they invest in a comparable portfolio. Nevertheless, the expected excess return over market return is more remarkable for sin stocks when compared against the non-sinful companies.

Key words - *Sin stocks, Alpha Alcohol, Tobacco, Gambling, Oil and Gas, SRI, Divesting, Exclusion, Undervalue, CAPE*

Preface

This thesis was written as a final part of our master's degree in financial economics at the Norwegian School of Economics (NHH) during the fall of 2022. It has been an enriching experience from which we developed our personal and academic abilities. The thesis' subject was suggested by the authors and reflects our interest for the financial markets.

The process of writing this thesis has been a humbling exercise in persistence, and we have developed a profound respect for the effort it takes to produce presentable and reliable results. We thank NHH for providing access to databases and literature that have been important for our research. The scope of our data set would not have been possible without the employed databases.

We wish to express our sincere appreciation to our supervisor Jørgen Haug for giving us thorough and constructive guidance throughout the process of writing our thesis. His feedback has truly been valuable. Finally, we thank each other for a great and enjoyable partnership. This has been a rewarding learning experience.

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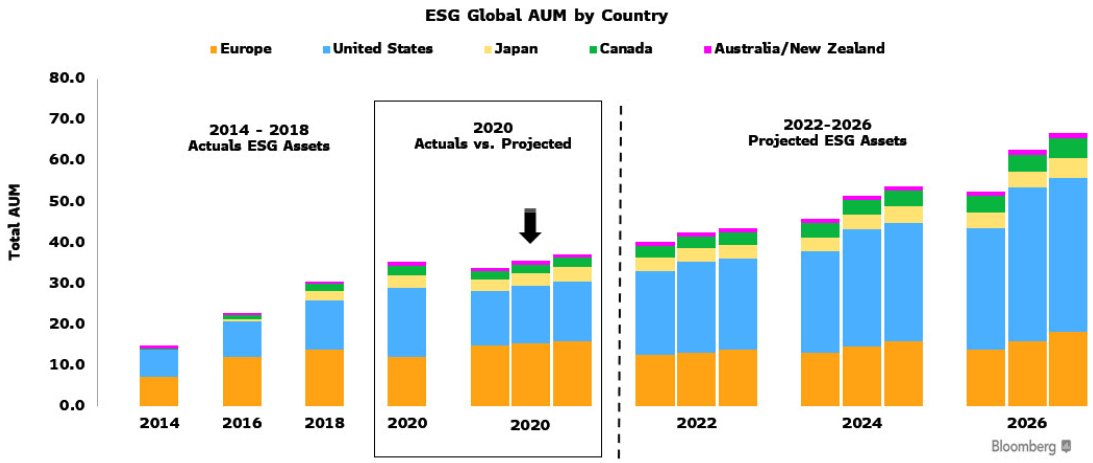
1. Introduction

Over the recent decade, socially responsible investing (SRI) awareness has significantly increased. Bloomberg Intelligence Estimates (2022) estimate ESG[1] investments to reach 41 trillion USD by the end of 2022, an increase of 75% from 2014 (see Figure 1.1). On the other side of the investment universe, we find sinful investing, an investment strategy where capital is allocated to firms involved in unethical or sinful activities (Kenton, 2020b). Traditional sin stocks can be defined as the "Triumvirate of sin", including alcohol, tobacco, and gambling companies. While these industries have been considered unethical for a long time, a heightened global effort towards lowering the planet's carbon footprint has paved the way for a broadened understanding of the sin industry (Sainsbury, 2020). Accordingly, this study expands on previous research by applying a modern definition of a sin industry that includes oil and gas companies. Thus, this thesis investigates the performance of traditional and modern sin stocks.

Figure 1.1: ESG Global Asset Under Management by country



Source: Bloomberg Intelligence Estimates, 2022

The choice of topic for this thesis was motivated by the recent divestment trends towards sin stocks. The growing amount of SRI challenges the traditional investment strategy. While "finance as usual" seeks to maximise shareholder wealth, SRI attempts to generate value by choosing to invest in businesses that also address societal issues (Schoenmaker & Schramade, 2018). With the growing SRI campaign, investor perceptions of sin industries may have changed over time. These

[1] Environmental, Social, and corporate Governance.

anticipated modifications in shareholder attitudes were key to why we chose to study the stock performance of the modern sin industry.

Investors are attracted to sin investments because they believe they will generate abnormal returns, known as the sin premium (Kenton, 2020b). Several hypotheses explore why sin stocks would offer such abnormal returns. Some highlight that investors shun sin stocks to the extent they offer alpha. Others note that investing in sin stocks causes reputational damage (Blitz & Fabozzi, 2017) or litigation risk (Fabozzi, Ma & Oliphant, 2008)[2]. Nevertheless, some assume that the increased risk results in an increased return. Moreover, some investors associate the sin stock premium with the very nature of the sin industries, in that such products and services tend to be addictive, resulting in a constant demand and steady cash flows (Kenton, 2020b).

With this in mind, this study dives into the presence of a sin stock alpha in developed countries and investigate whether sin stocks outperform the market and non-sinful comparable stocks offering alternative products or services. The excerpts from Hong and Kacperzyk (2009) and Blitz and Fabozzi (2017) show no lack of contradicting empirical studies on the topic. Hong and Kacperzyk (2009) and Blitz and Fabozzi (2017) have some differences in content, but there were also similarities. Both agreed that sinful investors might demand a sin stock premium. This leads us to the first hypothesis:

Hypothesis I: Traditional Sin Stocks Offer Alpha

Previous sin stock literature claims that what people consider sinful is constantly changing. The oil and gas industry contributes to a large share of the world's Co2 emissions, leaving the industry one of the most despised today. Hence, oil and gas stocks are increasingly exposed to negative screening and exclusion. Consequently, we present our second hypothesis:

Hypothesis II: Modern Sin Stocks Offer Alpha

To examine the presence of alpha that relates specifically to traditional sin stocks (I), we control for exposures to different asset pricing factors. Our results suggest that traditional sin stocks outperform the market, which is consistent with the prior findings of Hong and Kacperczyk (2009) and Fabozzi, Ma, and Oliphant (2008). However, it contradicts the findings

[2] Litigation risk implies to the risk that arises due to changes in regulations or laws that affect a stock, company, sector or market (Hayes, 2018).

of Blitz and Fabozzi (2017). When conditioning the preceding analysis on industries, we find evidence that all traditional sin industries outperform the market. In addition, there is insufficient evidence to conclude that traditional sin stocks outperform modern sin stocks, as the alpha becomes insignificant after testing for the momentum-, profitability- and investment factors. We find these results interesting as traditional sin stocks are often associated with higher investment risk, while most investors consider the non-sin comparable less risky (Levitt, 2021). Thus, we expected the traditional sin portfolio to yield higher returns than the comparable portfolio. Nevertheless, we conclude a larger economic alpha at a higher significant level for the traditional sin portfolio relative to the comparable portfolio. The latter findings also apply to the industry-divided portfolios.

We extend our research and test whether modern sin stocks offer alpha (II). We study the stock returns of oil and gas companies relative to the market and selected comparable companies. The results indicate that modern sin stocks offer alpha compared to the market. Another important finding is that the modern sin stock alpha increases economically and statistically[3] when comparing ex-ante and ex-post the divestment movement's regression results[4]. Consequently, our findings support the hypothesis of a modern sin industry, indicating that investors shun oil and gas related-stocks, outperforming the market and offering alpha. However, our findings indicate that the modern sin portfolio does not offer alpha relative to the comparable portfolio.

Our work relates to previous research on sin stock alpha. This paper is not a direct replica of a specific paper, but a summary of initial ideas gathered from various researchers. Hong and Kacperczyk (2009) discovered that sin stocks offer alpha relative to comparable portfolios. They argue that investors who avoid investing in sin stocks pay a substantial financial cost as they sacrifice excess return in exchange for doing what some of the world's largest international institutions consider ethically correct. On the other hand, Blitz and Fabozzi (2017) provides a contradictory conclusion. They discovered that the profitability and investment factors fully explain sin stock returns. More recently, Bolton and Kacperczyk (2021) presented evidence of alpha for stocks of companies with higher carbon emissions. Bolton and Kacperzyk's (2021) findings inspired our second hypothesis.

This study contributes to the existing literature by applying a contemporary definition of a sin industry, which includes oil and gas- related companies. In addition, we broaden the observation

[3] Statistical significance refers to a p-value below 5% throughout the rest of the thesis
[4] Ex-ante and ex-post the divestment movement in defined as the period from January 2000-December 2014 and January 2015-August 2022. See hypothesis 2, page 43.

period and the geographic scope beyond the previously conducted research and incorporate stock-selection criteria. Moreover, the study's data has been thoroughly adjusted for misclassifications in popular databases that may have impacted earlier studies. This thesis has, to the best of our knowledge, one of the most extensive sin stock samples to be analysed to date.

In our perspective, the topic is interesting as the studies on sin stock returns offer conflicting conclusions. Stock discussions often revolve around SRI concerns and whether to invest in morally "good" or "bad" equities. Proof of abnormal returns could thus alter investors' understanding of investments in sinful companies. Additionally, we believe that shedding light on the performance of both traditional and modern sin stocks could be a wakeup call for many investors. Perhaps it will not always pay to do the morally or ethically right thing.

The analysis will employ Thomson Reuters' Datastream, Refinitiv and Kenneth French's Data Library. This thesis focuses on four sin stock categories: alcohol, tobacco, gambling, and oil and gas. The time frame ranges from January 2000 to August 2022. We compare traditional sin stocks with food, soda, fun, meals, and hotels, while modern sin stocks are compared against renewable energy companies. Since companies are analysed over a 22-year span, both listed and delisted companies are considered. Building on previous research, the study analyses the portfolios by going long in the sin portfolios and 1) short in the market and 2) short in the comparable portfolios.

The remainder of this thesis is organized as follows: Section 2 introduces the sin stock premium and presents relevant literature. Section 3 describes the data used in our analysis and potential concerns. Section 4 presents the methodology, and section 5 provides the results of our analysis. Section 6 discusses the paper's limitations and suggests further research. Lastly, section 7 provides a conclusion for the study.

2. Theoretical Framework and Literature Review

The purpose of this section is to provide the reader with the theoretical framework implemented to comprehend our findings. Firstly, the section discusses the main essence of SRI. Next, we define traditional sin stocks and introduce a new modern sin industry. Further, it encompasses relevant portfolio theory. Then, the section seeks to explain how investors believe they may earn abnormal returns via a sin stock premium. Lastly, this section presents a review of the existing literature on the subject.

2.1 Socially Responsible Investing (SRI)

Socially responsible investment (SRI) is the process of integrating social and environmental goals into investment decisions (Sparkes & Cowton, 2004; Schueth, 2003). To our paper's relevance, SRI includes abstaining from investing in companies producing or selling addictive products like alcohol, tobacco and gambling (Chen, 2020). An increasing number of financial investors base their investment decisions on sustainable considerations. Nevertheless, it is rather challenging to define SRI as there is no consensus on what is ethically or socially good. Additionally, the definition changes over time as social standards do. Chen (2020) presents two goals of SRI, which do not necessarily go hand in hand: social impact and financial gain.

As Fries (2022) reveals, SRI started evolving hundreds of years ago. In the 1700's, a religious society group known as "Quakers" rebelled against weapons and the slave trade. Later, in 1750, John Wesley penned a text in which he asserted that earning money for the welfare of another person should be considered a sin. In particular, he advised against participating in gambling and other industries that could cause harm to others. As a result of John Wesley's ideologies, investors and companies were divested from their investments in South Africa due to the apartheid policy. Their efforts significantly contributed to the end of apartheid and racial discrimination in 1994.

ESG and SRI are terms that tend to be used conversely. The terms do, however, have some important differences in meanings. While ESG measures the company's environmental, social, and governance practices, SRI means using a screening process that enables investors to determine investments based on specific ethical criteria. SRI is often considered by investment professionals in the context of ESG factors for investing. Accordingly, focusing on ESG factors is one approach to SRI.

SRI typically employs four fundamental approaches: negative screening, positive investing, community investing, and shareholder action. Negative screening means divesting money from companies considered sinful, while positive inventing means investing in companies that contributes to the wellness of people and the earth. Accordingly, this paper investigates the existence of a premium investors demand when investing in sin stocks. Furthermore, community investing is an additional category in terms of responsible investing. The category includes providing loans to those without the opportunity to attain them; and financing projects in lower-class areas. Lastly, shareholder action may occur when investors provide management with resolutions (e.g., environmentally friendly) on how to run the company (Fries, 2022).

2.2 An Introduction to Sin Stocks

2.2.1 Traditional Sin Stocks

Luo & Balvers (2017) defines sin stocks as public companies that engage in socially or morally offensive activities, whereas Blitz and Fabozzi define sin companies as "companies directly involved in the alcohol, tobacco, gambling, or weapons industries". Following Hong and Kacperzyk (2009), we refer to traditional sin stocks (alcohol-, tobacco, and gambling[5]), as the "Triumvirate of Sin." Some may view these three industries as sinful due to their addictive tendencies and social implications when consumed extensively. Thus, investors who value ethical and moral rights principles tend to exclude sin stocks from their portfolios.

The definition of sin stocks has gradually evolved. Since social norms generally change over time, the recognition of sin stocks also changes. For example, the public listing of cannabis companies was unlikely decades ago, however, it is legalized today in major parts of the United States and other developed countries. What one may consider sinful is somewhat subjective and tends to rely on the investors' political, religious, and ethical views.

2.2.2 Modern Sin Stocks

The oil and gas industry is one of the largest industries in the global economy, with a market size of 5 USD trillion in 2022 (IBISWorld, 2022). In addition to its abnormal profits, the industry is vital due to its crucial energy security and central role in wars and conflicts. In 2021, oil and gas were considered the most prominent energy source in the world. Despite its importance, oil and gas extraction and use contribute a significant portion of the world's Co2 emissions, making it one of the most reviled industries in today's world. Indeed, a recent report by Scott and Pickard (2021) revealed that oil and gas were directly or indirectly responsible for 40% of global greenhouse gas emissions in 2017.

In view of the foregoing, oil and gas companies are today confronted with the same economic-, political- and social issues as tobacco companies were 50 years ago (Hong & Kacperczyk, 2009). Franta (2017) describes the divestment movement toward fossil fuel stocks as the fastest-growing divestment movement in history. Ever since the divestment movement escalated in 2015, investors and institutions have sold fossil fuel stocks to instead invest in other environmentally

[5] Gaming is included in our value-weighted gambling portfolio.

friendly investments. Blitz and Swinkels (2021) identify 11 industries as potential exclusion candidates, including oil and gas. Previous studies have recommended the oil and gas industry as a sin stock company for further research. Thus, this study investigates the oil and gas industry by introducing a newly developed modern sin industry.

2.2.3 Differences Between Traditional and Modern Sin stocks

There are some variations between the traditional sin industry and the modern sin industry which might affect the extent of alpha, presence and magnitude. An important distinction between the traditional and modern sin industries is that we currently depend in oil and gas as an energy source, whereas we are hardly dependent on alcohol, tobacco, or gambling. The traditional sin industries impose a substantial social cost that can only decrease by reducing demand for these sinful products. Carbon emissions through the use and production of oil and gas impose a substantial social cost. To avoid exclusion by "green" investors, oil and gas companies may therefore seek to transition to more environmentally friendly companies (Heinkel et al., 2001). Additionally, the industries have varying degrees of market exposure (Statista, 2022). Whereas traditional sin stocks have been shunned for years, modern sin stocks have more recently been exposed to negative screening. Lastly, the oil and gas industry accounts for a larger equity market share than the traditional sin industry (Statista, 2022).

2.3 Portfolio Theory

A common assumption within finance theory is that investors only have one goal: to maximize future expected wealth (Markowitz, 1952). Established by Markowitz (1952), the portfolio theory assumes homogenous investors with return-risk preferences. Following Markowitz (1952), when constructing a portfolio, investors desire to diversify their portfolio by holding a stock position in the market, i.e., constructing a value-weighted portfolio of all public stocks. Thus, according to theory, both neutral and sin investors[6] should hold the market portfolio[7] if they desire to maximize the returns, given their risk profile.

Exclusionary investing causes investors to evolve less homogenous since some investors restrict their investment universe. Based on Markowitz's portfolio theory (1952), exclusionary investing cannot be financially beneficial since it lowers the investor's efficient frontier. Therefore, exclusion

[6] Neutral investors refer to those who do not execute exclusionary investing. Sin investors refer to investors who execute exclusionary investing.

might raise risk and diminish return, damaging the exclusionary investors. Nevertheless, only some investors are concerned with financial return (Schoenmaker & Schramade, 2018). Therefore, additional factors, such as SRI, might affect investor behavior (Geczy et al., 2005).

Exclusionary investment causes demand discrepancies between excluded and non-excluded companies, resulting in excess demand for non-excluded firms (Dam & Scholtens, 2015; Fama & French, 2007; Heinkel, Kraus, & Zechner, 2001). In contrast, excluded stocks might face a scarcity of demand, meaning underpriced equities and restricted risk-sharing opportunities for "neutral" investors who hold these stocks (Merton, 1987). As a result, "neutral" investors require a return premium on the excluded stocks.

Stocks of firms that experience decreased demand due to exclusionary investment must provide greater returns, i.e., a stock premium. This risk premium might be interpreted in a variety of ways. In the following, we present different explanations for the sin premium.

2.4 The Sin Stock Premium

Hong and Kacperzyk (2009) claims that investors earn a premium through larger returns, by holding sin stocks. Hence, a financial gain might accumulate for not corresponding to social standards, thus earning a reputation risk premium. However, there is no consensus in the literature on whether a sin stock premium exists. This section will emphasize some of the arguments for why investors believe investing in sin stocks might yield positive, abnormal returns, i.e., offer alpha.

Some studies believe that investors favour sin stocks due to the dividends these companies pay out. Since tobacco, alcohol and gambling products have addictive tendencies, demand for these products is independent of economic trends. Additionally, the world relies on oil and gas as the main energy source. Thus, these industries are often referred to as “defensive stocks”. Accordingly, the companies within these industries generates stable earnings and income, enabling them to pay dividends to their shareholders. Colonello et. al (2019) investigate the substitution and complementarity between dividends and ethical investments. They suspect that investors weight their preferences for dividends after how socially responsible the companies are. Since SRI investors “refuse” to hold sin stocks, the sin stock premium is often identified as a “boycott risk factor” (Luo and Balvers, 2017). In other words; sinful companies must promise higher returns

to appeal to a larger investor base. They find empirically and theoretically that investors trade dividends for ethicality. Thus, substituting ethical considerations with dividend payouts.

A common explanation for the observed abnormal returns of sin stocks is that they are undervalued since so many investors shun them. Both Fabozzi, Ma & Oliphant 2008 (2008), Hong and Kacperzyk (2009), and Blitz and Fabozzi (2017) present a systematic undervaluation of sin stocks as a potential suggestion for abnormal returns. Simultaneously, Killins, Ngo, and Wang (2021) dedicate an entire study to the latter in their paper "Underpricing of Sin Stocks." They find that sin stock IPOs are undervalued to a greater degree relative to other IPOs, hence enabling investors to gain unique return characteristics. Accordingly, investors who manage to ignore other people's opinions regarding sin stocks might earn a reputational risk premium. Having mentioned the above, we believe that a historical and/or recent undervaluation of sin stocks has caused abnormal returns. We will, however, not test this empirically, but a suggestion for further research can be found in section 6.

An additional explanation is that sin stocks might benefit from monopolistic returns. Most people recognize these industries as strictly regulated markets with high entry barriers. The tobacco- and alcohol industry is regulated with an advertisement ban, shielding the companies within these industries from potential competitors (Saffer, 2004). It tends to be relatively difficult to gain market share from the already established players who have benn operating before the implementation of an advertisement ban as a newly established company in these market. Indeed, the alcohol and tobacco industry are somewhat oligopolistic with a large market share concentration (see figure 4.1). Accordingly, a small number of major players are acquiring smaller companies and benefiting from the limited competition in the industry.

2.5 Literature Review

Hong and Kacperzyk (2009) are among some of the most cited authors of sin stock studies. They provided a study of publicly traded sin stocks within the alcohol, tobacco and gambling industries. In doing so, they analysed the returns of these stocks based on a dataset of companies listed in the U.S. market. Their central hypothesis was that social norm exists on the contradiction of investing in companies promoting immorality. Accordingly, they argue that some investors, mainly institutions, pay a financial cost when excluding these stocks. Hence, investors holding these stocks are rewarded with additional returns. Following their hypothesis, they found that norm-constrained institutions hold fewer sin stocks. They identify an undervaluation of sin stocks

due to social norms. Their findings are lower P/E and P/B multiples relative to their comparables. Furthermore, they discovered that sin stocks have higher expected returns than their comparables (Hong & Kacperzyk, 2009).

Fabozzi and Oliphant (2008) conducted a study to evaluate sin stock performance. The study presented empirical evidence of sin stock outperformance relative to the market on a risk-adjusted basis. Fabozzi and Oliphant (2008) added value to the existing literature by including U.S. and non – U.S. firms, covering six sin industries. Besides covering the Triumvirate of sin, they study adult services, weapons, and biotech alterations. Using CAPM, they found that the sin portfolio yielded an annual return of 19%, thus outperforming the comparables. They discovered some reasonable explanations for the excess returns. They further claimed another explanation might be that it costs to maintain social standards, leaving the sin companies with one expense less than those striving to accomplish ESG criteria. Further, other studies found that sin stocks generally have been undervalued due to some investors' negative impact (Salaber, 2007). Analyzing the identified monopolistic characteristics within the sin companies, they found evidence of positive, risk-adjusted returns. They concluded that excluding sin stocks is the least effective approach regardless of the effort invested in maintaining social values.

Other authors emphasizing sin stock performance are Blitz and Fabozzi (2017). In 2017, they published a revised study of the sin stock anomaly. Their analysis includes a dataset from July 1963 to December 2016, including companies listed in the United States, Europe, Japan, and global markets (Blitz & Fabozzi, 2017). These companies operate in the alcohol-, tobacco- and gambling industries. They discovered that the performance of sin stocks could be fully explained by the two quality factors in the Fama-French five-factor model: profitability and investment. Further, they found that the alpha decreased for every additional asset pricing factor included in the model. The study found no evidence that sin stocks deliver a premium after controlling for their exposure to these factors. Blitz and Fabozzi (2017) further emphasize that what is considered sinful could change with time due to altering social norms, industries, and company operations. They highlight how investors increase their focus on SRI and set exclusion policies to reduce their investments in stocks with higher carbon emissions.

There is, to our knowledge, hitherto no established studies on the existence of alpha for modern sin stocks. However, the "modern sin industry" assumption is supported by Blitz and Fabozzi (2017) in their claim that the understanding of "sinful" is not fixed. Rather, it is a changing conception that varies in time. Through increased awareness of SRI, firms are incentivized to reduce their carbon footprint, thus improving their ESG profile. The definition of sinful, and

consequently – which firms are perceived as "sinful" will therefore vary according to current trends and perceptions in the market.

Following this logic, Blitz and Swinkels (2020) equate the lowest-scoring ESG firms to traditional sin stocks. As oil and gas companies tend to have weak ESG ratings, one may equate these companies with traditional sin stocks and thus argue that they are a modern type of sin stocks.

Trinks et al. (2018) compare fossil fuel portfolios to non-fossil fuel portfolios to examine the exclusion effect on risk-adjusted abnormal returns. They posit that eliminating fossil fuel equities from the investable universe imposes a financial penalty regarding missed profits (following Markowitz's (1952) portfolio theory). Furthermore, Bolten and Kacperzyk (2021) discuss whether carbon emission affects stock return and how the market responds to climate risk. They provided economic and statistical evidence that stocks of companies with higher carbon emissions generate greater risk-adjusted returns. Interestingly, In et al. (2019) discovered the opposite; they found that stocks of firms with low carbon emissions outperformed those with high carbon emissions. Accordingly, both papers suggest abnormal returns as a result of investor preferences. However, they disagree on which type of companies (high-or low emission) outperforms the other.

3. Methodology

The following chapter describes the methodology applied in our analysis. The first subsection (3.1) presents multi-factor models we have used to examine if there exist any differences in return between the traditional -and modern sin portfolio, their respective comparable portfolios, and the market. The second subsection (3.2) presents the long-short portfolio approach to interpreting alpha. The third and fourth subsection (3.3 & 3.4) presents model testing and discuss some weaknesses of the chosen methodology. The last subsection (3.5) outlines how we present and evaluate the generated results.

3.1 Asset Pricing Models

Capital Asset Pricing and Jensen`s alpha

The Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965; Mossin, 1966) is viewed as one of the first frameworks within asset pricing theory (Fama & French, 2004). According to the CAPM, variation in stock returns is solely explained by differences in stock volatility relative to the market, as measured by market beta, i.e., the systematic risk[8] (Perold, 2004). Consequently, adding more variables to the model should have no explanatory power. However, numerous empirical studies demonstrate that the observed risk-return relation contradicts the CAPM's predictions. For instance, Basu (1977) discovered that companies with low price-to-earnings (P/E) ratios tend to perform better than CAPM predicts. In contrast, companies with high P/E ratios consistently perform worse than what CAPM predicts. Additionally, there is evidence that companies with low market capitalizations outperform CAPM expectations (Banz,1981). According to Rosenberg, Reid, and Landsteiner (1985), CAPM cannot explain the outperformance of companies with high book-to-market values. However, CAPM's empirical inadequacies triggered an increased body of research. Hence, the CAPM model is expanded by adding various company-specific risk factors (Hayes, 2020).

Based on the CAPM, Jensen (1968) derived a risk-adjusted measure of portfolio performance known as «**Jensen's Alpha**». It refers to a security or portfolio's pricing error or abnormal return. If the alpha is positive (negative), the investment has outperformed its expected level of systematic risk, earning higher (lower) returns. Alpha will be equal to zero if the CAPM is valid.

Multi-Factor Models

Eugene Fama and Kenneth French introduced the **Fama-French three-factor model** (FF3) in 1993 to complement the empirical shortcomings of the CAPM model. The FF3 model is an extension of CAPM, suggesting that the size (SMB) and value (HML) factor can explain returns in excess of the risk-free rate. These factors serve as proxies for unobserved and systematic sources of risk (Bodie et al., 2018). The size factor captures the difference in returns between small-cap stocks and large-cap stocks. The value factor captures the return difference between high-book-to-market and low-book-to-market stocks. Thus, new factors become significant when

[8] Risk can be classified into two sorts: systematic- and unsystematic risk. Systematic risk is also named undiversifiable as it applies to the entire market. Therefore, the risk cannot be removed by diversifying portfolios. Unsystematic risk, also named diversifiable risk, is specific to a company or an industry. Thus, it can be mitigated through diversification (Fontinelle, 2019)

included in the model, explaining the stock performance. According to Jegadeesh and Titman (1993), equities that out or underperformed the market over the previous three to twelve months continue in the same direction, either increasing or decreasing. The return spread is not explained by the FF3 model (Fama & French, 1996). Carhart (1997) adds the momentum factor to the FF3 model, introducing the **four-factor Carhart model** (**FFC4**). Thus, the model increases explanatory power.

Moreover, Fama and French (2015) expand the FF3 model by including a profitability factor (RMW) and an investment factor (CMA), building on findings from Titman, Wei, and Xie (2004) and Novy-Marx (2013). The expanded model was named the **Fama-French five-factor model (FF5).** The profitability factor (RMW) is long in stocks with robust operating profits and short in stocks with weak operating profits. The investment factor (CMA) goes long in companies with a conservative investment strategy and short in companies that invest aggressively. The last multi-factor model is an extension of the **FF5 model augmented with the momentum** factor (**FF5 + MOM**). The multi-factor models presented can be illustrated through the following equation:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{mrkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{RMW} * RMW + \beta_{CMA} * CMA + \beta_{MOM} * MOM + \epsilon_t \quad (3.1)$$

Explanation of equation 3.1. $R_{i,t}$ is the return on portfolio i for month t, $R_{f,t}$ is the risk-free T-bill in month t. α_i is Jensen's alpha. β_{mrkt}, β_{SMB}, β_{HML}, β_{RMW}, β_{CMA} and β_{MOM} are the exposures to respectively the market, size, value, profitability, investment, and the momentum factor. If the β coefficients equals to zero, the stock performance in not tested against the factor exposure, thus not included in the model. The multi-factor models' factor loadings measure to which extent the portfolio returns are affected by the factor. Risk-premiums measure how much extra excess return the portfolio yields as a result of one unit increase in exposure to the factor, ceteris paribus.

Because the model is written in the excess return form, it predicts that alpha (α) should be equal to zero if the applied multi-factor model holds. Thus, a significant alpha reflects a multi-factor model's inability to explain cross-sectional disparities in stock returns. Hence, when we evaluate our results against commonly accepted multi-factor models, we are, to a larger extent, exclusively testing the validity of the applied model.

3.2 The Long-Short Portfolio Approach

Blitz and Fabozzi (2017) replace the risk-free rate on the left side of the equation (3.1) with the market return and define alpha as the sin portfolio's excess return over market return. Hong and Kacperczyk (2009) replace the risk-free rate on the left side of the equation (3.1) with the comparable portfolio return and define alpha as the sin portfolio's excess return over the comparable portfolio return.

We implement the long-short approach to examinate whether traditional and modern sin stocks offer alpha and thus outperform the market (3.2) and comparables (3.3). This is accomplished by employing the multi-factor models described above. However, we use the long-short portfolios rather than Jensen's alpha. Thus, we replace the risk-free rate on the left-hand side with 1) the market portfolio returns and 2) the comparable portfolio return. We apply the following equations when estimating alpha for the sin -and the difference portfolios:

$$R_{S,i,t} - R_{m,t} = \alpha + \beta_{mrkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{RMW} * RMW + \beta_{CMA} * CMA + \beta_{MOM} * MOM + \epsilon_t \quad (3.2)$$

Explanation of equation 3.2: Equation 3.2 is applied on the sin portfolios. The intercept reflects the total return of the VW sin portfolio in excess of the total return of VW market portfolio[9]. Thus, alpha represents the excess return of the sin portfolio relative to the return of the market. If significant, the sin portfolio outperforms the market.

$$R_{s,i,t} - R_{C,i,t} = \alpha + \beta_{mrkt} * (R_{m,t} - R_{f,t}) + \beta_{SMB} * SMB_t + \beta_{HML} * HML_t + \beta_{RMW} * RMW + \beta_{CMA} * CMA + \beta_{MOM} * MOM + \epsilon_t \quad (3.3)$$

Explanation of equation 3.3: Equation 3.3 is applied on the difference portfolios. The intercept reflects the total return of the VW sin portfolio, in excess of the total return of the corresponding VW comparable portfolio. Thus, alpha represent the excess return of the sin portfolio relative to the return of the comparable portfolio. If significant, the sin portfolio outperforms the comparable.

Consequently, we refer to alpha in two different contexts. Firstly, as the excess return above the market return, and secondly as the excess return above the comparable portfolio return. Our

[9] The market portfolio is constructed by adding the risk-free rate on the "Market minus Risk-free"-factor for developed countries from Kenneth French's Data Library. The market portfolio is created by weighting the monthly stock returns by their market capitalizations and rebalanced monthly. Thus, the market used in this thesis is a reliable representation of the actual market.

studies assume that the applied multi-factor models are true[10]. Thus, a significant alpha is evidence of out- or underperformance relative to the benchmark.

3.3 Model Testing

We address the assumptions behind the ordinary least square estimation technique to estimate the causal effect of a change in the independent variable on the response variable. A valid model is both consistent and unbiased. Hence, we test the five Gauss-Markov assumptions: I) linear parameters, II) no perfect collinearity, III) zero conditional mean, IV) homoskedasticity and V) no serial-/autocorrelation to determine whether our model is valid (Wooldridge, 2016).

The model includes independent risk factors which are established and have been documented to impact stock returns significantly. Thus, assumptions I and II are evaluated and fulfilled (Carhart, 1997). To test for the III) assumption regarding zero conditional means, we study histograms and QQ plots. The histograms verify the III assumption, and the sample means are centered around zero across all portfolios. The QQ plots show that the standardized residuals form a straight line in the center, indicating that the zero conditional mean assumption is satisfied.

Furthermore, we implement a Breush-Godfrey and a Breush-Pagan test for autocorrelation and heteroskedasticity in the error terms. The rationale is that such features can create biased ordinary least squares results and invalidate inference (Wooldridge, 2016). Our results suggest no presence of autocorrelation. Even though the OLS regression method assumes homoscedasticity, heteroskedasticity problems might exist[11]. When different portfolios are tested, the Breush-Pagan test finds evidence of heteroskedasticity for some multi-factor models[12]. Thus, we re-estimate the regressions using Huber-White standard errors. These heteroskedasticity-consistent standard errors did not affect the magnitude of alpha.

In addition to the five Gauss-Markov assumptions, stationarity is a vital prerequisite to test for when analyzing time series data. If the probability distribution of a time series remains steady throughout time, it is said to be stationary (Wooldridge, 2016). Thus, it suggests that we should be able to gather random variables in a sequence and then advance that sequence without affecting the probability distribution (Wooldridge, 2012). However, the findings might be spurious if our

[10] It is important to note that we document the alpha relative to multi-factor models. The estimated alphas can hence either be interpreted to be "true" in the sense that they illustrate the potential for riskless returns, or to be the result of a model error where the market correctly prices risk that is not reflected in the factor model.
[11] Homoskedasticity arises when the standard error term in a regression model is constant. Contrarily, heteroskedasticity arises when the standard error term is not constant.
[12] Outputs from the tests can be found in Appendix A2, Table A2.2

time series does not meet the latter criterion. We test for stationarity by conducting an augmented Dickey-Fuller unit root test[13]. Based on the test results, there is no reason to be concerned about non-stationary data in our data sample[14].

3.4 Model Weaknesses

According to Kapadia and Paye (2014), there is a risk related to an asset pricing model in terms of a misspecification. Indeed, the CAPM and Fama-French models have been criticized for misspecification for years. According to Daniel and Titman (1997), the value factor (HML) is more of a firm's feature. Investors prefer high book-to-market stocks over low book-to-market stocks, rather than book-to-market being a risk measure that affects the expected return. Furthermore, Fama and French (1996) concede that the FF3 model is missing an element that accounts for the short-term continuance of returns. The momentum factor supporters say is the missing element in the FF3 model.

Moreover, the expanded FF5 model has been criticized. According to Blitz, Hanauer, and Van Vliet (2018), controlling for additional explanatory variables is risky. The added factors are likely to correlate, thus making it challenging to summarize the cross-section of stock returns. Additionally, they claim that research on the profitability factor (RMW) and the investment factor (CMA) is relatively new and restricted. Consequently, they state that Fama and French's definitions of the factors need to be more precise.

Additionally, the FF5 model has been criticized for omitting the momentum factor. However, Fama and French (2014) argue that adding the momentum factor will cause a correlation between the explanatory variables. Hence, resulting in faulty diversification in the portfolios used to create the explanatory factors in the model.

[13] The Augmented Dickey-Fuller test is founded on the first-order autoregressive process model: $y_t = \emptyset_1 y_{t-1} + \varepsilon_t$. Where $\emptyset_1$ is the autoregression parameter and the foundation for the test. The tests assess the value $\emptyset_1$, and the null hypothesis phrases that the time series includes a unit root, meaning it is non-stationary. The test uses lags to assess the presence of unit root.
[14] Outputs from the tests can be found in section A2 in the Appendices.

Table 3.1: Pearson Correlation Matrix

	Rm-Rf	SMB	HML	RMW	CMW	RF	WHL
Rm-Rf	1						
SMB	0.057	1					
HML	-0.122	0.012	1				
RMW	-0.335	-0.274	0.051	1			
CMW	-0.406	-0.072	0.761	0.155	1		
RF	-0.131	-0.044	0.202	0.055	0.188	1	
WHL	-0.331	0.207	-0.238	0.145	0.048	-0.012	1

Table 3.1. presents the Pearson correlation matrix[15] for the explanatory variables incorporated in this thesis. There is no clear consensus on what absolute value for a correlation coefficient should be considered "too high". Nevertheless, a general guideline says that a coefficient around |0.7| or |0.8| indicates a robust linear relationship, which might affect the statistical power of the regression models (Nettleton, 2014; Studenmund, 2017). The value (HML) and the investment (CMA) factors have the highest correlation coefficient in absolute terms (0.76), which denotes a moderate-to-a-strong positive, linear relationship. The correlation between these factors is well recognized in the research of Fama and French (2015). Value firms tend to have conservative investment profiles, whereas growth firms tend to have a rather aggressive investment approach. Besides the correlation between the value and investment factors, the correlation matrix does not imply any strong linear relationships that might weaken the statistical power of the regression models.

3.5 Portfolio Evaluation

The focus of our analyses relies on past portfolio excess returns. To test the relation between the traditional and modern sin stock returns against the market and their comparables, we test the null hypothesis of portfolio alphas equal to zero. The latter is tested by using t-statistics adjusted for Huber-White standard errors[16] for the long sin-short market and long sin-short comparable portfolios. We are particularly interested in the alpha of the long sin-short market portfolio, which

[15] The Pearson coefficient is a mathematical correlation coefficient describing the relationship between two variables (in this case, factors), denoted as X and Y. The correlation coefficients range from +1 to -1, with +1 expressing a positive correlation, -1 expressing a negative correlation, and 0 expressing no relationship. Note that the Pearson coefficient shows correlation, not causation.

[16] We use the function for Huber White Standard errors from the sandwich package in R proposed by Eicker, Huber (1967), and White (1982) to adjust for heteroscedasticity. Usually, these standard errors will be larger than those produced by OLS, resulting in lower t-scores and increasing the p-value (King & Roberts, 2014).

should be statistically significant and positive after controlling for all Fama-French factors and the momentum factor. Alphas are estimated relative to four different multi-factor models: The Fama -French three-factor model (FF3), the four-factor Carhart model (1997) (FFC4), the Fama-French five-factor model (2015) (FF5), and lastly, the FF5 model augmented with the momentum factor (FF5 + MOM).

4. Data

4.1 Data Selection

This section presents the data sources and data cleansing process**.** We extract data from Datastream, Refinitiv and Kenneth R. French's Data Library. Datastream provides us with industry descriptions, monthly returns, share prices, revenues, and market caps. All factors are extracted in United States Dollars (USD). We sorted companies related to alcohol, tobacco, and gambling. Our sample consists of listed and delisted sin stocks in developed countries. Since our dataset range back to 2000, excluding delisted companies would neglect historically vital companies. Securities with less than 12 consecutive months of stock returns and an average market cap equal to or less than 50 million dollars are excluded. Additionally, we set a minimum criterion of 5% relevant industry revenue. Thus, we avoid including minority shareholders for each sin industry. Lastly, we obtain the Fama–French three factors (1993), the momentum factor (Carhart, 1997), the Fama–French five factors (2015), the risk-free rate from French (2022), and the market proxy from the Kenneth French's Data Library. A summary of the data sources can be found in **Table 4.1.**

Table 4.1: Data Source overview

Data source	
Refinitiv – Datastream	Company Financials; Closing Price, Total Returns, EPS, Market Capitalization
Fama-French Library	Fama-French risk factors and the momentum factor

Data Cleansing Process

The selection and classification of sin stocks was a considerable obstacle when examining sin stock performance. The significance and validity of the obtained findings depend on the quality of the underlying data. Accordingly, it leaves the data gathering and cleansing process as the most crucial and demanding part of the thesis.

Having mentioned the above, we find several issues when employing Datastream's industry classifications. Firstly, there is a risk that companies are incorrectly classified. Another issue is the classifications of those companies that, although they receive a significant part of their revenues from sinful activities, are classified under a different non-sinful industry. Thus, reflecting other aspects of the company's business. Manual screening of thousands of companies is demanding. We combine Datastream's company description and the company's websites to select and classify companies in our sample that align with our set criteria list introduced above.

4.1.1 Selection of Alcohol Companies

We used Datastream to select the companies within the alcohol industry. Companies like Heineken and Budweiser are examples of companies we have included. There are numerous industrial applications for alcohol, such as fuel, pharmaceuticals, and raw materials in the chemical industry (Solvchem, 2022). That is, types of alcohol typically not viewed as sinful by the public. Therefore, we exclude producers of industrial alcohol from our sample, ensuring that the sin effect is measured correctly.

4.1.2 Selection of Tobacco Companies

The business descriptions in Datastream are relatively comprehensive, enabling us to select the right companies within the industry names. Similar to the procedure when selecting alcohol companies, we used Datastream to select companies within the tobacco industry. We chose to include both manufacturers of Tobacco and companies with an indirect impact on the production, i.e., Phillip Morris International and SWM Tobacco Paper Manufacturer. Additionally, we included producers of cannabis since it can be addictive and may cause damage. This allows us to consider the industry as sinful. Nevertheless, some adjustments had to be made. Since a company in Datastream solely belongs to one industry group, we find misclassifications for companies participated in ownership shifts. Due to the relatively concentrated tobacco market, losing one or two significant enterprises for months or years could misinterpret the data. Thus, we executed an extensive manual screening process, examining the history of all major brands.

4.1.3 Selection of Gambling Companies

We had to determine where to distinguish what business activities and industries comprise a gambling company. For instance, we had to decide whether to include companies like cruises and hotels which offer gambling services. Indeed, gambling is a significant part of the marketing strategy of their services (RCL, 2022). Further, we argue that multiple investors would categorize most Las Vegas hotels as sinful. Nevertheless, the distinction must be set somewhere, and the

decision on this matter could always be debatable. The biggest gambling companies in our sample (measured by market capitalization) are Las Vegas Sands Corp (luxury hotels), Sands China Ltd, and Galaxy Entertainment Group Ltd. All of them are big luxury hotels offering gambling services. Hence, we decided to include them.

4.1.4 Selection of Oil and Gas Companies

We used Datastream to select companies based on SIC[17] – and NAICS[18] codes. The oil and gas industry is divided into three components: upstream, midstream and downstream. We included all three when selecting the companies, thus the entire value chain. The upstream sector includes companies operating in exploration and production activities. We have included Devon Energy as an example of an upstream company. Further, the midstream sector includes companies engaged in the transportation and movement of oil and gas to the end customer. An example of a midstream company is Kinder Morgan. Lastly, the downstream sector includes companies that provide refining and processing services, in addition to engaging in the sale and distribution of products. Marathon Petroleum is an example of a major downstream company in the oil and gas industry. Having mentioned the above, examples of activities these companies provide are drilling, oil and gas field exploration, petroleum refining and the arrangement of freight and cargo transportation. Thus, examples of these companies are Aker BP, Chevron and Exxon Mobil.

4.1.5 Selection of Comparable Companies

Finding the proper comparables to sin stocks is crucial to determine whether sin stocks yield abnormal returns. To our inspiration, we followed the same procedure as Hong and Kacperzyk (2009) when constructing the portfolios. Since there are no obvious guidelines regarding what might substitute alcohol, tobacco and gambling, we chose the same comparables as Hong and Kacperzyk (2009). People tend to substitute beer with non-alcoholic beverages, i.e., soda. Furthermore, one might alternate tobacco with food, and gambling with fun and meals. Accordingly, we compare these industries with traditional sin stocks.

Moreover, we suspect that some investors divest from fossil fuels to buy renewable energy shares. Ghabri et al. (2021) emphasize the economic uncertainty related to the covid-19 pandemic and its impact on global energy markets. They argue that the pandemic has affected investment activity related to the clean energy transition. Replacing fossil fuel with renewable energy to reduce CO2

[17] The SIC-codes for oil- and gas companies: 1311, 1381, 1382, 1389, 2911, 3272, 4731
[18] The NAICS-codes: 446120, 211112, 211111, 424720, 324110, 424510, 221210, 213112, 333415, 212210

emissions may explain these trends. Some investors tend to sell fossil fuel stocks for the benefit of a greener alternative. Conversely, some investors might divest from renewable energy stocks if they fear that they will not be able to substitute fossil fuel at scale. Having mentioned the above, we chose renewable energy companies as comparables for modern sin stocks.

4.1.6 Alternative Sin Considerations

The definition of a sinful firm is subjective and depends on, among other, political views, religion, and ethical values. We are not able to consider each definition in our research. Thus, we followed Hong and Kacperzyk's selection to narrow the dataset. Thus, the following present some alternative sin industries not included in this thesis.

Adult entertainment is often acknowledged as a sinful industry. Hugh Hefner launched Playboy, arguably the most well-known business in this field, despite its brief history as a publicly listed company. According to Hong and Kacperzyk (2009), few listed companies have heavy operations within this field. Hence, excluding them from our thesis will have a minimal effect on our results significantly. Also, there is no precise industry classification in Datastream. Thus, adult entertainment could be everything from horror movies to pornography.

The recognistion of the **weapon and defense** industry varies globally. Some investors might exclude weapons manufacturers because of ethical considerations, while others might consider serving in the military an act of patriotism. Moreover, while some consider the industry a necessity and create jobs, some might consider it a significant contributor to destruction and wars. Moreover, there are some remarkable differences between the selected countries regarding the law on weapons. Anyone in America can carry a gun in public, while it is forbidden in Europe and Australia (unless one has permission or a certificate from the police). Consequently, we excluded the weapon and defense industry in our thesis. The exclusion is in line with Hong and Kacperzyk (2009). However, in contrast to Blitz and Fabozzi (2017). They claim that companies producing weapons promote human vice, crime, and warfare, thus vital to include the industry as sinful.

One might also consider the **healthcare** industry as a potential sin industry. The industry has restrictions since some parts might cause addictive tendencies and bad habits and, thus, could be considered sin stocks. For example, companies producing sleeping pills, opioids, and Oxycodone are among some of the most addictive prescription drugs on the market (Krans & Grey, 2021). Fabozzi et al. (2008) did include the healthcare industry. Nevertheless, we have decided not to

include the industry in our thesis as we solely want to focus on the "Triumvirate of sin" when studying our first hypothesis. Indeed, we do not consider the industry as obviously sinful at first sight since we find it difficult to set a defined limit on which companies might be considered sinful.

4.1.7 Selection of Time Span

Our selected time span is from January 2000 to August 2022, equivalent to 272 months. We chose this period for two primary reasons. Firstly, analyzing more recent sin stock returns is crucial as the focus on SRI accelerates and the recognition of sin stocks evolves. Thus, including data until today enables us to analyze the more "up-to-date" investor trends. Secondly, we aim to analyze structural changes in returns of oil and gas stocks between two sub-periods, January 2000 to December 2014 and January 2015 to August 2022. The latter enables us to determine whether there is evidence that modern sin stock returns have developed in recent years.

4.1.8 Selection of Countries

The adoption of the SRI concept has significantly increased in nearly all countries and markets worldwide. However, we wanted to narrow the scope and focus exclusively on developed countries. We believe the analysis will strengthen when comparing more similar countries. Developed countries are characterized by high economic growth and security (Majaski, 2022). World Bank (2022) claims a positive correlation between stock market development and growth. Thus, the trading activity in a country with high income per capita is generally higher than in a less developed country.

Furthermore, Silver (2018) claims that Americans and Western Europeans match on crucial social and political concerns. Thus, comparing similar countries might enable us to focus on the specific question without dealing with the differences between these countries. According to World Population Review (2022), Christianity is the most dominant religion in developed countries. Unquestionably, religion has an effect, as ethical considerations may influence the investment decision of whether to purchase sin stocks. The countries included in the term "developed countries" varies. In this thesis, we have chosen the Fama-French (2022) country classification of "developed countries"[19], consisting of 23 well-established economies. Thus, we provide an

[19] Kenneth French defined developed countries; Australia, Austria Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, Great Britain, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Sweden, Singapore & United States.

extension to several US-focused sin stock literature. An overview of countries is illustrated in **Appendix A1 Table A1.1.**

4.2 Portfolio Construction

The analysis is based on a traditional and modern sin portfolio and their respective comparable portfolios. The portfolios are constructed to determine the potential differences within industries and periods. We construct value-weighted (VW hereafter) portfolios based on market capitalization. VW portfolio implies that the investment amount is proportional to the market capitalization. This will provide us with more reliable results than equally-weighted portfolios, as the returns of stocks of smaller (larger) companies will be valued less (more) in the total portfolios.

4.2.1 Total Return Data

To answer the hypothesis regarding sin stock alpha, we extract stock returns on a monthly frequency from Refinitiv. The total return is calculated as the change in stock price, adjusted for stock splits, assuming that all dividends are reinvested (Reuters, 2022). The monthly returns are calculated as follows:

$$Total\ Stock\ Return = \frac{(P_1 - P_0) + D}{P_0}$$

P_0 is the initial Stock Price. P_1 is the ending stock price and D is paid-out dividends. The monthly total returns are extracted in United States Dollars, isolating the effects of foreign exchange (FX) variations. Thus, we mitigate potential concerns related to currency fluctuation, which can assemble an investment more (less) profitable than the local currency return suggest.

4.2.2 Industry-Divided Portfolios

The first step in our modeling is to create a VW portfolio for the indexed return per sin industry. Thus, an individual portfolio for alcohol, tobacco, and gambling companies is formed. Then, we compute the total index return for each industry. The motivation is to examine if each sin industry portfolio offers alpha. We then calculate the companies' industry weights by dividing their

monthly market capitalization by the sum of the total market capitalization within that industry. The industry portfolio's weighted, total return is calculated as the following:

$$r_{p,t} = \sum_{i=0}^{N} (w_{i,t} * r_{i,t})$$

$$w_{i,t} = \frac{mv_{i,t}}{\sum_{i=1}^{N} mv_{i,t}}$$

Where $r_{p,t}$ is the market capitalization weighted return of portfolio i at time t, $r_{i,t}$ is the total return of stock i at time t, $w_{i,t}$ is the weight of stock i at time t and $mv_{i,t}$ is the market cap of stock i at time t.

4.2.3 Value-Weighted Sin Portfolio

We follow the same procedure as in **section 4.2.2** when creating the sin stock portfolio. The sin portfolio is VW in terms of the companies' market capitalizations relative to the entire sin industry. The weighting of these stocks is multiplied by their respective total returns to employ data on each stock's portfolio contribution. The same formula used for the industry-divided portfolios is applied on the total VW sin portfolio. However, the notations is different; $r_{p,t}$ is now the market capitalization weighted return of the total sin stock portfolio *p* at time *t*. $r_{i,t}$ is the total return of each sub-industry *i* at time *t*. $w_{i,t}$ is the weight of the industry-divided portfolio *i* at time *t*. $mv_{i,t}$ is the market capitalization of the industry-divided portfolio *i* at time *t*.

We apply the same methodology to construct portfolios for traditional sin, modern sin, and their comparable portfolios. An overview of the industry composition of the portfolios we study is illustrated in **Table 4.2.**

Table 4.2: Portfolio and Industry Overview

Traditional Sin	Comparable	Modern Sin	Comparable
Alcohol: Beverages Wine & Sprits Alcohol: Breweries	Alcohol Peers: Non-Alcoholic Beverages	Oil and Gas	Renewable Energy Source
Tobacco	Tobacco: Food-Misc./Diversified		
Gambling: Casino Services, Gambling Non-Hotels, Internet Gambling, Lottery Services	Gambling: Entertainment Software		

The Table provides an overview of our four portfolios and which industries they include. Additionally, we employ a difference portfolio that has a long position in sin stocks and a short position in comparable stocks. Please see subsection 3.1 to see how the companies are selected within each industry.

4.2.4 The Difference Portfolio

The long-short approach is in line with the methodology applied by Hong and Kacperczyk (2009) and Blitz and Fabozzi (2017). We use the sin- and comparable portfolios to create a difference portfolio. The difference portfolio employs a zero-net investment strategy, going long in the sin portfolio and short in the comparable portfolio. That is, the income from shorting will fund the long portfolio. In the case of positive alpha for such a strategy, we can conclude that there are abnormal returns for the sin portfolio relative to their respective comparable portfolio.

4.3 Data Set Concerns

4.3.1 Datastream

Each year, the number of sin companies in developed countries increases steadily. Hence, very few significant companies yield returns in the early phases. Thus, it might result in a surviving bias since growth and profitability might exclusively refer to companies who have been market leaders for a long time. To mitigate surviving bias, we have included companies that were delisted or bankrupt within the same period.

Geography

Although we include more countries than previous research, which exclusively focuses on the U.S., we exclude some countries that could have strengthened our thesis. However, we aimed to limit the research to developed countries to analyse countries with similar economic conditions, investment activity, and critical financial and social traits.

Nevertheless, a major concern is that we cannot conclude whether the sin premium varies between developed countries and less developed countries. A second issue is that we exclude some of the world's largest economies based on market capitalization ratios to gross national income (GNI). Among the excluded in our analysis are India, South Korea, China and Russia, which are among the top ten largest countries by market cap, (Siblis Research, 2022). Additionally, one could raise concerns regarding the fact that we have chosen to exclude some of the biggest producers of the products within the industries we analysis. Indeed, China was the biggest tobacco producer in 2021, following India and Brazil. Also, Russia is the second biggest oil producer after the United States Shahbandeh (2022).

Time Span

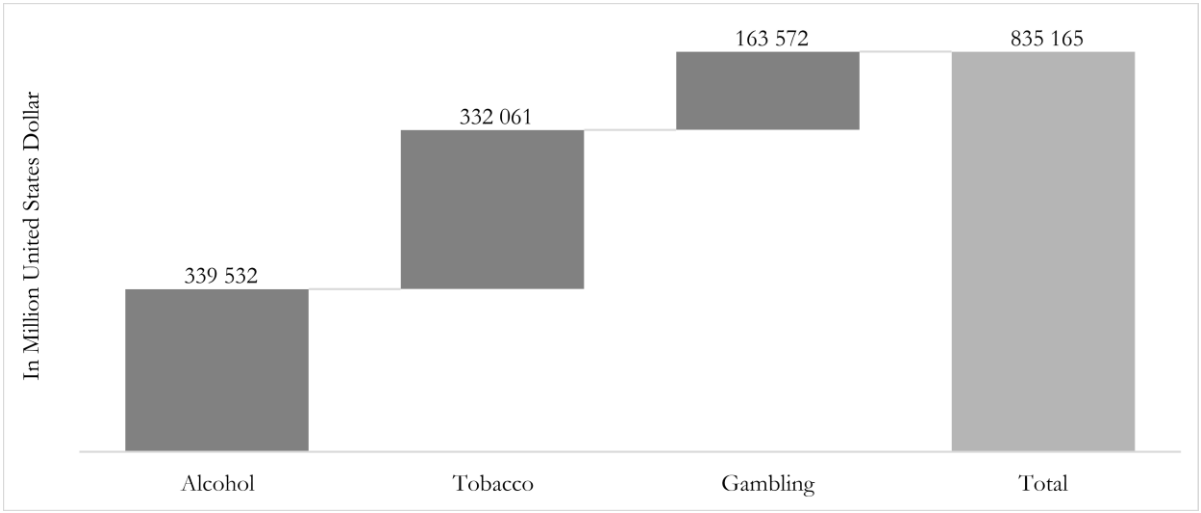
The analysis relies on data from 01.01.2000 to 31.08.2022. Since the dot.com bubble occurred from 1998 – 2000, we might observe extreme outliers at the beginning of the data set. Equities entered a bear market after the bubble ended in 2001, so these observations might not be representable for the rest of our data set (Hayes, 2019). Additionally, we observe extreme outliers due to oil and energy price shocks in 2022. The covid-19 crisis and Russia's invasion of Ukraine have caused a global economic recession; however, more importantly for our data set, exaggerated an increase in energy prices. Hence, we will test whether contextual factors such as periods with wars or other conflicts change the regression results by omitting these periods in a robustness test.

Industry Composition

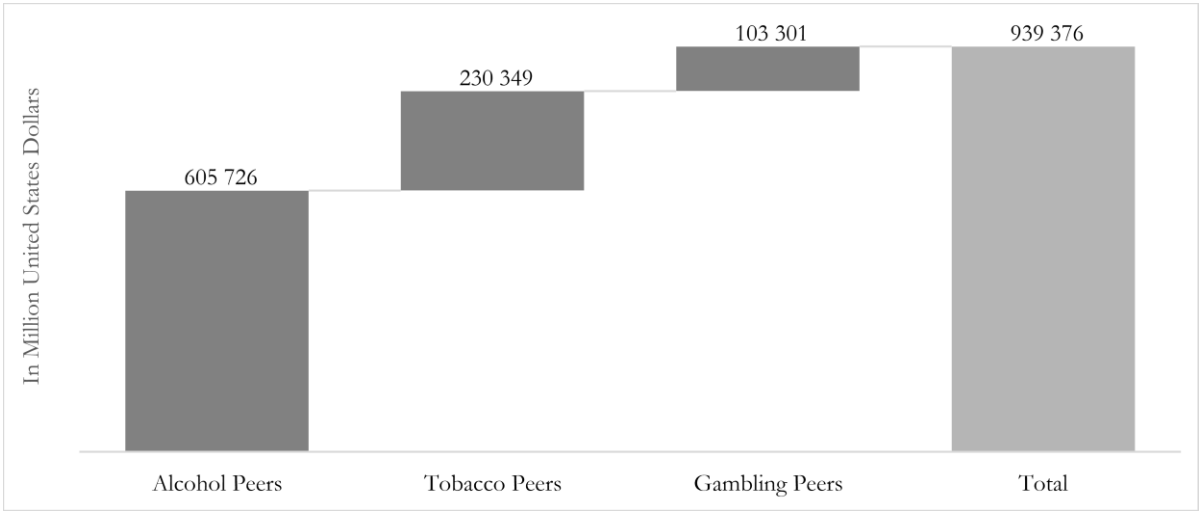
The final concern is the discrepancy in market capitalization between the traditional sin industries. The skewness is illustrated in **Figure 4.1**, demonstrating that the alcohol industry is the primary contributor to the total average market capitalization of the traditional sin portfolio. While tobacco companies also hold a significant share of the total average market capitalization, gambling companies are significantly underrepresented in market capitalization. This can pose a problem as the industries might be related to different biases and risks.

Figure 4.1 Average Market Capitalization for each portfolio

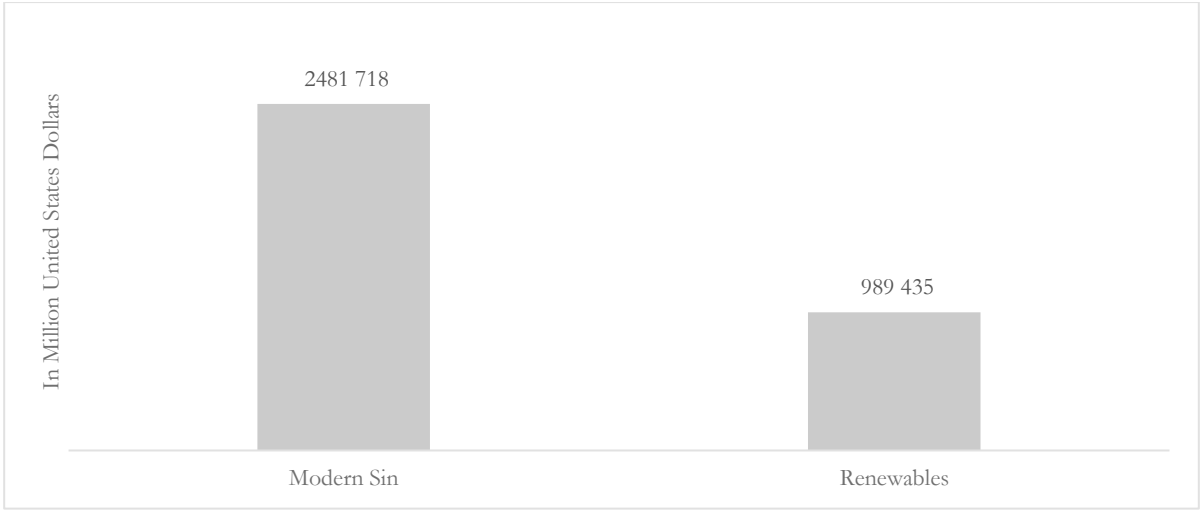
Panel A: Average Market Cap for the Traditional Sin Industries



Panel B: Average Market Cap for the Traditional Sin Industries Comparables



Panel C: Average Market Cap for Modern Sin Stocks and their Comparables



The bars present the total, average market cap for each traditional and modern sin industry and their respective comparable industries from the period of January 2000 to August 2022. The percentages demonstrate the market share within the industry in terms of market cap.

5. Empirical Results and Analysis

This section presents the results of our analysis. The structure conforms to the hypotheses presented in the introduction, where each part is dedicated to one hypothesis. The section begins with an assessment of whether the portfolio outperforms the market. Then we assess whether the portfolio outperforms its comparables[20]. Each section first presents the results obtained relative to the hypotheses following an analysis of the findings. Lastly, we conduct several robustness tests to increase the reliability of our findings.

[20] We note that the alpha in our thesis refers to the excess returns against two different benchmarks: the market and the comparable. Thus, it is essential to note that alpha in this context does not refer to Jensen's alpha but rather the outperformance of 1) the market and 2) the comparable. Hence, the thesis estimates two different alphas; thus, we note the importance of interpreting the alpha in the proper context.

5.1 Hypothesis I: Traditional Sin Stocks Offer Alpha

Table 5.1.1: Descriptive Statistics of the Traditional Sin Portfolios and the Comparable Portfolios

Panel A: Descriptive Statistics for the Value-Weighted Traditional Sin Portfolios

		N	MIN	MAX	R	SD	Annualized SR
01.01.2000-31.08.2022	Traditional Sin Portfolio	272	-13.040%	16.200%	0.900%	4.290%	1.170%
	Alcohol Portfolio	272	-14.700%	18.200%	0.600%	4.140%	0.956%
	Tobacco Portfolio	272	-18.000%	23.600%	0.870%	5.360%	0.914%
	Gambling portfolio	272	-27.760%	58.086%	1.340%	8.480%	0.772%
	Market	272	-19.430%	13.350%	0.500%	4.540%	0.410%
01.01.2000-31.12.2014	Traditional Sin Portfolio	180	-12.340%	11.900%	1.730%	4.230%	1.416%
	Alcohol Portfolio	180	-14.710%	11.080%	1.300%	3.870%	1.160%
	Tobacco Portfolio	180	-18.010%	23.570%	1.790%	5.520%	1.125%
	Gambling portfolio	180	-27.760%	58.090%	2.270%	8.610%	0.911%
	Market	180.0	-19.400%	11.420%	0.465%	4.651%	0.346%
01.01.2015-31.08.22	Traditional Sin Portfolio	92	-13.040%	16.230%	0.900%	4.380%	0.714%
	Alcohol Portfolio	92	-12.400%	18.200%	0.840%	4.620%	0.627%
	Tobacco Portfolio	92	-10.800%	10.240%	0.680%	4.980%	0.478%
	Gambling portfolio	92	-26.900%	21.770%	1.150%	8.220%	0.482%
	Market	92	-13.650%	13.350%	0.710%	4.340%	0.560%

Panel B: Descriptive Statistics for the Value-Weighted Comparable Portfolios

		N	MIN	MAX	R	SD	Annualized SR
01.01.2000-31.08.2022	Comparable Portfolio	272	-13.700%	9.400%	1.000%	3.200%	1.060%
	Alcohol Portfolio	272	-13.400%	9.600%	0.900%	3.400%	0.910%
	Tobacco Portfolio	272	-11.490%	10.800%	1.100%	3.300%	1.170%
	Gambling portfolio	272	-29.400%	38.300%	1.200%	6.700%	0.590%
	Market	272	-19.430%	13.350%	0.540%	4.540%	0.410%
01.01.2000-31.12.2014	Comparable Portfolio	180	-13.700%	9.800%	0.970%	3.190%	1.056%
	Alcohol Portfolio	180	-13.430%	9.510%	0.840%	3.370%	0.862%
	Tobacco Portfolio	180	-11.490%	10.130%	1.210%	3.330%	1.254%
	Gambling portfolio	180	-23.430%	38.360%	1.250%	6.730%	0.640%
	Market	180	-19.400%	11.420%	0.465%	4.651%	0.346%
01.01.2015-31.08.22	Comparable Portfolio	92	-8.020%	9.380%	1.010%	3.270%	1.063%
	Alcohol Portfolio	92	-7.130%	9.640%	0.990%	3.370%	1.015%
	Tobacco Portfolio	92	-9.760%	10.840%	0.970%	3.270%	1.025%
	Gambling portfolio	92	-29.400%	27.800%	1.070%	7.430%	0.498%
	Market	92	-13.650%	13.350%	0.710%	4.340%	0.560%

The table presents descriptive statistics for the observations in our dataset. The data sample was retrieved from Datastream in the period from January 2000 to August 2022. Panel A presents summary statistics for the traditional sin portfolio, while Panel B presents descriptive statistics for the comparable portfolio. The minimum and maximum values show the lowest and highest monthly return observation during the observation period. N is the number of observations, and R presents the time-series mean monthly portfolio return. The standard deviation (SD) identifies the average volatility of the monthly returns for the portfolio, and the annualized portfolio Sharpe ratio (SR) is the excess return reward (average return minus the average risk-free rate) per unit of risk

Figure 5.1.1: Cumulative Returns of the Traditional Sin Portfolios and the Comparable Portfolios

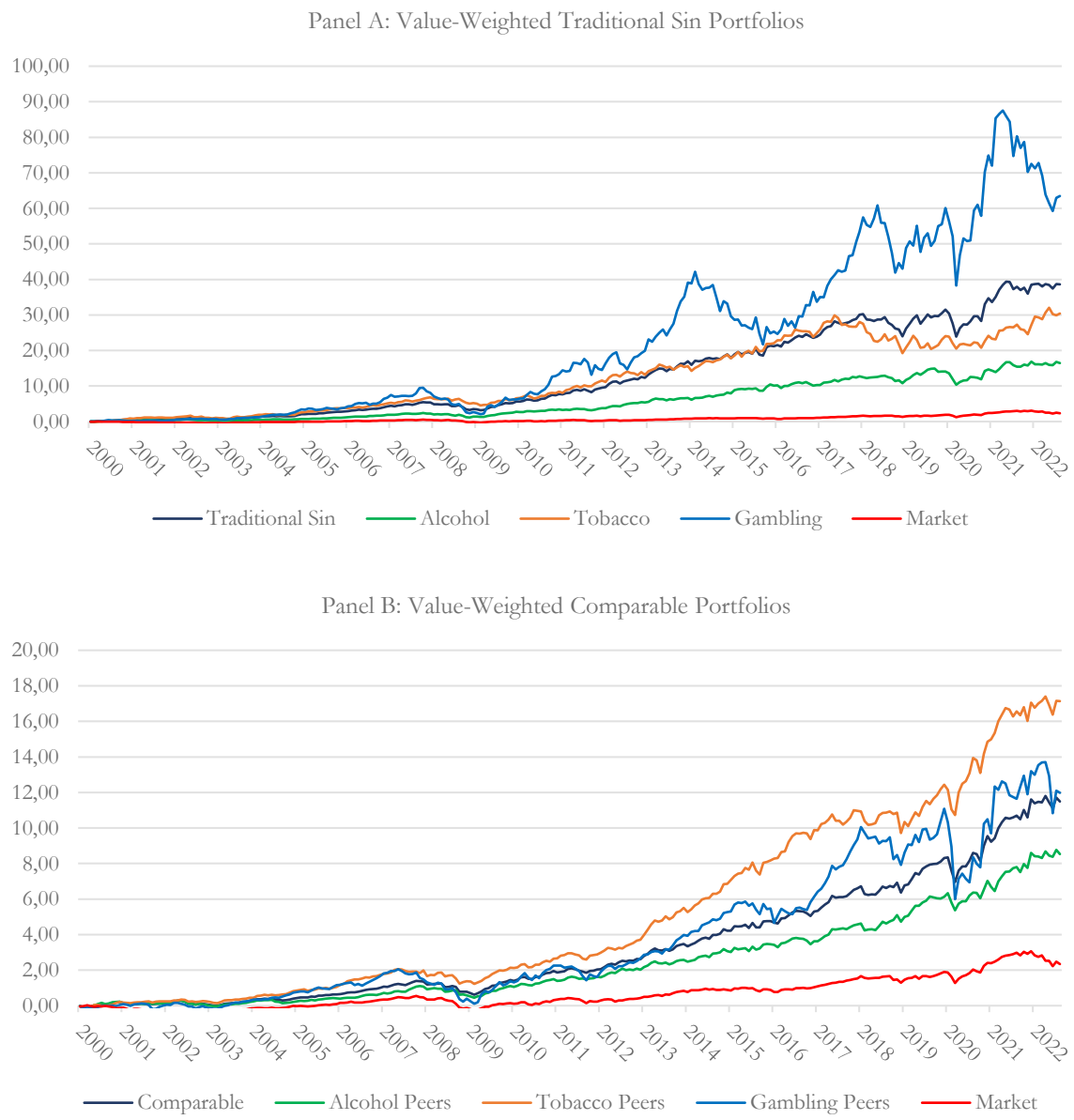


Figure 5.1.1 presents the historical cumulative returns of 1 USD investment in each of the portfolios from January 2000 - August. 2022. The portfolios are rebalanced monthly; all dividends and cash payouts are assumed to be reinvested, and the return calculation assumes no transaction costs. Panel A includes the V.W. portfolios for the total traditional sin portfolio, industry-divided portfolios consisting of traditional sin stocks for alcohol, tobacco, and gambling, and the market proxy. Panel B includes the V.W. comparable portfolio, the industry-divided traditional sin portfolios for alcohol, tobacco and gambling peers, and the market.

Figure 5.1.1 presents the historical cumulative return on an investment of 1 USD in each portfolio, starting in January 2000. The results are striking. The traditional sin portfolio has outperformed the comparable portfolio from December 2000 to August 2022. Accordingly, the figure shows that both the traditional sin and the comparable portfolio have outperformed the market. These descriptive statistics differ from the CAPM, which considers the market portfolio the most optimal choice (Kenton, 2020a). The fluctuations of both portfolios exhibit the same pattern as the market. The traditional sin portfolio generated cumulative returns of 3872%, the comparable portfolio generated a cumulative return of 1149%, and the market generated a cumulative return of 233%. However, the traditional sin portfolio has higher volatility than the comparable portfolio, measured by the monthly standard deviation of nominal returns. We note us that the traditional sin portfolio has delivered an annual Sharpe Ratio of 1.2%, which is greater than the comparable portfolio of 1.06% and the market of 0.46% Hence, it implies that traditional sin stocks yield greater excess returns for the volatility of holding a risky asset relative to the comparable portfolio. Nevertheless, it indicates that the risks of investing in traditional sin stocks are worth the returns.

We observe that the industry-divided portfolios have outperformed their comparable portfolios when not adjusting for risk. Moreover, the gambling portfolio performed better than both the alcohol- and tobacco portfolio in the sample period. However, measured by the standard deviation, the gambling portfolio has significantly higher volatility relative to the two other sin industries and their comparables. Accordingly, the portfolio has the most "extreme" minimum and maximum monthly returns of approximately -27.8% and 58,1%. The lower performance of the alcohol and tobacco portfolio is, however, steadier, as seen in **Figure 5.1.1**. The historical cumulative returns patterns seem thus to be in line with the descriptive statistic in **Table.5.1.1**.

We note that the gambling portfolio has generated a cumulative return of 6348% from January 2000 to August 2022, while the comparable gambling portfolio generated a cumulative return of 1199%. The cumulative returns were 1641% and 3042% for the alcohol and tobacco portfolios, respectively, far above the cumulative returns for their respective comparable portfolios with a cumulative return of 853% and 1713%. Thus, the gambling portfolio has delivered the best cumulative returns over the period, although with significantly higher volatility in the returns relative to the other traditional sin industries and their respective comparables. The latter is reflected through the gambling portfolios lower Sharpe Ratio. The comparable portfolio for the gambling industry has the lowest Sharpe Ratio and the highest standard deviation among the

comparable industries. These findings were expected as the comparable companies have similar risk exposure and firm characteristics. Furthermore, we argue that the gambling portfolio and its comparable portfolio's higher volatility might be explained by the exposure to an industry in the earlier phases, with potentially higher growth opportunities such as the sub-industry online gambling. In comparison, the alcohol and tobacco industries are more mature. Nevertheless, is makes economic sense that consumers of sin products choose to purchase alcohol and tobacco rather than gambling in times when one's ability to pay is lower. Thus, one could argue that the volatility reflects a rather cyclic trend for the gambling portfolio.

More interestingly, the traditional sin and comparable portfolio have an opposite development of risk-adjusted returns measured with the Sharpe Ratio, whereas the traditional sin portfolio illustrating a negative trend. The opposite is true for the comparable portfolio. The latter aligns with the 2020 Organization for Economic Co-operation and Development study, indicating a gradually increased exclusion criteria of sinful stocks in recent years. Although we cannot conclude solely based on this observation, it might imply a changed investor sentiment towards traditional sin stocks. Thus, it might suggest that investors have sold traditional sin stocks and bought non-sinful companies with similar characteristics.

On a nominal and non-risk-adjusted basis, the traditional portfolios have performed better than the market. We expect this outperformance to be partially explained by higher exposure to various risk factors.

5.1.2 Multi-Factor Regressions

Table 5.1.2: Regression Results for the Value-Weighted Tradition Sin Portfolio

Panel A: Vale-Weighted Traditional Sin Portfolio

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	1.178***	1.142***	.793***	.795***
	(.187)	(.201)	(.183)	(.188)
Rm-Rf	-.340***	-.320***	-.210***	-.212***
	(.042)	(.046)	(.045)	(.045)
SMB	-.056	-.087	.120	.124
	(.116)	(.116)	(.110)	(.111)
HML	.368***	.393***	.157	.150
	(.081)	(.083)	(.103)	(.128)
WML		.060		-.007
		(.069)		(.070)
RMW			.680***	.682***
			(.167)	(.167)
CMA			.392*	.398*
			(.160)	(.188)
Observations	272	272	272	272
R^2	.296	.300	.384	.384
Adjusted R^2	.288	.289	.372	.370

Panel B: Value-Weighted Comparable Portfolio

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.851***	.847***	.500***	.518***
	(.138)	(.147)	(.138)	(.142)
Rm-Rf	-.491***	-.488***	-.361***	-.374***
	(.036)	(.041)	(.037)	(.038)
SMB	-.253***	-.258***	-.098	-.055
	(.090)	(.090)	(.077)	(.079)
HML	.219***	.223***	-.044	-.102
	(.067)	(.065)	(.084)	(.089)
WML		.008		-.067
		(.056)		(.053)
RMW			.553***	.573***
			(.101)	(.104)
CMA			.494***	.551***
			(.124)	(.134)
Observations	272	272	272	272
R^2	.557	.557	.643	.648
Adjusted R^2	.552	.550	.637	.640

This table presents the time-series regressions of value-weighted portfolios from January 2000 to August 2022. Panel A presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in a traditional sin portfolio and a short position in the market. Panel B presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in a comparable portfolio and a short position in the market. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, and SMB is the Small-minus-Big size factor. HML is the High-minus-Low value factor, and UMD is the Up-minus Down momentum factor. RMW is the Robust-

minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Lastly, MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

The alphas of the traditional sin portfolio are both economically large and statistically significant across all models, declining from 1.178% for the FF3 model to 0.795% for the FF5+ MOM model, albeit not monotonically. The same alpha benefits from statistical significance at a 0.1% level across all models. We note that the traditional sin portfolio loads negatively on the highly significant market risk factor, independent of which multi-factor model is applied. Thus, suggesting a tilt towards low-beta stocks.

Starting with the FF3 model, the findings are largely consistent with Blitz and Fabozzi (2017) findings. The portfolio archives an FF3 monthly alpha of 1.178.% with a corresponding t-statistic of 6.299[21]. Hence, indicating that the portfolio outperforms the market. The size factor is insignificant, suggesting no tilt toward small or large market capitalization stocks.

Furthermore, the FF3 and FFC4 models propose that the traditional sin portfolio's abnormal return is partly attributed to the value factor (HML). This may result from how the traditional sin portfolio is constructed, as the portfolio gives more weight to the performance of the companies with high book-to-market values.

The alpha shrinks once the profitability and investment factors are included. However, it is still significant in economic and statistical terms. An important note is an empirically tested correlation between the value and investment factors discussed in subsection 3.4: I.e., value firms tend to have conservative investment strategies. In contrast, growth firms tend to execute a more aggressive investment strategy. In this sample, the correlation between the two is 0.76[22]. When the investment factor is included, the value becomes insignificant. Given the positive correlation, we argue that the value factor has absorbed some of the effects of the investment factor. Thus, the investment factor drives the portfolio return rather than the value factor. The findings align with financial theory, which suggests that high book-to-market stocks stocks applies to companies with a conservative investment strategy and vice versa. Nevertheless, as the value factor becomes insignificant, we find no evidence of traditional sin stocks as cash cows or value stocks (Tromp, 2019). As expected, the profitability factor (RMW) is highly economically and statistically

[21] The t-statistic is calculated as the coefficient divided by the standard error. The critical values are retrieved from a t-distribution table for a two-sided test at a 5%-0.1% significance level with an infinite (n>200) number of observations. The t-statistic for the FF3 alpha in the traditional sin portfolio is 6.299 (1.178/0.187).

[22] The correlation between all the explanatory variables can be found in the correlation matrix in Table 3.1 and in Appendix A3 table A3.1.

significant. Hence, it indicates a historical outperformance of profitable companies, enhancing investor returns. This corresponds to the findings of Blitz and Fabozzi (2017), who argue that the profitability factor is a substantial driver of the sin stock returns. Further, our findings are consistent with the well-recognized theory, which claims that sinful firms generally have robust profitability due to their monopolistic characteristic and addictive products (Tromp, 2019).

The statistically significant alpha contradicts Blitz and Fabozzi's (2017) findings, who found no abnormal returns for traditional sin stocks in the FF5 model. They claim that these stocks do not offer alpha but that investors earn high nominal returns through stocks tilting towards the investment and profitability factors. An industry, stock or geographic discrepancy might explain the difference. We also find positive return drivers from the investment and profitability factors. However, the regressions offer alpha, Hence, it might that some returns are not captured by the asset pricing factor, suggesting a market outperformance.

When adding the momentum factor to the FF5 model, the alpha still benefits from statistically significance at a 0.1% level. These findings seem reasonable as the factor is insignificant. As illustrated in the Pearson correlation matrix from **Table 3.1,** the momentum factor correlates with some of the other asset pricing factors. Thus, as expected, we observe minor deviations in the coefficients after controlling for the momentum factor.

As illustrated in **Table 5.1.2, Panel B**, we run regressions on the comparable portfolio. We observe a positive and significant alpha across all models. However, the alpha is lower than in the traditional sin portfolio. The comparable portfolio has a positive tilt toward the significant profitability and investment factors, which is expected since the comparable companies has similar firm characteristics as the sin companies. We observe that the profitability factor is lower in magnitude relative to the traditional sin portfolio. Albeit it is also a vital return driver for comparable stocks. This aligns with Tromp's (2019) argument, suggesting that traditional sin companies have monopolistic tendencies and thus should have somewhat higher profitability, ceteris paribus. A positive tilt is expected, as the comparable portfolio might also benefit from monopolistic tendencies (Lall and Siddenharthan, 1982).

5.1.3 Controlling for Traditional Sin Industries

As we observe a statistically significant alpha throughout all the regressions models in **Table 5.1.2**, we find it interesting to condition the preceding analysis on industries. The FF5 model is applied as this model has the highest explanatory power.

Table 5.1.3: Value-Weighted Industry-Divided Portfolios

Value-Weighted Traditional Sin Industry-Divided Portfolios

	Alcohol	Alcohol Peers	Tobacco	Tobacco Peers	Gambling	Gambling Peers
Constant(α)	.611**	.439**	.728*	.613***	1.152**	.556*
	(.208)	(.178)	(.286)	(.152)	(.367)	(.261)
Rm-Rf	-.360***	-.441***	-.271***	-.366***	.255**	.232***
	(.058)	(.046)	(.067)	(.042)	(.089)	(.066)
SMB	.214	-.202*	-.252	.013	.883***	.239
	(.125)	(.102)	(.164)	(.075)	(.198)	(.163)
HML	.059	-.180*	.075	-.011	.692***	.726***
	(.127)	(.111)	(.165)	(.096)	(.343)	(.266)
RMW	.742***	.599***	.625***	.578***	.547*	.114
	(.164)	(.127)	(.250)	(.124)	(.257)	(.207)
CMA	.180	.627***	.869***	.475***	-.714*	-.279
	(.188)	(.166)	(.262)	(.141)	(.515)	(.351)
Observations	272	272	272	272	272	272
R^2	.379	.606	.342	.607	.157	.215
Adjusted R^2	.367	.598	.330	.599	.141	.200

The table presents the time-series regressions of value-weighted industry-divided portfolios from January 2000 through August 2022. The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in a traditional sin industry-divided portfolio and a short position in the market. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, and SMB is the Small-minus-Big size factor. HML is the High-minus-Low value factor, while UMD is the Up-minus-Down momentum factor. RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Lastly, MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table 5.3.1 reports that all industry-divided portfolios offer FF5 alpha. The gambling portfolio delivers a substantially higher alpha, and several of the coefficients differ in factor loadings, magnitude, and significance compared to the other traditional sin industries. Thus, we observe that the gambling portfolio differs in characteristics. The regression results suggest a significant monthly alpha of respectively 0.611%, 0.728%, and 1.152% for the alcohol-, tobacco- and gambling portfolios with corresponding t-statistics of 2.937, 2.734 and 3.139.

Nevertheless, the gambling portfolio loads positively on the market risk factor at a 1% significance level, suggesting that the portfolio primarily includes stocks with higher beta. This finding appears reasonable as the gambling industry is somewhat cyclical. It seems sensible that one selects

tobacco rather than gambling in times when one's ability to pay is lower. The alcohol and tobacco portfolios load negatively on the market risk factor at a 0.1% significance level, which is in line with Hong and Kacperczyk (2009) findings. Stephen Connolly (2019) argues that the gambling business still goes through a rapid transformation due to the online betting industry, which increased significantly during the Covid-19 pandemic (Streeter, 2021). As many of the selected firms in the sample are online gaming and gambling companies, it may contribute to the overall volatility of the gambling portfolio. Thus, a higher risk premium relative to the two other traditional sin industries.

Moreover, we argue that the gambling portfolio's loading on the market risk factor can be partly explained by the industry's exposure to companies in earlier phases. As discussed earlier, alcohol- and tobacco are more established industries under stricter regulations, thus more stable and predictable (Brand et al., 2007; Savell et al., 2015; Jacobson et al., 2010). Further, in contrast to alcohol and tobacco companies, the gambling portfolio provides a high, positive significant size factor at a 0.1% level. Thus, suggesting that the gambling portfolio consists of firms with smaller market capitalization. The latter is in line with **Figure 4.1, Panel A,** which illustrates that the average market capitalization for gambling stocks is remarkably lower than other traditional sin industries. Moreover, the value factor is only statistically significant in the gambling regression. Thus, indicating that the gambling portfolio primarily consists of high book-to-market equities compared to the market and are primary value stocks.

The profitability factor loads positively on all three regressions and is economically and statistically significant, suggesting that the traditional sin industries mainly include firms with robust profitability relative to the market. As for the alcohol portfolio, the investment factor is insignificant, implying an investment strategy that is neither aggressive nor conservative. The tobacco portfolio loads positively on the investment factor and is statistically significant at the 0.1% level, which might imply a conservative investment strategy. The significant and positive tilt makes economic sense as the tobacco industry is regulated with an advertisement ban. Since marketing usually takes up a large part of the investment budget of companies, tobacco companies save a significant part of their cash due to these restrictions. Thus, it allows them to exercise a more conservative investment strategy. Accordingly, it makes economic sense that the significant factor explains some tobacco returns. Moreover, the gambling portfolio loads negatively on the investment factor, indicating a more aggressive investment approach. Thus, consistent with our previous discussion regarding the market risk factor. As the gambling industry consists of firms

in the early stages of their investment cycle, it seems reasonable that these companies execute a rather aggressive investment strategy to grow and gain market shares.

Another noticeable finding is that each traditional sin industry offers an economically higher alpha than the comparable industries. However, the tobacco industry's alpha is less significant than the comparable industry's alpha. Despite differences in statistical significance, each of the traditional sin industries offers alpha and outperforms the market.

The findings indicate that the alcohol and tobacco industries have similar characteristics, while the gambling portfolio differs. The alcohol and tobacco portfolio loads negatively on the market risk factor, which indicates that these portfolios consist of low-beta stocks. The latter finding makes economic sense as the tobacco and alcohol industries are known for their addictive tendencies, hence a continuous demand causing lower risk. Furthermore, these regressions have similar alphas in magnitude, whereas the alcohol regression delivers a positive and significant alpha at a 1% level and the tobacco regression at a 5% level. The gambling portfolio loads positively on the market risk factor. Additionally, the portfolio returns a highly significant and positive exposure to the size- and value factors relative to the market.

5.1.4 The Difference Portfolio[23]

Table 5.1.4: Value-Weighted Difference Portfolio

Value-Weighted Difference Portfolio				
	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.326	.296	.293	.277
	(.170)	(.173)	(.179)	(.178)
Rm-Rf	.151***	.169***	.151***	.162***
	(.044)	(.046)	(.048)	(.048)
SMB	.197*	.170	.218*	.180
	(.107)	(.106)	(.110)	(.108)
HML	.149*	.171**	.201*	.253*
	(.068)	(.070)	(.123)	(.129)
WML		.052		.060
		(.061)		(.064)
RMW			.127	.109
			(.147)	(.147)
CMA			-.102	-.153
			(.174)	(.182)
Observations	272	272	272	272
R^2	.095	.100	.101	.107
Adjusted R^2	.085	.086	.084	.086

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in a traditional sin portfolio and a short position in the comparable portfolio from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French's Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, while SMB is the small-minus-big size factor. Further, HML is the High-minus-Low value factor, whereas UMD is the Up-minus-Down momentum factor. RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Lastly, MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

To examine whether the traditional sin portfolio outperforms the comparable portfolio consisting of non-sinful stocks, we proceed with our analysis by running a regression on the difference portfolio[24].

At first sight, we note that the alpha is statistically indistinguishable from zero across all models. However, the alphas imply a monthly excess return above the comparable portfolio between 0.326% and 0.277%. I.e., it should be considered economically significant. Due to the lack of statistical significance, we cannot conclude that the traditional sin portfolio outperforms the non-

[23] The Difference Portfolio for Traditional Sin stocks
[24] The dependent variable being the traditional sin portfolio's monthly returns less the comparable portfolio's monthly returns.

sin comparable portfolio. However, we note that both the traditional sin and the comparable portfolio outperform the market individually[25].

Moreover, we observe a positive tilt towards the market risk factor at a 0.1% significance level. Thus, the traditional sin portfolio return is more volatile than its comparable portfolio. It is consistent with the descriptive statistics from **Table 5.1.1**, presenting a higher standard deviation and more extreme minimum and maximum monthly returns for the traditional portfolio. Furthermore, the difference portfolio tilts toward the significant size factor. Hence, it indicates that the traditional sin portfolio consists of companies with smaller market caps relative to the stocks of the comparable portfolio. **Figure 4.1, Panel A and B** confirms the latter as the average market cap for the total comparable portfolio exceeds the average market cap for the total traditional sin portfolio. We find this surprising since traditional sin industries tend to be dominated by firms with larger market capitalization due to their monopolistic attributes (Fabozzi, Ma, and Oliphant, 2008). However, **Figure 4.1 Panel B** indicates that the tobacco and gambling industry has an average market cap greater than its comparable portfolios. Thus, the difference portfolio's loading on the size factor is most likely a result of the market capitalization for the alcohol-comparable portfolio.

Furthermore, the profitability and investment factors are positive, albeit insignificant. Thus, we cannot with certainty comment on the traditional sin stocks' profitability and investment strategy relative to the comparable firms.

Lastly, we note that the explanatory power for the difference portfolio is significantly lower relative to the regressions applied to the traditional sin portfolios and their respective comparable portfolios (see Table 5.1.2). Thus, the multi-factor model's ability to explain disparities in stock returns might be poorer when applied to the different portfolios. Therefore, we are careful with exclusively relying on the interpretations of the coefficients for the difference portfolio regression.

[25] The regression results for the traditional sin and the comparable portfolio's monthly returns are less than the market monthly returns in Table 5.1.2.

5.1.5 Robustness Tests of the Traditional Sin Stock Alpha

As the alpha is not as well documented in developed countries as it is in the U.S., we conduct several robustness tests to validate our results. We do this by modifying one assumption at a time, ceteris paribus[26].

First, the multi-factor regressions indicate that the traditional sin portfolio's outperformance is primarily due to the performance of the gambling portfolio. Thus, to test whether the regression results are robust to the exclusion of gambling stocks, we estimate multi-factor regressions of a traditional sin portfolio excluding gambling. The results can be found in **Table 5.1.5.1.** Once gambling stocks are excluded from the traditional sin portfolio, the alpha is 710 basis points per month, representing a drop of 83 basis points compared to the total traditional sin portfolio (which includes gambling stocks). The alpha still benefits from a statistical significance at a 0.1% level. Interestingly, the explanatory power increase for all models. Thus, implying that the multi-factor model's ability to explain the returns works more poorly on the gambling sample than on the total traditional sin sample.

Table 5.1.5.1: Value-Weighted Traditional Sin Portfolio, Excluding Gambling

Value-Weighted Traditional Sin Portfolio, Excluding Gambling				
	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	1.136***	1.067***	.710***	.700***
	(.201)	(.212)	(.205)	(.205)
Rm-Rf	-.462***	-.422***	-.309***	-.301***
	(.045)	(.049)	(.050)	(.052)
SMB	-.216*	-.276*	-.026	-.052
	(.121)	(.120)	(.107)	(.113)
HML	.349***	.398***	.056	.091
	(.089)	(.089)	(.112)	(.122)
WML		.117*		.040
		(.069)		(.056)
RMW			.695***	.683***
			(.132)	(.133)
CMA			.548**	.514**
			(.168)	(.175)
Observations	272	272	272	272
R^2	.358	.368	.439	.440
Adjusted R^2	.351	.359	.428	.427

[26] For brevity, not all robustness test results are displayed in this section. All the results described in this section are, however, available in Appendix 4.

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in a traditional sin portfolio excluding gambling stocks and a short position in the market from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and present the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, and SMB is the small-minus-big size factor. HML is the High-minus-Low value factor, while UMD is the up-minus-down momentum factor. Further, RMW is the robust-minus-weak profitability factor, whereas CMA is the conservative minus-aggressive investment factor. Lastly, MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Additionally, we examined the sensitivity of the results in regard to the market. We re-run the regression using the Morgan Stanley Capital International (MSCI) World Market Index[27] in comparison to Kenneth French's market portfolio applied in the analysis. The results are presented in **Appendix 4, Table A4.1.** We found that the alphas for the traditional sin portfolios remain statistically significant at the 0.1% level across all multi-factor models. Interestingly, the alpha increased in magnitude for each additional control factor. Hence, this finding aligns with the ones of Blitz and Fabozzi (2017). Furthermore, we observed that the portfolio loads differently on the investment factor and that the momentum factor benefits from statistical significance. **Figure 5.1.1** illustrates the latter.

The comparable portfolio approach is revisited to test the robustness of the methodology employed in this analysis. We exploited other comparable portfolios from the 49 Fama-French portfolios[28], testing the performance of alcohol against soft drinks and tobacco against drugs. Lastly, we tested gambling against hotels, restaurants, and motels. **Appendix 4, Table A4.5** indicates that the performance of the traditional difference portfolio[29] is sensitive to which comparable portfolio we choose to compare it with. Accordingly, when Fama-French portfolios are applied, the traditional sin portfolio outperforms the comparable portfolio across all multi-factor models.

5.2 Hypothesis II: Modern Sin Stocks Offer Alpha

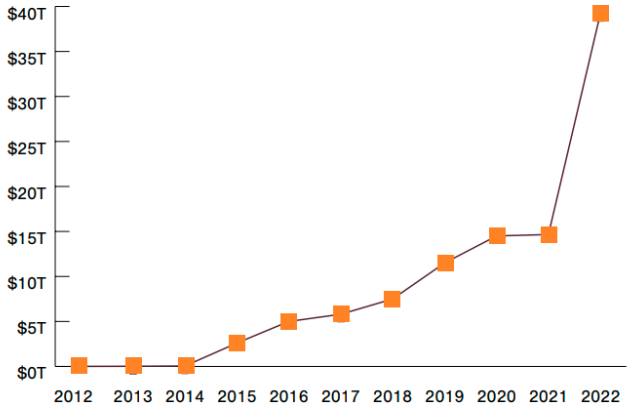
This section provides descriptive statistics, empirical findings and an analysis of the modern sin portfolio performance. We hypothesise that modern sin stocks offer alpha relative to the market and a comparable portfolio of companies within the renewable energy sector. We further suspect

[27] The MSCI World Index captures large and mid-cap representation across 23 Developed Markets (DM) countries*. With 1,507 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country (MSCI, 2022).
[28] We use the Fama–French 49 industry classification to test the robustness of a broad industry classification than what is used in the analysis.
[29] This refers to the difference portfolio for traditional sin stocks.

that the alpha has increased significantly ex-post the fossil fuel divestment movement defined as the year-end of 2014.

An intuitive and appealing explanation for the observed abnormal returns of sin stocks is that they are undervalued since so many investors shun them. Tobacco was disfavoured and feared when people enjoyed the first findings and oil and gas exploration. Today, oil and gas companies face the same economic, political, and social issues as tobacco companies. The Fossil Fuel Divestment Campaign emerged in the United States in 2011, blooming at American universities (Divestment Database, 2022). Seeking to minimize greenhouse gas emissions, the movement encouraged investors to sell their positions in fossil fuel companies (Ansar et al., 2013). By September 2014, investors have divested more than 50 billion USD. These numbers increased to 2.6 trillion USD in a year (Divestment Datbase, 2022). Since then, the total amount has increased to 40.5 trillion USD (Divestment Database, 2022). **Figure 5.2.1** presents this development.

Figure 5.2.1: Fossil fuel divestment in cumulative USD numbers (assets)



Source: Global Divestment Commitments Database, 2021

Further, several institutional investors seem to follow the divestment trend. Handelsbanken's Norwegian index fund recently excluded oil and gas companies from their portfolio, resulting in an index decrease of 20 percent. The outperformance of OBX relative to other stock exchanges in the recent year might be explained by the modern sin stock theory, as oil and gas companies accumulate the most significant part of the stock market (Magnus., 2022). Thus, a heightened global effort towards lowering the planet's carbon footprint has paved the way for a modern definition of the sin industry (Sainsbury, 2020).

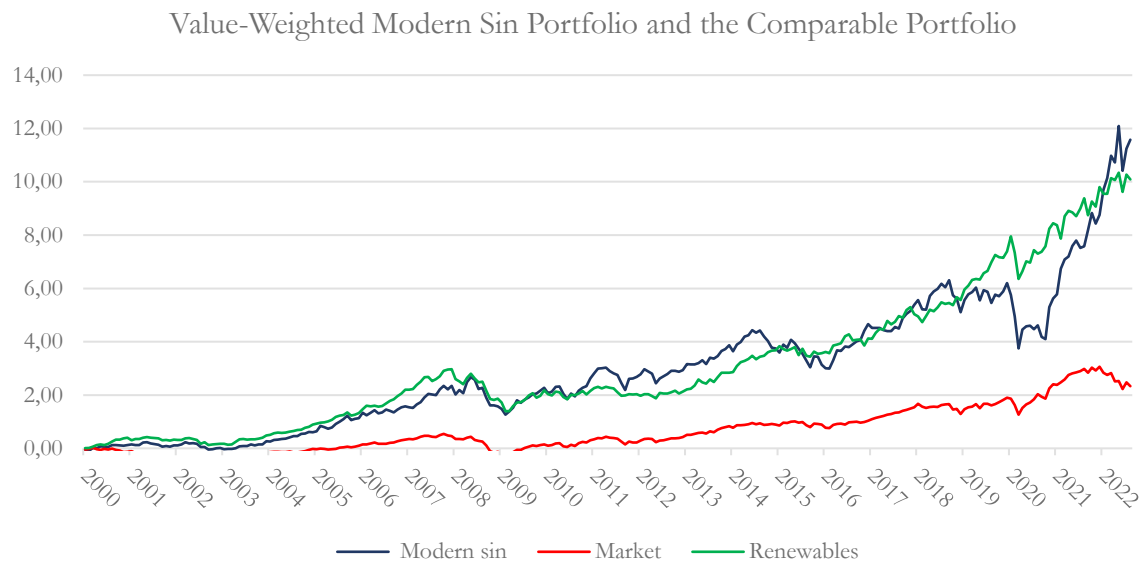
As the total amount divested increased notably between the end of 2014 and 2015, we study whether the performance of oil and gas stocks is significant in the years after 2014 compared to the years before. In the following section, we refer to the period of January 2000 to December 2014 as the "ex-ante divestment movement" and the "ex-post divestment movement" as the period of January 2015 to August 2022.

Table 5.2.1: Descriptive statistics of the Modern Sin Portfolio and the Comparable Portfolio

		N	MIN	MAX	R	SD	Annualized SR
01.01.2000-31.08.2022	Modern Sin Portfolio	272	-20.300%	23.700%	1.100%	0.700%	0.700%
	Comparable Portfolio	272	-11.800%	9.400%	0.900%	0.890%	0.890%
	Market	272	-19.430%	13.350%	0.500%	4.540%	0.410%
01.01.2000-31.12.2014	Modern Sin Portfolio	180	-11.440%	13.730%	0.980%	4.730%	0.710%
	Comparable Portfolio	180	-11.540%	8.350%	0.930%	3.660%	0.870%
	Market	180	-19.400%	11.420%	0.465%	4.651%	0.346%
01.01.2015-31.08.2022	Modern Sin Portfolio	92	-20.300%	23.750%	1.250%	6.160%	0.703%
	Comparable Portfolio	92	-11.830%	9.400%	1.010%	3.770%	0.931%
	Market	92	-13.650%	13.350%	0.710%	4.340%	0.560%

The table presents summary statistics for the observations for the value-weighted modern sin portfolio and the comparable portfolio. The data sample was retrieved from Datastream from January 2000 to August 2022. The minimum- and maximum values present the lowest and highest monthly return observation during the observation period. N is the number of observations, and R presents the time-series mean monthly portfolio return. Further, the standard deviation (SD) identifies the average volatility of the monthly returns for the portfolio. Lastly, the annualized portfolio Sharpe ratio (SR) is the excess return reward (average return minus the average risk-free rate) per unit of risk.

Figure 5.2.1: Figure 5.1.1: Cumulative Returns of the Traditional Sin Portfolios and the Comparable Portfolios



The figure presents the historical cumulative returns of a 1 USD investment from January 2000 – August 2022 in each portfolio for modern sin, their comparable portfolio, and the market. The portfolio rebalances monthly; we assume all dividends and cash payouts to be reinvested, and the return calculation assumes no transaction costs.

Figure 5.2.1 presents the historical, cumulative return on an investment of 1 USD in the modern sin and the comparable portfolio and the market. The figure shows that both the modern sin and comparable portfolio have outperformed the market. The fluctuations of both portfolios exhibit a similar pattern as the market. The modern sin portfolio generated cumulative returns of 1158%; the comparable portfolio generated a cumulative return of 1009. However, the modern sin portfolio has higher volatility than the comparable portfolio, measured by the monthly standard deviation of nominal returns. **Table 5.2.1** illustrates that the modern sin portfolio has delivered an annual Sharpe Ratio of 0.7%, which is better than the market, generating a Sharpe ratio of 0.45%. Nevertheless, both portfolios perform worse than the comparable portfolio of 0.89%. Thus, the comparable portfolio has the best, overall performance in terms of Sharpe ratio.

Furthermore, we observe a negative development of modern sin stock risk-adjusted returns in terms of the Sharpe ratio. The modern sin portfolio returned a Sharpe ratio of 0.710 from 2000 to 2014, while the comparable portfolio had a ratio of 0.87% in the same period. The modern sin portfolio had the lowest Sharpe ratio (0.703%) in the period of January 2015 to August 2022, whereas the comparable portfolio experienced an improvement in risk-adjusted performance with

a Sharpe ratio of 0.931%. Thus, we argue that this notable trend in the Sharpe Ratio aligns with our theory of the oil and gas industry's new development into a of modern sin industry.

5.2.2 Multi-Factor Regressions

Table 5.2.2: Regression Results for the Value-Weighted Modern Sin Portfolio and the Comparable Portfolio

Panel A: Value-Weighted Modern Sin Portfolio

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.606**	.569**	.610**	.588**
	(.192)	(.195)	(.204)	(.204)
Rm-Rf	-.107*	-.086	-.125*	-.109*
	(.042)	(.046)	(.050)	(.051)
SMB	-.057	-.089	-.051	-.104
	(.102)	(.106)	(.107)	(.112)
HML	.639***	.665***	.744***	.816***
	(.068)	(.072)	(.111)	(.121)
WML		.063		.083
		(.053)		(.056)
RMW			.092	.067
			(.131)	(.132)
CMA			-.203	-.273
			(.168)	(.174)
Observations	272	272	272	272
R^2	.274	.278	.280	.286
Adjusted R^2	.266	.267	.266	.269

Panel B: Value-Weighted Comparable Portfolio

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.799***	.724***	.550**	.525**
	(.172)	(.183)	(.178)	(.177)
Rm-Rf	-.472***	-.428***	-.388***	-.371***
	(.038)	(.048)	(.044)	(.044)
SMB	-.251**	-.317***	-.137	-.197*
	(.091)	(.099)	(.093)	(.097)
HML	.269***	.323***	.134	.215*
	(.061)	(.082)	(.097)	(.105)
WML		.128**		.093
		(.061)		(.048)
RMW			.442***	.413***
			(.115)	(.115)
CMA			.249	.170
			(.146)	(.151)
Observations	272	272	272	272
R^2	.433	.449	.469	.476
Adjusted R^2	.427	.440	.459	.464

This table presents the time-series regressions of value-weighted portfolios from January 2000 to August 2022. Panel A presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a modern sin portfolio and a short position in the market. Panel B presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a comparable portfolio and a short position in the market. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor, determining the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Throughout 22 years of observations, the modern sin portfolio returns monthly average abnormal returns at a 1% significance level. The alpha is economically significant, declining from 0.606% for the FF3 model to 0.588% for the FF5+ MOM model, albeit not monotonically. Consequently, our findings are in line with Bolton and Kacperczyk's (2021), who documents a significant alpha for high fossil-fuel companies.

The negative market factor is significant for all models except the FFC4 model. Thus, it might imply that the modern sin portfolio is less volatile than the market. As expected, the modern sin portfolio has a high economic loading on the significant value factor and a negative loading on the significant size factor. Oil and gas companies tend to be "asset-heavy," i.e., they tend to have a great number of assets in their balance sheets. Indeed, oil and gas firms often account for a large part of the total market capitalization on various stock exchanges. The latter can be seen as analogous to **Figure 4.1, Panel C**, which illustrates that oil and gas companies have larger market capitalizations than the other industries in general.

Furthermore, we observe that the modern sin portfolio loads positively on the coefficient measuring firm profitability, albeit it is indistinguishable from zero. The investment factor is also statistically insignificant. Thus, we cannot conclude whether the profitability and investment factors partly explain the portfolio returns for modern sin stocks. The FF5 + MOM model fits best in explaining the variations, whereas we observe a monthly alpha close to 0.588%.

Table 5.2.2, Panel B, reports the abnormal returns for the comparable portfolio. We observe an economically large and statistically significant alpha, decreasing from 0.799% for the FF3 model to 0.525% for the FF5+MOM. Moreover, we observe a larger economic alpha at a higher significant level for the comparable portfolio relative to the modern sin portfolio when applying the FF3 and FFC4 models. However, when controlling for the profitability and investment factor, the alpha declined to 0.555% with a corresponding t-statistic of 3.089. Consequently, the alpha offered by the comparable portfolio lies below the modern sin stock alpha under the FF5 model

with and without momentum. Lastly, the results suggest that the return is partly attributed to the profitability factor, thus decreasing the alpha reported under the FF3 and FFC4 model.

5.2.3 Ex-ante and Ex-post The Divestment Movement

We suspect that the economic magnitude of alpha for modern sin stocks results from the recent trend of negative screening, divestment campaigns, and exclusion of oil and gas stocks. Thus, we find it interesting to consider the preceding analysis ex-ante and ex-post the divestment movement. The FF5 + MOM model is applied as mentioned in section 5.2.2, and it has the highest explanatory power.

Table 5.2.3: Regression Results for the Value-Weighted Modern Sin Portfolio Ex-ante and Ex-post the Divestment Movement

	Ex-Ante 2000-2014	Ex-Post 2015-2022
Constant(α)	.527*	.984**
	(.237)	(.309)
Rm-Rf	-.131*	.124
	(.062)	(.083)
SMB	-.149	.006
	(.121)	(.215)
HML	.474**	.439
	(.146)	(.251)
WML	.110*	-.096
	(.056)	(.145)
RMW	.554**	-.738**
	(.167)	(.276)
CMA	-.318	.616
	(.189)	(.331)
Observations	180	92
R^2	.292	.583
Adjusted R^2	.267	.554

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio. The portfolio takes a long position in a traditional sin portfolio and a short position in the comparable portfolio Ex-ante (2000-2014) and Ex-post (2015-2022) the divestment movement. The coefficients on the explanatory variables are retrieved from Kenneth French's Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, while SMB is the Small-minus-Big size factor. HML is the High-minus-Low value factor, and UMD is the Up-minus Down momentum factor. RMW is the Robust-minus-Weak profitability factor, while CMA is the Conservative- minus-Aggressive investment factor. MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Studying the performance of the modern sin portfolio ex-ante the divestment movement, we find an average monthly alpha of 0.527% when implementing the FF5 + MOM model at a 5% significance level. Indeed, the portfolio is statistically significant ex-post the divestment

movement, offering a monthly alpha of 0.984% at a 1% significance level. Thus, and in line with our expectations, we conclude on differences in alphas in the two periods. Additionally, as we find no indications of a continuous trend of increasing oil prices after the divestment movement (see figure 6.1), we suspect other factors affecting the abnormal returns. Indeed, we believe that an increase in alpha might be explained by the increased focus on the importance of divesting from oil and gas stocks due to environmental reasons.

Interestingly, we observe differences in the two periods regarding loading, magnitudes, and significance for all factors. The market risk factor coefficient moves from negative to positive between the two periods, implying that the modern sin portfolio has changed from low-beta stocks to high-beta stocks. I.e., indicating that the portfolio's volatility has increased. In exchange, high-beta stocks provide higher return potential. These findings align with the presence of a sin stock premium. The increased risk comes with an increased awareness of the environmental aspects of the oil and gas industry, hence abnormal returns.

Furthermore, the modern sin portfolio holds a heavy, positive loading on the value factor for both periods. The value factor is significant, partly explaining the abnormal returns ex-ante the divestment movement. However, the factor becomes insignificant ex-post the divestment movement. Hence, we do not find evidence that the value factor explains the abnormal returns ex-post the divestment movement. Moreover, the modern sin portfolio moves from oil and gas companies with robust profitability to less profitable companies. These findings seem reasonable as we suspect a recent increase in the awareness of oil and gas as a sinful industry. Comparing the results for the ex-ante and ex-post the divestment movement suggests changes in characteristics of 1) the market or 2) the companies, or 3) a combination of them. Thus, supporting the theory of a modern sin industry.

We should mention that the number of observations (N) is lower for the ex-ante and ex-post portfolios than for the overall regressions. The period from 2000 to 2014 includes 180 observations, while the period from 2015 to 2022 includes 92 observations. Nevertheless, the number of observations is still sufficient to get adequate statistical results.

5.2.4 The Difference Portfolio[30]

Table 5.2.4: Regression Results for the Value-Weighted Difference Portfolio

Value-Weighted Difference Portfolio				
	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	-.193	-.155	.060	.063
	(.251)	(.269)	(.263)	(.264)
Rm-Rf	.365***	.343***	.263***	.261***
	(.055)	(.069)	(.065)	(.066)
SMB	.194	.227	.086	.093
	(.133)	(.152)	(.137)	(.145)
HML	.370***	.343***	.610***	.601***
	(.089)	(.136)	(.143)	(.157)
WML		-.065		-.010
		(.099)		(.072)
RMW			-.350*	-.346*
			(.169)	(.171)
CMA			-.452*	-.443*
			(.216)	(.225)
Observations	272	272	272	272
R^2	.181	.184	.207	.207
Adjusted R^2	.172	.172	.192	.189

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in a modern sin portfolio and a short position in the comparable portfolio from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French's Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the Small-minus-Big size factor, and HML is the High-minus-Low value factor. UMD is the Up-minus Down momentum factor, and RMW is the Robust-minus-Weak profitability factor. CMA is the Conservative-minus-Aggressive investment factor, and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

We further examined the presence of alpha for modern sin stocks relative to the comparable portfolio. The intercept reflects monthly abnormal returns in percentage through a long position in the modern sin portfolio and a short position in the comparable portfolio[31]. Empirical findings are presented in **Table 5.2.4.**

The regression results show no indication of abnormal returns when comparing the modern portfolio against the comparable portfolio. Hence, we can hardly conclude that the modern sin portfolio outperforms the comparable portfolio. Thus, our results contradict the findings of In et al. (2019). The market risk factor is positive and statistically significant in all models at a 0.1% significance level, indicating that renewable stocks are less volatile than oil and gas stocks. These findings make some economic sense as renewable energy is meant to replace oil and gas as a more

[30] The Difference Portfolio for Modern Sin stocks

[31] The dependent variable being the modern sin portfolio's monthly returns less the comparable portfolio's monthly returns.

environmentally friendly energy source. Ghabri et al. (2021) emphasize the economic uncertainty related to the covid-19 pandemic and its impact on global energy markets. They argue that the pandemic has affected investment activity associated with the clean energy transition. The substitution of divesting from fossil fuel to investing in renewable energy to reduce CO2 emissions may explain these trends. Investors fear the future of fossil fuels, leaving oil and gas stocks at risk.

Table 5.2.1 illustrates that the comparable portfolio has a lower standard deviation and minimum and maximum monthly returns relative to the modern sin portfolio. Furthermore, the value factor is positive and statistically significant at a 0.1% level for the difference portfolio. Hence, this implies that the modern sin portfolio is more exposed to high-book-to-market companies than the comparable portfolio. Indeed, it aligns with the consideration of oil and gas companies as "asset-heavy." However, it may also indicate that the market values the companies' equity cheaply compared to its book value (Kenton, 2022). Hence, it might (partly) explain why modern sin stocks yield abnormal returns. We should however mention that the oil and gas industry is more mature in terms of the life cycle of the companies compared to the renewable energy industry. Thus, the modern sin portfolio is more exposed to high book-to-market firms than the renewable energy portfolio as expected.

Even though we discover insignificant alphas for the difference portfolio across all models, we find strong evidence of alpha in both the modern sin and their comparable renewable energy portfolio. This might indicate that both modern sin and comparable renewable portfolios offer a premium that the different factor exposures do not capture. Thus, an investor could expect to earn abnormal returns by investing in both the modern sin and comparable portfolios in the data period.

We observe a considerably lower explanatory power when employing the different portfolios to the regressions. It may indicate that the model works poorly in the regressions. Thus, we are careful when analyzing these interpretations of the coefficients.

5.2.5 Robustness Tests of the Modern Sin Stock Alpha

We conduct several additional tests to examine whether the regression results are robust. First, the modern sin industry is central in wars and conflicts, as the Ukraine war and other previous crises shows. The invasion of Ukraine has led to energy price shocks, resulting in a positive cash

flow for oil and gas companies. Accordingly, pushing oil and gas prices to their highest levels in nearly a decade (see figure 6.1). Hence, resulting in a significant increase in share prices and, thus, returns. Petroleum companies have historically returned super profits when such conditions hit the markets (Mihajlo, 2022). The fossil fuel industry's average annual net income from 1970 through 2020 amounted to 1 trillion USD, which is set to double by 2022 (World Bank, 2022). For instance, our sample's largest oil company, ExxonMobil, generated a net profit of 17.9 billion USD in the second quarter of 2022, compared to 4.69 billion USD in the same quarter in 2021 (Mihajlo, 2022). Consequently, recent energy crisis might explain the abnormal returns. Thus, to test whether the regression results are robust to the exclusion of the ongoing energy crisis, we re-run the multi-factor models, excluding the period from January 2022 to August 2022.

Table 5.2.5.1: Regression Results for the Value-Weighted Modern Sin Portfolio, Excluding 2022

Value-Weighted Modern Sin Portfolio, Excluding 2022				
	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.518**	.491*	.472*	.458*
	(.190)	(.193)	(.202)	(.202)
Rm-Rf	-.109**	-.093*	-.119*	-.108*
	(.042)	(.046)	(.050)	(.051)
SMB	-.029	-.053	.005	-.036
	(.101)	(.104)	(.105)	(.111)
HML	.574***	.595***	.700***	.754***
	(.071)	(.075)	(.110)	(.120)
WML		.047		.061
		(.052)		(.054)
RMW			.228	.205
			(.134)	(.135)
CMA			-.275	-.325
			(.165)	(.171)
Observations	264	264	264	264
R^2	.228	.230	.244	.248
Adjusted R^2	.219	.218	.230	.230

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio with a long position in the modern sin portfolio and a short position on the comparable portfolio from January 2000 to December 2021. The coefficients on the explanatory variables are retrieved from Kenneth French's Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, and SMB is the Small-minus-Big size factor. HML is the High-minusLlow value factor, and UMD is the Up-minus Down momentum factor. RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

The results are presented in **Table 5.2.5.1**. We find that the FF3 alpha of the modern sin portfolios remains statistically significant at the 1% level. When we extend the model and control

for several factors, the model still benefits from statistically significance, albeit at a lower level. Hence, resulting in a decrease in the magnitude of alpha across all models.

We argue that the economic magnitude of alpha for the entire sample period might result from the super profits earned through the current energy crisis. Thus, resulting in a biased estimate for the relative performance in the period. Since 2022 represents a clear peak in terms of super profits, we argue that the regression results from the sample period might be biased. Accordingly, generating an overestimation of alpha for the long-term performance of the modern sin portfolio. Further, as the modern sin portfolio consists of stocks with significant exposure to the oil price, we argue that it is essential to be aware of the cyclical nature of the oil price when evaluating the modern sin portfolio. Since the oil companies have gone through several cycles and crises since 2000, we argue that when excluding 2022 from our sample period, the robust results improve the findings and provide fair estimates of the long-term performance of modern sin. Thus, we consider the decrease of alpha when controlling for the latest energy crisis as a point of concern for robustness. Thus, we conclude that the alpha reported in **Table 5.2.2** is overestimated, and the monthly alpha is closer to 0.458%.

Table 5.2.5.2: Value-Weighted Modern Sin Portfolio Ex-ante and Ex-post the Divestment Movement, Excluding 2022

	Ex-Ante 2000-2014	Ex-Post 2015-2021
Constant(α)	.527*	.691*
	(.237)	(.316)
Rm-Rf	-.131*	.081
	(.062)	(.085)
SMB	-.149	.123
	(.121)	(.220)
HML	.474**	.395
	(.146)	(.245)
WML	.110*	-.185
	(.056)	(.148)
RMW	.554**	-.591*
	(.167)	(.282)
CMA	-.318	.415
	(.189)	(.351)
Observations	180	84
R^2	.292	.490
Adjusted R^2	.267	.450

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolio. The portfolio takes a long position in a traditional sin portfolio and a short position in the comparable portfolio Ex-ante (2000-2014) and Ex-post (2015-2021) the divestment movement, excluding 2022. The coefficients on the explanatory variables are retrieved from Kenneth French's Data Library and present the monthly returns of the Fama-French factors. The momentum factor captures the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the Small-minus-Big size factor, and HML is the High-minus-Low value factor.

UMD is the Up-minus Down momentum factor, and RMW is the Robust-minus-Weak profitability factor. CMA is the Conservative-minus-Aggressive investment factor, and MOM is the momentum factor, which seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, 1%, and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Because we consider the decrease in alpha (when excluding 2022 from the sample period) as a point of concern, we condition the preceding robustness test and exclude 2022 from the ex-post divestment movement period. The results are displayed in **Table 5.2.5.2**, demonstrating that once the year 2022 is excluded from the sample period, the alpha is only 691 basis points per month, representing a drop of 287 basis points compared to the ex-post period, including 2022. The alpha still benefits from statistical significance, albeit at a 5% significant level. Despite differences in statistical significance, the regression still presents evidence of a significant increase in alpha ex-post the divestment movement. Thus, we find the robustness test results to support the theory of a newly developed modern sin industry.

To finally test the robustness of the methodology employed in this thesis, we conducted the same robustness test as for the traditional sin portfolio by changing 1) the market proxy and 2) the comparable portfolio. The results as shown in **Appendix 4. Table A4.3** shows that neither the regression coefficient nor the significant levels exhibit any sizeable deviation from those reported in the analysis when Kenneth French's market portfolio is applied. However, the alpha represents a rise of 851 basis posits compared to the modern sin portfolio. As for the traditional sin portfolio, the comparable portfolio approach is revisited by exploiting Fama-French portfolios. We test the performance of oil and gas stocks against utilities. **Appendix 4, Table A4.6** illustrates the results of the robustness test. The modern difference portfolio does not exhibit any sizeable deviations from those reported in the analysis when renewable energy stocks are used as comparable.

6. Limitations and Further research

This section briefly reviews the most apparent limitations of our thesis, thus suggesting areas for further research. In our view, the most obvious candidate for further research is an empirical analysis of the valuation of traditional and modern sin stocks. We believe that a systematic undervaluation of sin stocks can explain the abnormal returns; however, we need a more comprehensive analysis to investigate this suggestion.

Controlling for Additional Factors

A significant limitation to our thesis might be that we have yet to replicate all the analyses of the most established literature on the sin stock alpha. If the applied risk models are accurate, we infer the presence of alpha for traditional and modern sin stocks when using data on developed countries from January 2000 to August 2022. However, if there exist excluded asset pricing factors that can explain the abnormal returns, it could bias the inference of alpha. Most remarkable, the study of Blitz and Fabozzi (2017) and Bolton and Kacperczyk (2021) control for the asset factor betting-against-beta (BAB)[32]. They include this factor as some studies present evidence of a low-beta anomaly for sin stocks. Indeed, the factor projects that higher beta assets are overvalued while lower beta assets are undervalued. Nevertheless, they implemented the BAB factor to strengthen their suggestion of an alpha reflected in the intercept.

Inclusion of Additional Sin Stock Industries

As we saw in subsection 2.2.1, there are numerous ways to define a sin stock, and these definitions can lead to various outcomes. Hence, one could argue that other fossil fuel industries should be considered in defining a modern sin industry. The main types of fossil fuels are coal, oil, and gas. Increased use of coal was the main factor in increasing global energy-related CO2 emissions, accounting for more than 40% of the global CO2 emissions in 2021 (EIA, 2022). The increased demand (and rebound) for the use of coal was primarily due to record-high gas prices. The inclusion of coal as a modern sin stock could therefore have had an impact on our alpha. However, we chose to omit it due to several reasons. According to the IEA, coal supply investment is far less capital-intensive than oil and gas. Additionally, some major oil and gas companies (I.e., Chevron, BP, and Exxon Mobile) are integrated, meaning their businesses consist of a mix of up, mid and downstream activities. Hence, we seek to limit the scope of our data set in terms of industries. Nevertheless, we suggest the inclusion of coal to modern sin stocks for further research. Since coal is considered the most polluting fossil fuel, we believe we might achieve different results for the modern sin stock portfolio.

Empirical Analysis of the Valuation of Sin Stocks

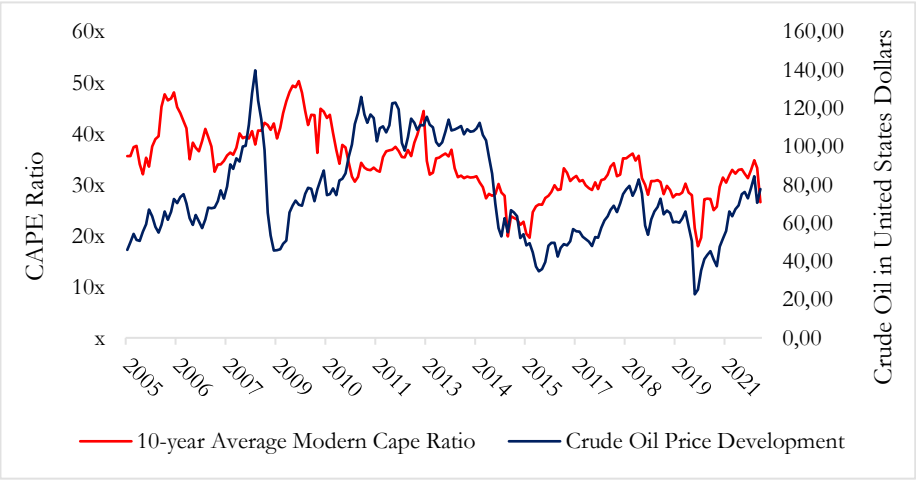
In line with previous sin stock studies, we noted that a sin stock premium might result from a systematic undervaluation of sin stocks. Low valuations of sin stocks might indicate a level of

[32] BAB - Betting against beta- is a low- versus high-beta factor. The factor isolates the return of a diversified portfolio of high-beta stocks in excess of the return on a diversified portfolio of low-beta stocks (Frazzini & Pedersen, 2013).

uncertainty regarding the attempts of these companies to develop their businesses away from fossil fuels (Schürmann, 2022). However, we did not test this empirically. Hence, further research might be an in-depth empirical analysis of the valuation of traditional and modern sin stocks. Thus, investigating whether there is a clear downward trend in the valuation of sin firms by implementing different asset pricing factors and fundamental company characteristics. Accordingly, one could run a cross-sectional valuation regression by employing the methodology of Fama and Macbeth (1973).

Additionally, one could compare the valuation of modern sin stocks with the development in Crude Oil Prices (see figure 6.1 below). Oil prices directly impact oil and gas stocks since their earnings are multiplied by the amount the companies realize on each barrel. Accordingly, we suspect that changes in oil prices might affect the view on the industry. Ebaid et al. (2022) empirically studied whether oil price shocks influence Co2 emissions. They discovered that positive oil shocks (increasing oil prices) statistically affect Co2 emissions. Consequently, one might increase the awareness of the oil and gas industry as sinful when oil prices are high. Although the oil price is highly correlated with the oil companies' earnings and thus share price, we seek to limit the scope of our thesis. However, we still found the development in oil price an interesting explanation of the sin stock premium. Hence, further research on implementing an empirical analysis would be of great interest.

Figure 6.1: Crude Oil Prices Relative to the Cape Ratio (CAPE)[33] for Modern Sin Stocks



The figure presents the cyclically adjusted price earnings ratio (CAPE). The CAPE is based on prices, earnings and crude oil prices retrieved from Refinitiv. Since the ratio is cyclically adjusted, CPI' adjustment factors are extracted from Shillers Online Database. All numbers are on a monthly basis; however, earnings are collected on a yearly basis. Source: Refinitiv, 2022.

[33] The CAPE ratio, also known as the Shillers' P/E, was developed by Robert Shiller during the dotcom crisis. It was developed to prove that equities in general were overvalued. The ratio is measured by dividing the share price by the average earnings for 10 (or 5) years, adjusted for inflation.

7. Conclusion and Contributions

This study aimed to examine the alpha for sin stocks in developed countries between January 2000 to August 2022. The study expanded on the previous research by applying a contemporary definition of the sin industry that considers oil and gas companies. To achieve the study's objectives, the study focused on four sin stock categories: alcohol, tobacco, gambling, and oil and gas. We aim to contribute to the existing literature on sin stock performance by introducing new periods and markets, a new inclusion criterion, and a broader geographical scope, as previous research has reached contradictory conclusions. This section provides a summary of the findings and highlights the thesis contribution.

By analyzing the performance of traditional sin stocks between January 2000 and August 2022, the study offers compelling proof that traditional sin stocks offer alpha. During the period, a value-weighted portfolio of alcohol, tobacco, and gambling stocks generated cumulative returns of 3872 %. A corresponding portfolio comprised of comparable stocks would only have generated cumulative returns of 1149 %, and the market generated cumulative returns of 233% over the same period. The multi-factor regressions show that the traditional sin portfolio outperforms the market and yields an average monthly alpha of 0.793 %, statistically significant at the 0.1 % level under the FF5 model. This is consistent with Hong and Kacperczyk (2009) and Fabozzi, Ma, and Oliphant's (2008) findings but contrary to the findings of Blitz and Fabozzi (2017). Furthermore, our data imply that traditional sin stocks tend to consist of low-beta stocks with robust profitability. Moreover, our industry regressions suggest that the gambling portfolio is the superior investment over time, albeit the volatility is significantly higher than the other sin industries and the comparable portfolios.

Conditioning the initial analysis on the difference portfolio, the traditional sin portfolio does not outperform the comparable portfolio. Thus, traditional sin investors are compensated with a risk premium, though not considerably more than investors investing in comparable stocks. The strong performing comparable portfolio might be due to common factors driving the returns for both the sin- and comparable portfolios. However, the study concludes with a more extensive economic alpha for the traditional sin portfolio at a higher significant level. Thus, evidence suggests that excluding sin stocks from an investment portfolio will negatively affect the portfolio's performance. The latter findings also apply to the industry-divided portfolios. Thus, our findings defy the critique of Hong and Kacperczyk's (2009) paper, as we have mitigated any

potential excess returns of illiquid stocks via our stock inclusion criteria that include size and liquidity.

By examining the performance of modern sin stocks in the same period, we found strong evidence suggesting the presence of alpha. A modern sin portfolio composed of oil and gas stocks would have produced cumulative returns of 1158 % from January 2000 to August 2022. The comparable portfolio would have generated cumulative returns of 1009% over the same period. The multi-factor regressions show that the modern sin portfolio outperforms the market and yields an average monthly alpha of 0.588 %, statistically significant at the 0.1 % level, under an FF5 model, which is consistent with Bolten and Kacperczyk's (2021) findings.

Interestingly, when comparing the ex-ante and ex-post divestment movement regression results, we find changes in 1) the market, 2) the companies, or 3) a combination of the three. After controlling for the current energy crisis and the accompanying super profits for modern sin stocks, the latter statement still holds true. Furthermore, the alpha increased from 0.527% to 0.984% ex-post the divestment movement. Thus, the finding supports the theory of a newly developed modern sin industry. Furthermore, we emphasize that the development of a modern sin industry is in its early phases. Hence, the economically and statically significant intercept could be overestimated due to the exclusion of unknown exogenous factors. Lastly, we find no alpha for the modern sin portfolio compared to the renewable portfolio.

The study's results indicate that we can question the market efficiency of traditional and modern sin stocks in developed countries. The findings of this study are relevant to private and institutional investors aiming for abnormal returns. Based on the findings, investors should consider investing in traditional and modern sin stocks, particularly in developed countries, as these investments would yield a return premium. Thus, it might impact the favorable abnormal returns that investors may achieve by investing in these equities. As a result, investors seeking to earn alpha through sinful investing should constantly be updated on this development.

Our findings suggest that investors seeking abnormal returns could also invest in comparable firms, as these industries offer alpha. Hence, a premium-linked common factor may affect both sin and non-sinful stocks. However, the expected excess return over market return is more remarkable for traditional sin stocks when compared against the non-sinful companies as they

offer a larger and more statistically significant alpha than their comparables. The same applies to the modern sin portfolio when controlling for the FF5 model with and without momentum.

Nevertheless, investments in sin stocks are not as straightforward as this thesis may suggest. While our empirical study provides evidence of the presence of a sin stock alpha, there are obstacles related to investing in stocks vulnerable to exclusion. In an attempt to promote green finance, institutions such as the United Nations, European Union, and World Economic Forum advise against investing in sin stocks. While the actual impact of excluding sin stocks remains questionable, one may argue that it indirectly leads to a more sustainable world. One example may be the influence of an active shareholder through voting or engaging with certain firms. Ergo, some investors may take environmental, societal, or governance issues into account in their decision-making process rather than exclusively seeking profits.

In conclusion, our thesis establishes the presence of a statistically and economically significant alpha for traditional and modern sin stocks in developed countries. The most interesting finding is perhaps that "some sins do bear their privilege on earth" (William Shakespeare,1598).

"Doing Good, by Doing Bad"

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9. Appendices

Appendix 1: Data

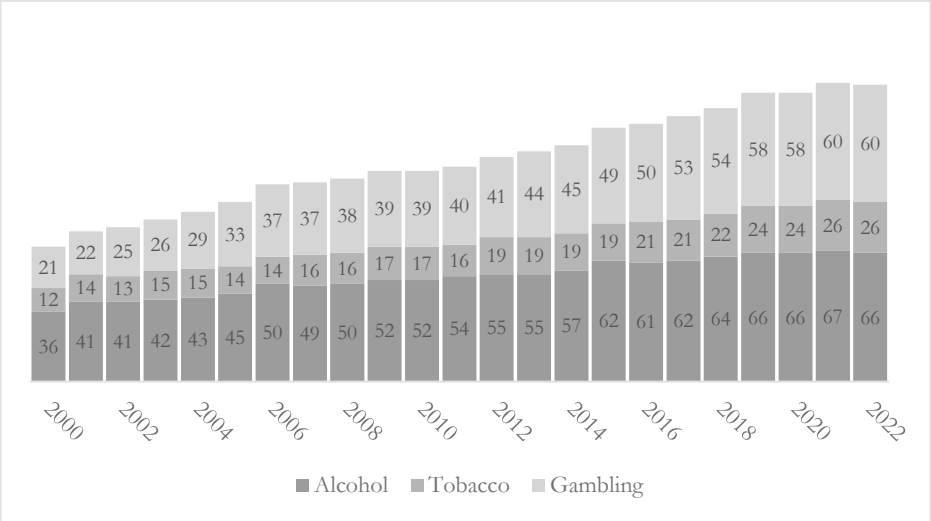
Table A1.1 Kenneth French' Continent Division

Country	Developed Markets	Europe	Japan	Asian-Pacific ex Japan	North America
Australia	●			●	
Austria	●	●			
Belgium	●	●			
Canada	●				●
Switzerland	●	●			
Germany	●	●			
Denmark	●	●			
Spain	●	●			
Finland	●	●			
France	●	●			
Great Britain	●	●			
Greece	●	●			
Hong Kong	●			●	
Ireland	●	●			
Italy	●	●			
Japan	●		●		
Netherlands	●	●			
Norway	●	●			
New Zealand	●			●	
Portugal	●	●			
Sweden	●	●			
Singapore	●			●	
United States	●				●

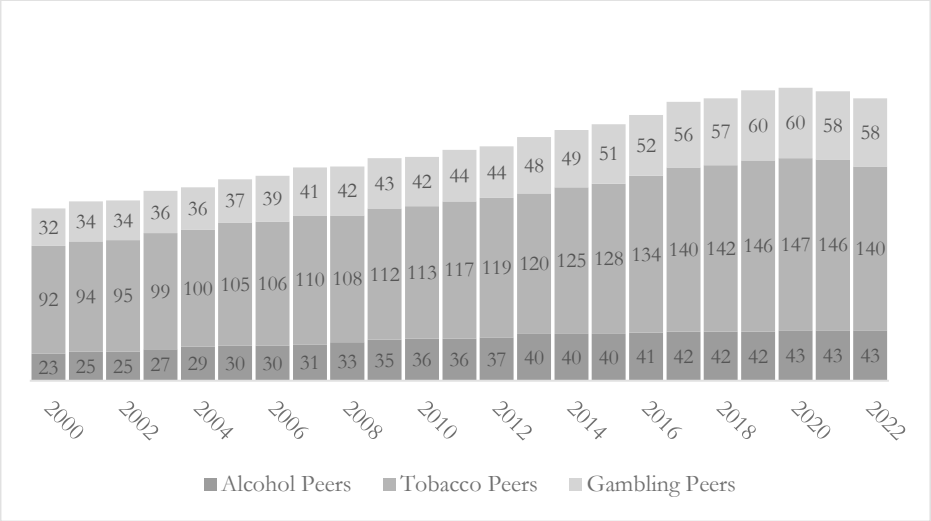
Table A1.1 presents the countries categorized as developed in Kenneth French's Data Library. As the table displays, our geographic selection consists of 23 well-established economies.

Figure A1.1: Industry Composition Each Year

Panel A: Number of Companies Within the Traditional Sin Industry



Panel B: Number of Companies Within the Traditional Sin Comparable Industries



Panel C: Number of Companies Within the Modern Sin Industry and The Comparable Industry

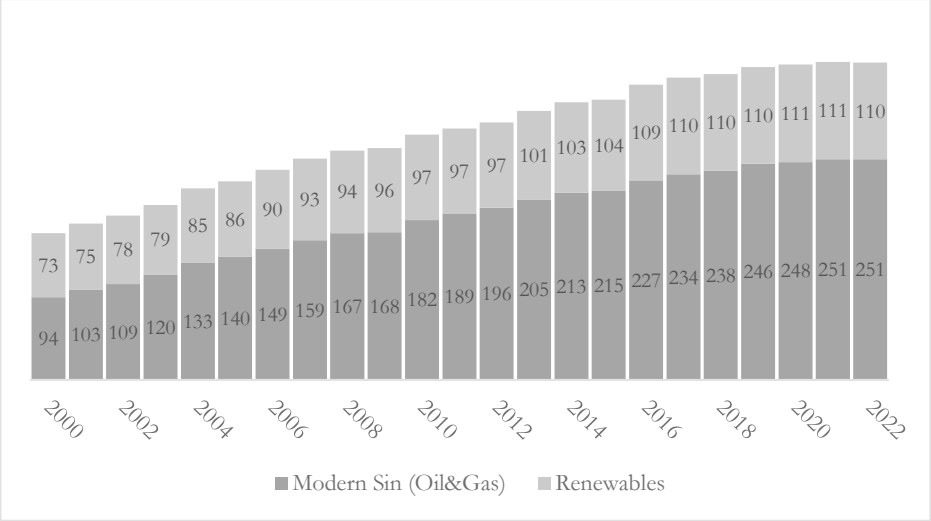
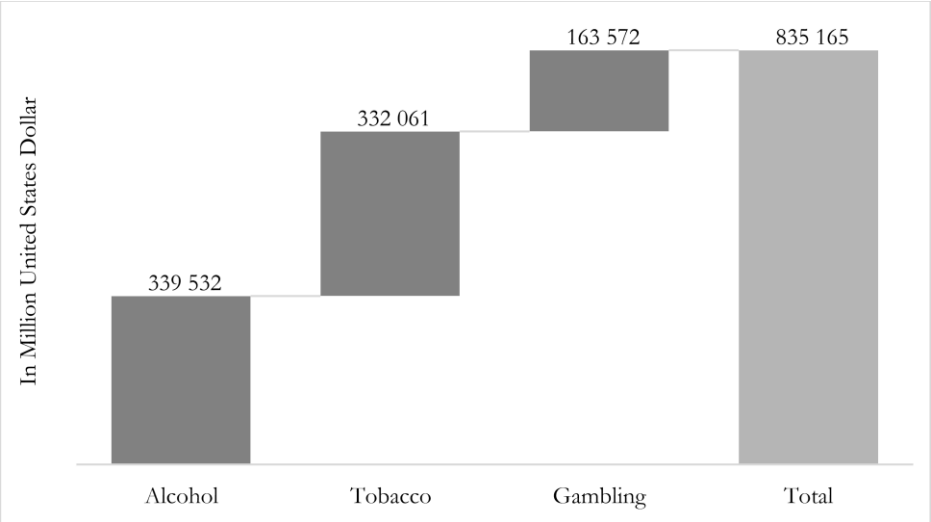
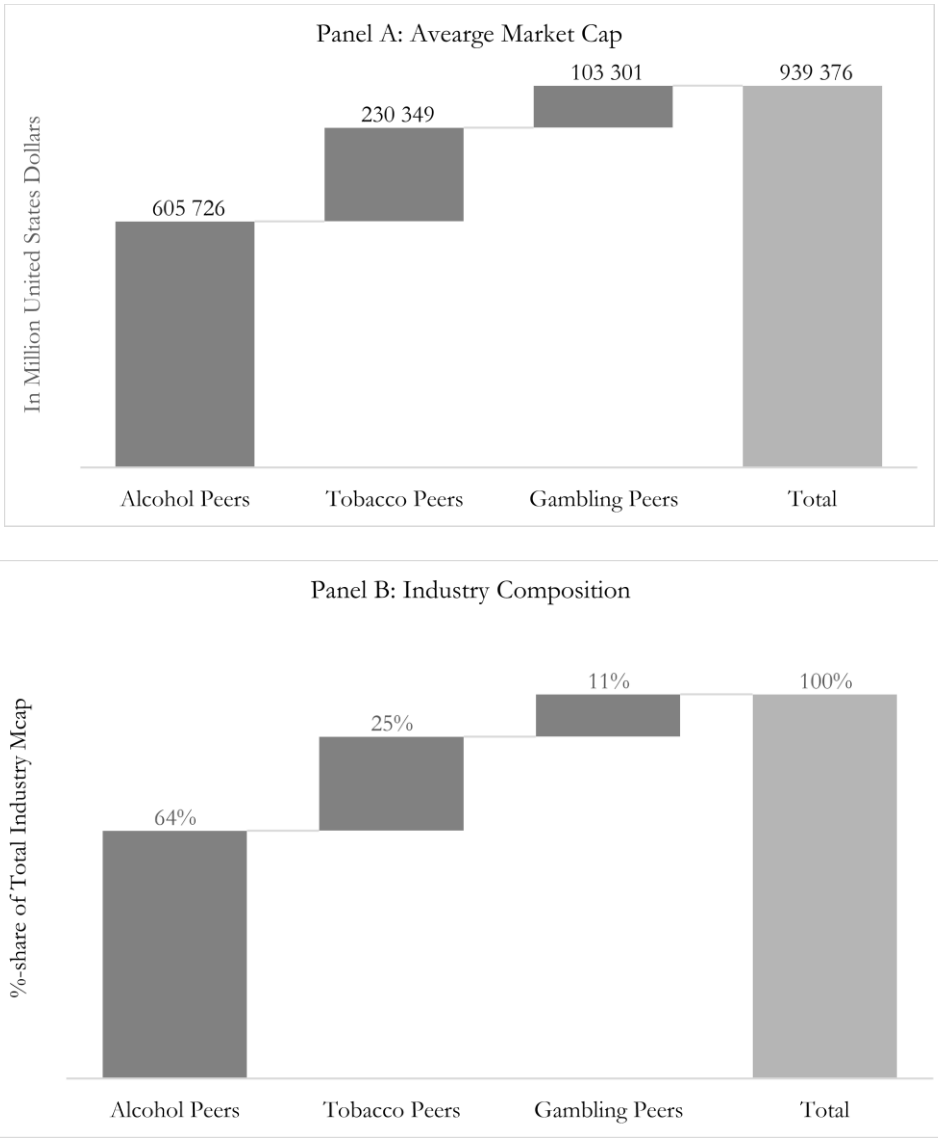


Figure A1.3: Average Market Capitalization for the Traditional Sin Industries



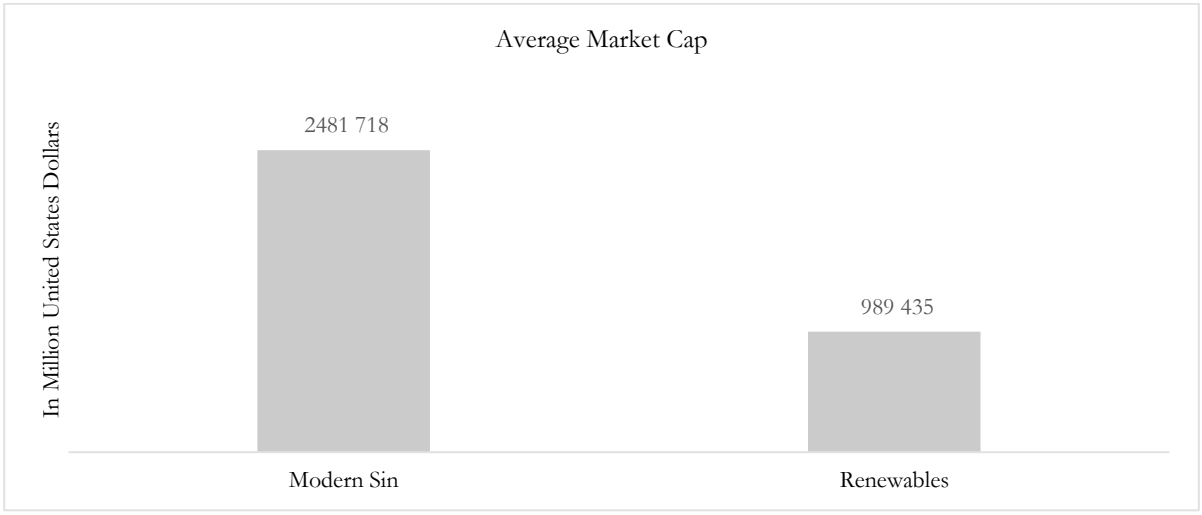
The figure presents the average distribution and composition within the traditional sin industries for developed countries in million United States Dollar. In panel A the bars represent the average market capitalization for each of the traditional sin industries. In Panel B the bars represent the average percentage market share based on the average market capitalization from panel A.

Figure A1.4: Average Market Capitalization for the Traditional Sin Peers Industries



The figure presents the average distribution and composition within the traditional sin Peers industries for developed countries in million United States Dollar. In panel A the bars represent the average market capitalization for each of the traditional sin industries. In Panel B the bars represent the average percentage market share based on the average market capitalization from panel A.

Figure A1.5: Average Market Capitalization for the Modern Sin Industry and their Comparable Industry

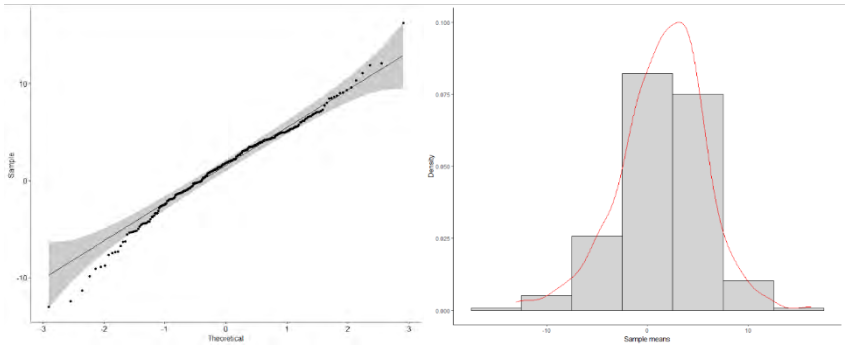


The figure presents the average distribution and composition within the modern sin industry and its respective comparable industry for developed countries in million United States Dollar. In panel A the bars represent the average market capitalization for each of the traditional sin industries. In Panel B the bars represent the average percentage market share based on the average market capitalization from panel A.

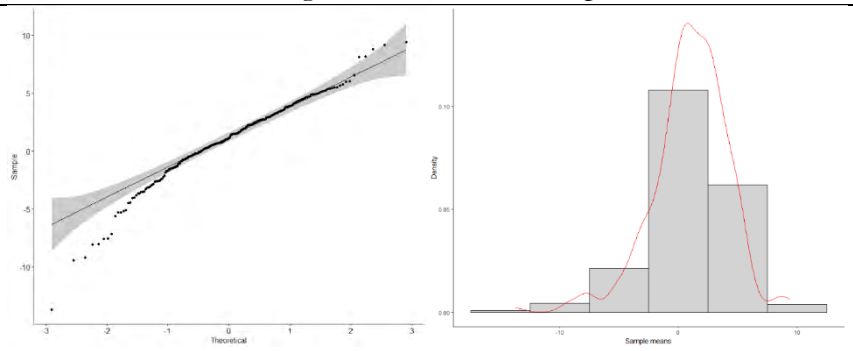
Appendix 2 Model Testing

Figure A2.1 Portfolio Distribution: QQ-Plot of Model Residuals and Histogram

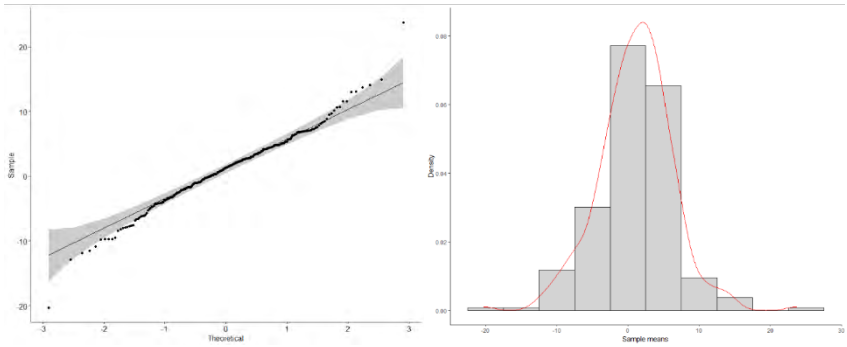
Panel A: Value-Weighted Traditional Sin Portfolio



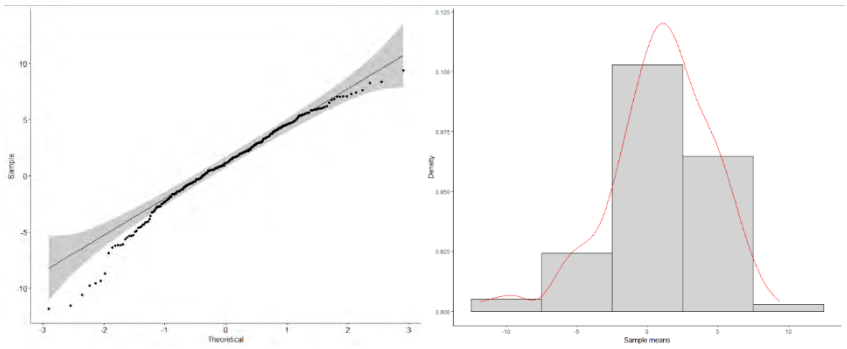
Panel B: Value-Weighted Traditional Comparable Portfolio



Panel C: Value-Weighted Modern Sin Portfolio



Panel D: Value-Weighted Renewable Comparable Sin Portfolio



We investigate the distribution of our portfolios' residuals using histograms, density lines, and QQ-plots. Figure X displays the QQ-plot and the normal distribution of the traditional sin portfolio. The QQ-plot for the sin portfolio's standardized residuals, which form a pretty straight line in the centre with short tails on each side. The density line is centered around zero, and the data has little skewness. Figure X displays the QQ-plot and the normal distribution of the traditional comparable sin portfolio. Figure X displays the QQ-plot and the normal distribution of the modern sin portfolio. Figure X displays the QQ-plot and the normal distribution of the renewable comparable sin portfolio. The figures indicate the same as for the traditional sin portfolio: the data is normally distributed around zero and there is limited skewness.

Table A2.2 Breusch-Godfrey and Breusch-Pagan and Test for Autocorrelation and Homoscedasticity

	Alpha	BG P-Value	Conclusion	BP P-value	Conclusion
FF3					
VW Traditional Sin Portfolio	0.05	0.35	No Autocorrelation	0.006	Heteroscedastic
VW Traditional Comparable Portfolio	0.05	0.75	No Autocorrelation	0.002	Heteroscedastic
VW Modern Sin Portfolio	0.05	0.58	No Autocorrelation	0.319	No heteroscedastic
VW Renewable Comparable Portfolio	0.05	0.15	No Autocorrelation	0.131	No heteroscedastic
FF3 + Carhart	0.05				
VW Traditional Sin Portfolio	0.05	0.51	No Autocorrelation	0.000	Heteroscedastic
VW Traditional Comparable Portfolio	0.05	0.76	No Autocorrelation	0.000	Heteroscedastic
VW Modern Sin Portfolio	0.05	0.56	No Autocorrelation	0.170	No heteroscedastic
VW Renewable Comparable Portfolio	0.05	0.18	No Autocorrelation	0.001	Heteroscedastic
FF5	0.05				
VW Traditional Sin Portfolio	0.05	0.10	No Autocorrelation	0.097	No heteroscedastic
VW Traditional Comparable Portfolio	0.05	0.75	No Autocorrelation	0.020	Heteroscedastic
VW Modern Sin Portfolio	0.05	0.78	No Autocorrelation	0.176	No heteroscedastic

VW Renewable Comparable Portfolio	0.05	0.50	No Autocorrelation	0.466	No heteroscedastic
FF5 + MOM	0.05				
VW Traditional Sin Portfolio	0.05	0.09	No Autocorrelation	0.062	No heteroscedastic
VW Traditional Comparable Portfolio	0.05	0.97	No Autocorrelation	0.007	Heteroscedastic
VW Modern Sin Portfolio	0.05	0.76	No Autocorrelation	0.098	No Heteroskedastic
VW Renewable Comparable Portfolio	0.05	0.51	No Autocorrelation	0.307	No Heteroskedastic

The table presents the results of the Breusch-Godfrey test for autocorrelation and the Breusch-Pagan for homoscedasticity. Using the different multi-factor models, we test for autocorrelation and homoscedasticity in the traditional and modern sin and their respective comparable portfolios. The null hypothesis for th Breusch-Godfrey test is that there is no autocorrelation in our portfolios. We observe P-values above alpha and cannot reject H0 for any of our tests. We conclude that autocorrelation is not a problem in our data set. The null hypothesis for the Breusch-Pagan test is that the error variances are all equal, i.e., homoscedasticity. If the P-value is lower than alpha (0.05), we reject H0 and conclude the presence of heteroscedasticity in our data. As we see, there is a necessity to adjust the standard errors for heteroscedasticity for some of the regression models (Wooldridge, 2012). These regressions are re-estimated using Huber-White standard errors. The use of these heteroskedasticity-consistent standard errors does not affect alpha.

Table A2.3: Augmented Dickey Fuller Test for Unit Root

	DF	**P-value**
Dependent variable		
VW Traditional Sin Portfolio	-5.80	0.01
VW Traditional Comparable Portfolio	-5.73	0.01
VW Modern Sin Portfolio	-5.46	0.01
VW Renewable Comparable Portfolio	-5.15	0.01
Pricing Factors		
Rm-Rf	-5.33	0.01
SMB	-6.11	0.01
HBL	-5.44	0.01
WML	-6.18	0.01
RMW	-5.75	0.01
CMA	-5.66	0.01

Table X present the results for stationarity when the augmented Dickey-Fuller is applied. All dependent and independent variables utilized in our regressions are subjected to the test. "DF" denotes the test statistic, which should be less than a predetermined critical number. The null hypothesis is that the data is non-stationary, indicating the presence of a unit root. As a result, a high P-value suggests that there is a problem. The table shows that our portfolios and pricing components have low P-values, and we can definitely reject H0 at the 5% level for all of our tests. As a result, we conclude that all of our variables are stationary and can be used in OLS regressions without difficulty.

Appendix 3 Multicollinearity

Table A3.1: Pearson Correlation Matric

	Rm-Rf	SMB	HML	RMW	CMW	RF	WHL
Rm-Rf	1						
SMB	0.05790116	1					
HML	-0.122509328	0.012923166	1				
RMW	-0.335215164	-0.2741761	0.051918247	1			
CMW	-0.406817662	-0.072804196	0.76193329	0.155874137	1		
RF	-0.131782044	-0.04413609	0.202506165	0.05504763	0.188197191	1	
WHL	-0.331130924	0.207471414	-0.23894122	0.145226793	0.04851991	-0.012673562	1

Table A3.1. presents the Pearson correlation matrix for the explanatory variables incorporated in this thesis. There is no clear consensus on what absolute value for a correlation coefficient should be considered to be "too high". Nevertheless, a general guideline says that a coefficient around |0.7| or |0.8| indicates a robust linear relationship, which might affect the statistical power of the regression models (Nettleton, 2014; Studenmund, 2017). The HML and CMA factors have the highest correlation coefficient in absolute terms (0.76), which denotes a moderate-to-a-strong positive, linear relationship. The correlation between these factors is well recognized in the research of Fama and French (2015). Value firms tend to have conservative investment profiles, whereas growth firms tend to have a rather aggressive investment approach. Besides the correlation between the HML and CMA factors, the correlation matrix does not imply any strong linear relationships that might weaken the statistical power of the regression models.

Table A3.2: The Variance Inflation Factor

Variable	**VIF**
Rm-Rf	1.523
SMB	1.219
HBL	3.185
WML	1.447
RMW	1.237
CMA	3.419

We utilize the variance inflation factor (VIF) to assess the level of multicollinearity in our explanatory variables to see if it is an issue in our data. There have been several recommendations regarding the maximum limit of the VIF value. Hair et al. (1995), for example, proposed 10 as an acceptable threshold, while Rogerson (2001) proposed a maximum level of 5. Regardless, the VIF function for the included explanatory variables, as shown in table A2.2, indicates that multicollinearity is not a significant issue for our explanatory variables, since they are all less than 5. As a result, we use all of the variables in our regressions. However, we keep the correlation matrix results in mind when we assess the regression.

Appendix 4: Robustness tests

Robustness Test 1: Changing Market Portfolio

Table A4.1: Value-Weighted Traditional Sin Portfolio with MSCI World Index

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	1.367***	1.484***	1.494***	1.506***
	(.272)	(.273)	(.266)	(.263)
Rm-Rf	-.992***	-1.006***	-1.027***	-1.025***
	(.079)	(.081)	(.061)	(.060)
SMB	.044	.163	-.017	.107
	(.154)	(.155)	(.141)	(.148)
HML	.225*	.132	.687***	.504**
	(.013)	(.105)	(.141)	(.157)
WML		-.256***		-.184*

		(.086)		(.072)
RMW			.061	.145
			(.168)	(.169)
CMA			-.851***	-.641**
			(.199)	(.213)
Observations	272	272	272	272
R^2	.504	.531	.536	.547
Adjusted R^2	.498	.524	.527	.537

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in the traditional sin portfolio and a short position in the market from January 2000 to August 2022. The multi-factor regressions are run using the MSCI world market index instead of the Kenneth French's market portfolio. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table A4.2: Value-Weighted Comparable Portfolio for Traditional Sin Stocks with MSCI World Index

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.942***	1.045***	1.001***	1.015***
	(.207)	(.191)	(.207)	(.209)
Rm-Rf	-.941***	-.954***	-.960***	-.958***
	(.059)	(.045)	(.060)	(.059)
SMB	-.177	-.072	-.205	-.064
	(.130)	(.103)	(.119)	(.121)
HML	.115	.032	.378***	.170
	(.091)	(.069)	(.157)	(.156)
WML		-.227***		-.209***
		(.048)		(.071)
RMW			.067	.162
			(.147)	(.139)
CMA			-.487**	-.248
			(.223)	(.217)
Observations	272	272	272	272
R^2	.616	.645	.630	.650
Adjusted R^2	.612	.640	.623	.643

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in the comparable portfolio traditional sin stocks and a short position in the market from January 2000 to August 2022. The multi-factor regressions are run using the MSCI world market index instead of the Kenneth French's market portfolio. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table A4.3: Value-Weighted Modern Sin Portfolio with MSCI World Index

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.901**	1.065***	1.432***	1.439***
	(.317)	(.307)	(.293)	(.292)
Rm-Rf	-.983***	-1.003***	-1.076***	-1.075***
	(.074)	(.072)	(.067)	(.067)
SMB	.076	.244	-.206	-.128
	(.167)	(.165)	(.155)	(.164)
HML	.451***	.319**	1.337***	1.222***
	(.112)	(.112)	(.155)	(.174)
WML		-.361***		-.116
		(.077)		(.079)
RMW			-.604**	-.551**
			(.184)	(.187)
CMA			-1.600***	-1.467***
			(.218)	(.236)
Observations	272	272	272	272
R^2	.431	.474	.553	.556
Adjusted R^2	.425	.466	.545	.546

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a modern sin portfolio and a short position in the market from January 2000 to August 2022. The multi-factor regressions are run using the MSCI world market index instead of the Kenneth French's market portfolio. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table A4.4: Value-Weighted Comparable Portfolio for Modern Sin Stocks with MSCI World Index

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.916***	.979***	1.057***	1.060***
	(.227)	(.243)	(.229)	(.229)
Rm-Rf	-.975***	-.983***	-1.007***	-1.007***
	(.053)	(.070)	(.052)	(.053)
SMB	-.171	-.107	-.242*	-.209
	(.120)	(.140)	(.121)	(.129)
HML	.155	.106	.542***	.494***
	(.080)	(.103)	(.121)	(.136)
WML		-.137*		-.048
		(.076)		(.062)
RMW			-.035	-.013
			(.144)	(.147)
CMA			-.710***	-.654***
			(.171)	(.185)
Observations	272	272	272	272
R^2	.567	.577	.595	.596
Adjusted R^2	.563	.570	.587	.587

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a comparable portfolio for modern sin stocks and a short position in the market from January 2000 to August 2022. The multi-factor regressions are run using the MSCI world market index instead of the Kenneth French's market portfolio. The coefficients on the explanatory

variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Robustness Test 2: Changing Comparable Stocks for Each Sin Industry

Table A4.5: Value-Weighted Difference Portfolio for Traditional Sin Stocks with New Comparables

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.480*	.440*	.227	.207
	(.208)	(.216)	(.188)	(.186)
Rm-Rf	.039	.062	.115*	.129**
	(.051)	(.052)	(.050)	(.050)
SMB	.250*	.215	.116	.069
	(.135)	(.138)	(.114)	(.111)
HML	.225**	.254***	.192	.257*
	(.079)	(.085)	(.130)	(.138)
WML		.068		.075
		(.067)		(.060)
RMW			.106	.083
			(.155)	(.153)
CMA			-.036	-.099
			(.184)	(.193)
Observations	272	272	272	272
R^2	.056	.062	.059	.067
Adjusted R^2	.046	.047	.041	.046

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a traditional sin portfolio and a short position in a new comparable portfolio (compared to those in the analysis) from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table A4.6: Value-Weighted Difference Portfolio for Modern Sin Stocks with New Comparables

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	-.123	-.062	.262	.269
	(.263)	(.281)	(.286)	(.296)
Rm-Rf	.401***	.365***	.249***	.245***
	(.077)	(.079)	(.088)	(.090)
SMB	.189	.242	.023	.038
	(.153)	(.167)	(.156)	(.170)
HML	.365***	.321**	.708***	.686***
	(.100)	(.152)	(.195)	(.210)
WML		-.105		-.025

		(.100)		(.096)
RMW			-.555**	-.548**
			(.217)	(.217)
CMA			-.645**	-.624**
			(.266)	(.27)
Observations	272	272	272	272
R^2	.181	.187	.232	.232
Adjusted R^2	.172	.175	.217	.215

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a modern sin portfolio and a short position in a new comparable portfolio (compared to those in the analysis) from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Robustness Test 3: Excluding Gambling

Table A4.7: Value-Weighted Traditional Sin Portfolio, Excluding Gambling

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	1.136***	1.067***	.710***	.700***
	(.201)	(.212)	(.205)	(.205)
Rm-Rf	-.462***	-.422***	-.309***	-.301***
	(.045)	(.049)	(.050)	(.052)
SMB	-.216*	-.276*	-.026	-.052
	(.121)	(.120)	(.107)	(.113)
HML	.349***	.398***	.056	.091
	(.089)	(.089)	(.112)	(.122)
WML		.117*		.040
		(.069)		(.056)
RMW			.695***	.683***
			(.132)	(.133)
CMA			.548**	.514**
			(.168)	(.175)
Observations	272	272	272	272
R^2	.358	.368	.439	.440
Adjusted R^2	.351	.359	.428	.427

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a traditional sin portfolio excluding gambling stocks and a short position in the market from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table A4.8: Value-Weighted Difference Portfolio, Excluding Gambling

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.265	.224	.227	.207

	(.177)	(.178)	(.188)	(.184)
Rm-Rf	.108**	.132**	.115*	.129**
	(.045)	(.047)	(.050)	(.046)
SMB	.096	.060	.116	.069
	(.110)	(.107)	(.114)	(.101)
HML	.174**	.204**	.192	.257*
	(.072)	(.074)	(.130)	(.109)
WML		.070		.075
		(.060)		(.050)
RMW			.106	.083
			(.155)	(.119)
CMA			-.036	-.099
			(.184)	(.157)
Observations	272	272	272	272
R^2	.056	.064	.059	.067
Adjusted R^2	.045	.050	.041	.046

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a traditional sin portfolio excluding gambling stocks and a short position in a comparable portfolio excluding gambling stock peers from January 2000 to August 2022. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Robustness Test 4: Excluding 2022

Table A4.9: Value-Weighted Modern Sin Portfolio, Excluding 2022

	FF3	FFC4	FF5	FF5 + MOM
Constant(α)	.518**	.491*	.472*	.458*
	(.190)	(.193)	(.202)	(.202)
Rm-Rf	-.109**	-.093*	-.119*	-.108*
	(.042)	(.046)	(.050)	(.051)
SMB	-.029	-.053	.005	-.036
	(.101)	(.104)	(.105)	(.111)
HML	.574***	.595***	.700***	.754***
	(.071)	(.075)	(.110)	(.120)
WML		.047		.061
		(.052)		(.054)
RMW			.228	.205
			(.134)	(.135)
CMA			-.275	-.325
			(.165)	(.171)
Observations	264	264	264	264
R^2	.228	.230	.244	.248
Adjusted R^2	.219	.218	.230	.230

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in the modern sin portfolio and a short position om the comparable portfolio from January 2000 to December 2021. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor

and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Table A4.10: Value-Weighted Modern Sin Portfolio Ex-ante and Ex-post the Divestment Movement, Excluding 2022

	Ex-Ante 2000-2014	Ex-Post 2015-2021
Constant(α)	.527*	.691*
	(.237)	(.316)
Rm-Rf	-.131*	.081
	(.062)	(.085)
SMB	-.149	.123
	(.121)	(.220)
HML	.474**	.395
	(.146)	(.245)
WML	.110*	-.185
	(.056)	(.148)
RMW	.554**	-.591*
	(.167)	(.282)
CMA	-.318	.415
	(.189)	(.351)
Observations	180	84
R^2	.292	.490
Adjusted R^2	.267	.450

The table presents the factor loadings and abnormal returns (in percentage) of a value-weighted (VW) zero-investment portfolios with a long position in a traditional sin portfolio and a short position in the comparable portfolio Ex-ante (2000-2014) and Ex-post (2015-2021) the divestment movement, excluding 2022. The coefficients on the explanatory variables are retrieved from Kenneth French`s Data Library and presents the monthly returns of the Fama-French factors and the momentum factor and capture the difference in exposure between the traditional sin portfolio and the market. Rm-Rf is the market factor, SMB is the small-minus-big size factor, HML is the high-minus-low value factor, UMD is the up-minus down momentum factor, RMW is the robust-minus-weak profitability factor, CMA is the conservative minus-aggressive investment factor and MOM is the momentum factor and seizes the exposure to previous price movements (Fama, French, n.d). The stars *, **, and *** denote statistical significance at the 5%, and 1% and 0.1% significance levels, respectively. t statistics based on heteroscedasticity-consistent standard errors in parentheses.

Appendix 5

Table A5.1: Overview of Alphas

Panel A: Analysis

Portfolio	FF3	FFC4	FF5	FF5 + MOM
Traditional Sin Portfolio	1.178***	1.142***	0.793***	0.795***
Alcohol Portfolio			0.611**	
Tobacco Portfolio			0.728*	
Gambling Portfolio			1.152**	
Traditional Sin Difference Portfolio	0.326*	0.296	0.293	0.277
Modern Sin Portfolio	0.606**	0.569**	0.610**	0.585**
Modern Sin Portfolio ex-ante				0.527*
Modern Sin Portfolio ex-post				0.984**

Modern Sin Difference Portfolio	-0.193	-0.155	0.06	0.063

Panel B: Robustness tests

	FF3	FFC4	FF5	FF5 + MOM
Traditional Sin Portfolio excluding Gambling	1.136***	1.067***	0.710***	0.700***
Traditional Sin Portfolio with MSCI	1.367***	1.484**	1.494***	1.506***
Traditional Sin Difference Portfolio with new comp	0.480*	0.440*	0.419*	0.397
Modern Sin Portfolio excluding 2022	0.518**	0.491*	0.472*	0.458**
Modern Sin Portfolio ex-post excluding 2022				0.691*
Modernl Sin Portfolio with MSCI	0.901**	1.065***	1.432***	1.439**
Modern Sin Difference Portfolio with new comp	0.263	0.224	0.227	0.207

Appendix 6: Green Transition

A mandatory carbon intensity measure will come into force in 2023 to reduce greenhouse gas emissions in the oil and gas industry. The regulations will, directly and indirectly, concern many oil- and gas companies. Companies must pay a tax on their emissions. Thus, the EU and the International Maritime Organization (IMO) will implement a carbon tax system where companies that do not meet the emission requirements must pay the tax (Tradewinds, 2022). Additionally, the shipping companies will demand higher contract rates. Thus, the companies will also have to pay an indirect cost to compensate for the shipping companies' carbon taxes. In other words, transporting oil will become more expensive, leading to lower net revenues. In addition, it will affect returns, prices, and revenues.

Not only will the regulation affect financials, but we also believe it will strengthen the view of oil and gas as a sin industry. The order books for ships running on green fuel will continue to increase, such that a green industry transition means lower oil demand. Indeed, increased awareness of the importance of a green transition in shipping might impact recognizing the oil and gas industry as sinful. We mention this coming regulation because we believe that modern sin stocks might be considered even more sinful when implemented next year. As already mentioned, we are still early in looking at the impact of the view of oil and gas as a sinful industry. Hence, we suggest a revised study where one can see the effect of the exclusion of modern sin stocks. A revised study may return different results ex-post the carbon tax implementation.