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**Sin Stocks: An Analysis of the Sin Premium
in the US, European, and Asia-Pacific
Markets**

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Abstract

This thesis aims to explain the return of so-called sin stocks, which include businesses operating in the alcohol, tobacco, gambling, weapon, and oil & gas industries. Due to their negative public perception, these stocks are anticipated to yield a sin premium. This study analyses the potential variation of sin premiums across three different markets, specifically the US, European, and Asia-Pacific markets. By employing three different factor models introduced by Fama and French and Carhart, we analyze the presence of a sin premium across the three markets. Our findings indicate that there is no consistent sin premium; however, investors may realize an outperformance by selectively investing in specific industries within the European (tobacco) and Asia-Pacific (alcohol and tobacco) markets. Furthermore, we investigate the behavior of sin stocks during both the financial crisis and the COVID-19 pandemic. Our analysis shows no discernible state-varying behavior in the US and European markets. Nonetheless, the Asia-Pacific market demonstrates an outperformance of alcohol stocks during the financial crisis and tobacco stocks during the COVID-19 crisis.

Keywords: Sin Stocks, Factor Models, USA, Europe, Asia-Pacific

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1 Introduction

Today, investors increasingly consider moral or ethical beliefs when deciding what stocks to include in their portfolios. Consequently, socially responsible investing (SRI) and environmental, social, and governance (ESG) friendly investing have become more prevalent in recent years, especially during the COVID-19 pandemic. Between 2019 and 2021, assets under management (AuM) of ESG investments grew enormously, with 114% in Europe and 135% in the USA (KPMG, 2022).

On the other hand, so-called sin stocks - mostly, but not exclusively, alcohol, tobacco, and gambling - can be seen as the counterpart of SRI and ESG, causing investors to actively exclude these stocks from their investment universe. Therefore, lower demand due to neglect by investors can lead sin stocks to become relatively cheap compared to their intrinsic value (Blitz & Fabozzi, 2017). But does this lead sin stocks' performance to alter from the market?

Much of the previous literature has found a significant positive outperformance of these stocks compared to the broader market (e.g. Hong and Kacperczyk, 2009). In contrast, other studies, like Blitz and Fabozzi (2017), suggest that today's asset pricing models can explain sin stock returns, contradicting the notion of a sin premium.

However, it is important to know that the definition of sin stocks varies considerably based on individual ethical and moral beliefs or religious orientations. While certain behaviors or industries may be perceived as sinful in one society, they may be accepted in another. This cultural variability complicates the analysis of sin stocks, as consequently, different datasets may yield different results. Furthermore, there is a notable gap in existing research when it comes to including multiple markets and making clear distinctions between them in the analysis. This leads us to include the three major markets, the US, Europe, and Asia-Pacific.

Contrary to most literature, we will incorporate all industries associated with oil & gas in our sin portfolio, inspired by Sagbakken and Zhang's (2021) analysis of the European market. Considering that China and the US are the world's largest greenhouse gas emitters (Crippa et al., 2021), examining these markets' oil & gas industries is particularly interesting. Moreover, including industries related to weaponry & defense in the analysis of sin stocks is another area of interest, especially given the ongoing conflicts in the Middle East and the Russia-Ukraine war.

Furthermore, as Salaber (2009) stated, sin stocks have stable returns during economic downturns due to their addictive nature. However, contrary to the alcohol, tobacco, and gambling industries (also called the triumvirate of sin stocks), the weapon and oil & gas industries do not exhibit addictive properties. Thus, an analysis of these industries, especially during economic downturns, may yield differing results. By examining sin stocks' performance during the 2007-2008 financial crisis and the COVID-19 crisis, we will investigate whether sin stocks exhibit state-varying behavior.

Lastly, very few researchers have disclosed the extent to which each individual sin industry contributes to their findings. This leads us to perform our analysis also at an industry level rather than just at a sin portfolio level.

Our data consists of weekly returns for all stocks in our markets for a period of 20 years, starting from January 2003 until December 2022. To conduct our study, we will utilize the widely known three- and five-factor model of Fama and French (1992; 2014) and the Carhart four-factor model (1997). These models have been widely used in the previous literature on sin stocks providing us with a robust basis for our analysis.

We find no sin premium across all industries in the US market. In contrast, in the European market, the triumvirate of sin stocks and the tobacco industry consistently demonstrate a significant sin premium for all three factor models. The sin premium is also evident in the Asia-Pacific market, primarily driven by the alcohol and tobacco industries, with the alcohol industry showcasing an impressive sin premium of 21.86% annually. Notably, the oil & gas industry does not exhibit signs of outperformance in all three markets.

During the 2007-2009 financial crisis and the COVID-19 crisis, we observe that no sin industry in the US and European markets display a significant sin premium. However, during the financial crisis, the tobacco industry in the Asia-Pacific market demonstrated a significant outperformance, while the gambling industry underperformed the market. Additionally, during the COVID-19 crisis, the alcohol industry exhibits a significant sin premium. When examining the triumvirate of sin stocks, which are expected to exhibit a sin premium due to their addictive nature, we only find a positive alpha during the COVID-19 crisis in the Asia-Pacific market.

The upcoming section will highlight the previous literature about sin stocks and their results. Next, the data and methodology applied will be defined, followed by the results of our analysis. The last section constitutes the conclusion.

2 Related Research

In economic research, the classification of stocks as sin stocks is not commonly defined. Thus, in the first part, we highlight the differences in previous research on what and how sin stocks were classified. Secondly, previous results of the financial performance of sin stocks are summarized.

2.1 Classifying sin stocks.

Following their working paper in 2007, Hong and Kacperczyk (2009) were among the first to analyze sin stocks and their impact on the market. They focused on the triumvirate of sin, namely alcohol, tobacco, and gambling in the US market. The triumvirate was chosen due to the general view of many individuals in the US and many other countries that these industries are sinful. Alcohol, tobacco, and gaming are considered sinful due to their addictive nature, health consequences, and association with corruption and criminal involvement. Hong and Kacperczyk (2009) laid the foundation for further literature on this triumvirate.

Salaber (2009) analyzed the returns of sin stocks over the business cycle using the three sin industries alcohol, tobacco, and gambling. Kim and Venkatachalam (2011) examined, among other things, the increased risk and higher abnormal returns of companies operating in the alcohol, tobacco, and gambling industries due to poor financial reporting quality. They followed Hong and Kacperczyk (2009) in classifying sin stocks. However, according to their beliefs, they added companies operating in the adult entertainment industry to the analysis, even though many researchers (e.g. Salaber, 2007; Richey, 2013; Blitz & Fabozzi, 2017) neglected the adult entertainment industry due to the lack of available data.

An additional widely spread sin industry is the weapon & defense industry. Contrary to the triumvirate of sin stocks, the weapon industry does not exhibit addictive behavior or has direct health impacts, which leads Hong and Kacperczyk (2009) to exclude it from their analysis because it is not considered a sin by many Americans. However, the negative association and the moral and ethical controversy connected with the weapon industry led other researchers to include it in their sin portfolio (Fabozzi, Ma & Oliphant, 2008; Ginsburg, 2019). Furthermore, Richey (2013) decided to include soft drinks as a sin industry with the reasoning that soft drinks exhibit addictive behavior and have limited substitute options, which are possible requirements for sin stocks, according to Salaber (2009). Being a relatively new study of sin stocks' return performance, Sagbakken and Zhang (2021) additionally classify energy- and carbon-intensive

industries as "new sin stocks" in their analysis. Categorizing these stocks as new sin stocks is reasonable, as according to Ramelli, Ossola, and Rancan (2020), investors' expectations of environmental preferences are shifting towards a more sustainable economy.

Furthermore, the Paris Agreement of 2015 has led investors to divest from carbon-intensive industries, which are the primary drivers of global warming, leading Bolton and Kacperczyk (2021) to support the increased focus on carbon emissions. Blitz and Swinkels (2021) analyzed the most extensive portfolio of sin industries, comprising 11 sinful sectors: smoke, beer, soda, meals, gold, mines, coal, oil, guns, transportation, and utilities. Blitz and Swinkels (2021) argue that soda and meals (mainly fast food) are sinful due to the growing obesity epidemic and the unhealthy lifestyle associated with it. Since decarbonization has become popular among investors, Blitz and Swinkels (2021) included oil, transportation, coal, and utilities in their analysis. Lastly, gold and mines are incorporated due to their environmental impact.

In summary, categorizing what constitutes a sin stock is highly dependent on the authors' assumptions and their ethical and moral beliefs, which will also serve as the basis for this thesis.

2.2 Previous literature results

Hong and Kacperczyk (2009) followed Fama and French's (1997) industry classification of 48 different industries and selected the relevant industries (alcohol, tobacco, gambling) as sin stocks (they had to adjust the gambling industry, which increased their industry sample to 49). They concentrated on the US market data from 1962 to 2006, including all stocks traded at the New York Stock Exchange (NYSE), Amex, and Nasdaq in their universe. Furthermore, Hong and Kacperczyk (2009) analyzed the stocks at a segment level to include diversified companies operating in sin industries. Therefore, if a company exhibited a segment in the respective sin industry, it was classified as a sin stock.

Hong and Kacperczyk (2009) used the CAPM and Carhart (1997) four-factor models to analyze possible abnormal returns. Additionally, they used cross-sectional regression to examine if the abnormal return still held when compared to comparable stocks. They found that sin stocks exhibited a significant abnormal return using the four-factor model, which held when compared to similar stocks. Lastly, an analysis of the primary holders of sin stocks provided reasoning that norm-restrictive investors, such as pension funds or religious organizations, held fewer sin stocks. As Fabozzi, Ma & Oliphant (2008) stated, while norm-restrictive investors are constrained by their mandates to invest according to certain moral beliefs, the analyst following and demand for sin stocks

declines. This is the main reason for Hong and Kacperczyk (2009) why sin stocks exhibit an abnormal return and leads them to conclude that institutional investors exhibit a significant price effect of 15-20% on their cost of capital.

The method employed by Hong and Kacperczyk (2009) in identifying sin stocks with Fama and French's (1997) industry classifications has gained popularity among other researchers in the field. Several studies, such as those conducted by Kim and Venkatachalam (2011) and Richey (2013), have adopted this method. Salaber (2009) also builds upon Hong and Kacperczyk's work by extending the time horizon from 1926 to 2005 while also focusing on US stocks traded at the NYSE, Amex, and Nasdaq and analyzing sin industries like alcohol, tobacco, and gambling. In her study, Salaber employs a conditional model incorporating macroeconomic variables and examining earnings growth during recessionary and expansionary periods. She aims to determine whether sin stocks continue to exhibit outperformance compared to similar industries, as previously shown in empirical studies (e.g. Statman, 2007). The results of her analysis indicate that sin stocks outperform the market during recessionary periods. However, this outperformance diminishes when compared to industries with similar characteristics, such as the food and soda industry. Additionally, the excess return disappears when controlling for macroeconomic variables.

Salaber's research is not limited to the US market but also explores the European market. In a study conducted in 2007, she investigates 18 European countries from 1975 to 2006 to examine the impact of excise taxation, litigation risk, and religious preferences on the sin premium. Adopting Fama and French's (1992) three-factor model, Salaber finds a sin premium in the European market that varies based on a country's legal and cultural characteristics. This suggests that the level of sin stock outperformance is influenced by country-specific factors. These findings align with the conclusions of Hong and Kacperczyk (2009) and provide further support for the existence of excess returns associated with sin stocks, both in the US and European markets. Additionally, they highlight the importance of considering regional nuances and legal contexts when analyzing sin stock performance.

When expanding the database to include additional sin industries such as adult entertainment and biotech, Fabozzi, Ma & Oliphant (2008) conducted research across 21 countries worldwide. Their data sample, provided by DataStream, spans from 1970 to June 2007 and includes all exchange-traded stocks, regardless of whether they are still active or not, to account for survivorship bias. Furthermore, they also include stocks from peripheral service and product companies, such as liquor stores that sell alcoholic beverages or dice producers that sell to casinos. This broader inclusion of sin industries and countries provides them with a more extensive and comprehensive data sample,

which is unique compared to previous literature. They found a significant sin premium using the Capital Asset Pricing Model (CAPM). They provided reasoning for the outperformance, suggesting that sin companies have no direct or indirect costs associated with upholding social standards and that sin stocks earned positive returns due to the frequent monopolistic positioning of sin companies.

In a subsequent analysis, Blitz and Fabozzi (2017) reduced the number of sin industries to four (alcohol, tobacco, weapon, and gambling). They changed the markets under consideration to include the US, European, Japan, and other emerging global markets. They conclude that the sin premium exists in simple regressions and the three-factor model. However, contrary to previous literature, when adding a betting against beta factor from Frazzini and Pedersen (2014 cited in Blitz & Fabozzi, 2017) to the Fama-French five-factor model (2014), the sin anomaly can be explained by today's asset pricing models and thus disappears.

Kim and Venkatachalam (2011) recognized the sin premium in most research. They attempted to explain it with other reasons than neglecting investments by institutional investors, as previously mentioned (Fabozzi, Ma & Oliphant, 2008). They considered higher information risk in the form of inferior financial reporting quality as a reason for the higher excess returns of sin stocks. Their data sample followed Hong and Kacperczyk (2009) with the addition of adult entertainment as a sin industry, covering the years from 1988 to 2006 in the US market. Contrary to their assumption that sin companies exhibit low financial reporting quality, they find that sin stocks have higher quality in anticipating future earnings and realizing losses promptly compared to their control groups. Thus, despite higher reporting quality and excess returns of sin stocks, Kim and Venkatachalam (2011) concluded that investors who follow social norms and actively neglect sin stocks are willing to bear the accompanying costs to live up to their preferences. This result supports the findings of Fabozzi, Ma & Oliphant (2008).

The more recent study by Sagbakken and Zhang (2021) includes "new" sin stocks in their analysis, as mentioned in the previous section. Their data sample ranges from 2006 to 2020 and covers the European and UK economic areas. Like Hong and Kacperczyk (2009), Salaber (2009), and Blitz and Fabozzi (2017), they use time-series regressions to examine the sin premium. They comprehensively analyzed new and traditional European sin stocks by applying the CAPM, three-, four-, and five-factor models, and cross-sectional regressions to their sample. Analyzing returns before and after the Paris Agreement of 2015, they only find a slight, significant outperformance of new sin stocks after the agreement. Traditional sin stocks such as alcohol, tobacco, gambling, and weaponry show a small but significant outperformance of up to 0.70% for the time-series regressions (except for the five-factor model). For the cross-sectional regressions, they

find a significant alpha only for the CAPM and the three-factor model, leading them to conclude that sin stocks do not exhibit an apparent excess return.

Contrary to Sagbakken and Zhang (2021), Blitz and Swinkels (2021) find a significant impact of sin stocks on a portfolio. Blitz and Swinkels (2021) also include newer industries as sin industries, as mentioned above. Their analysis assesses whether the active exclusion of sin stocks from an investor's portfolio affects performance. The sample consists of monthly stock returns from the beginning of 2011 to the end of 2020 and is split into 49 US industries. Using a tracking error approach, they argue that excluding sin stocks from a portfolio may lead to underperformance due to reduced diversification benefits and added unrewarded risks. Furthermore, Blitz and Swinkels (2021) extend the Fama and French five-factor model with a low-risk factor. Their results show that excluding sin stocks significantly decreases a portfolio's expected return by 0.25% to 0.50%. However, the decrease in expected return and increased tracking error can be offset by actively increasing the weights of stocks similar to the excluded ones or adjusting requirements to allow small portions of sin stocks in the portfolio.

With all the literature mentioned focusing on the US, Europe, or the global market, Visaltanachoti, Zheng, and Zou (2011) were among the first to shed light on sin stock performance in the Chinese stock market (Shanghai, Shenzhen, and Hong Kong stock exchanges). However, their findings align with previous studies, as they concentrate on the triumvirate of sin stocks. They find a significant sin premium of 5.94% for Shanghai and Shenzhen and 29.11% for Hong Kong between 1995 and 2007. Nevertheless, this finding does not indicate a more profitable company, as sin companies do not outperform comparable companies. Further, Durand, Koh & Tan (2013) analyzed sin stock performance in seven Asia-Pacific markets. They are alone in their conclusion that sin stocks exhibit a negative risk-adjusted return.

In summary, Hong and Kacperczyk's study (2009) on the triumvirate of sin stocks and their approach to data collection for industries has provided a solid foundation for further researchers (e.g. Salaber, 2009; Kim & Venkatachalam, 2011). Most literature (e.g. Salaber, 2007, 2009; Fabozzi, Ma & Oliphant, 2008; Hong & Kacperczyk, 2009; Visaltanachoti, Zheng & Zou, 2011; and Blitz & Swinkels, 2021) agrees that sin stocks exhibit a statistically significant excess return, even across different data samples in terms of sin industries, time horizons, and countries. However, the recent paper by Sagbakken and Zhang (2021) only finds a slight outperformance of sin stocks. Lastly, Fabozzi and Blitz (2017) argue that today's pricing models can explain the sin premium and that sin stocks have no sustained outperformance.

3 Data and Methodology

In this section, we first explain the data set used in our study. Secondly, the methodology used for classifying stocks as sin and analyzing their financial performance will be highlighted.

3.1 Data

Our study mainly compares sin stocks in three markets: The United States, Europe, and Asia-Pacific. To identify sin stocks in the American stock market, we selected the Russell 3000 Index, which includes the 3000 largest stocks traded on US stock exchanges. For the European market, we selected the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index (EURO), comprising the 1800 largest publicly traded stocks in Europe. For the Asia-Pacific market, we used the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index, which includes the 4400 largest stocks traded in the Asia-Pacific region. We selected the APAC since we are particularly interested in analyzing the sin premium in Asian countries, which constitute over 90% of the index's market cap. Additionally, the index excludes Japan to have a higher focus on emerging Asia-Pacific markets. Further, the period from January 2003 until December 2022 was selected to have a long enough and representative time horizon. Secondly, we have the financial and COVID-19 crises in our analysis, where a particular focus is laid.

A primary objective is to minimize survivorship bias. Therefore, considering our time period, we include every stock once part of the respective indices and their stock return over the whole period if available. Consequently, we include 6836 stocks from the Russell 3000, 3602 stocks from the EURO, and 8754 stocks from the APAC. Not all stocks were trading at the beginning or end of our time period or stopped trading because they were acquired or went into bankruptcy and thus ceased to exist. In such a manner, we can account for survivorship bias.

We utilized The Refinitiv Business Classifications (TRBC), which offers multiple classification levels, to classify individual stocks into sin or non-sin stocks. Specifically, we used the "Activity" classification, which offers a detailed analysis of the primary business activities. For the stocks in this study, we found 742 unique classifications, of which we classified 47 as sin industries. Further, we extracted the weekly market capitalization of each stock in US Dollars. Finally, we obtained weekly absolute return data in US Dollars for all considered equities in the three indices from January 2003 until December 2022 using the Reuters Refinitiv Eikon database. Stocks that did not have any market capitalization data or return data were excluded from the sample.

3.2 Methodology

This section first highlights the methodology used to identify relevant sin stocks. Secondly, the theoretical framework used to analyze the financial performance of sin stocks will be described.

3.2.1 Identifying and classifying Sin Stocks

As previously mentioned, individual ethical and moral beliefs heavily influence the definition of sin stocks or sin industries (Fabozzi, Ma & Oliphant, 2008). This thesis's classification of sin industries is based on this premise. Following the previous literature, we categorize the triumvirate of sin stocks as sinful due to their addictive behavior and associated health consequences. The corresponding business activities are indicated in Table 1 below based on TRBC classifications. Additionally, following Fabozzi, Ma, and Oliphant (2008), we consider the weapon industry, including defense, as sinful as they state that what is considered sinful "... requires a subjective value judgment" (2008, p.87). Therefore, given the connection to violence, harm, and especially the ongoing war in Ukraine, we choose to include this industry in the sin portfolio. Table 1 below outlines the specific activities associated with the weapon industry. To ensure thoroughness, we assessed all stocks to determine their involvement in the weapon industry, even if they operate in non-sinful sectors such as aircraft or spacecraft. Contrary to much of the literature, our sin stock portfolio diverges by incorporating oil & gas as a sin industry. This decision acknowledges the heightened focus on climate change, considering that oil & gas industries significantly contribute to greenhouse gas emissions and global warming. Table 1 below provides an overview of the diverse activity classifications associated with oil & gas, encompassing exploration, extraction, and refining processes.

We employed indices as proxies for each market to identify sin stocks within each market. The Russell 3000, EURO, and APAC indices, known for their comprehensive coverage of companies in their respective markets, encompass many prominent sin companies. Utilizing the TRBC classification, we categorized each stock in the indices as either sin or non-sin. Consequently, we constructed seven portfolios: All sin stocks, the triumvirate of sin stocks, and the five individual sin industries tobacco, alcohol, gambling, weapon, and gas & oil. Following the selection process, stocks were weighted based on their market capitalization for each year and multiplied by their respective returns, enabling us to derive the portfolio return.

Table 1: The Refinitiv Business Classifications allocated to each Sin Industry

Industry	The Refinitiv Business Classifications	
Alcohol	Beer, Wine & Liquor Stores Brewers Distilleries	Distillers & Wineries Pubs, Bars & Night Clubs Wineries
Tobacco	Chewing Tobacco Products Cigars & Cigarette Manufacturing	Tobacco Tobacco Stores
Gambling	Casinos Casinos & Gaming Gambling & Gaming Machine Manufacturers	Gaming Machine Operators Lottery Operators
Weapon	Aerospace & Defence Aerospace & Defence Electronics Aircraft Parts Manufacturing Arms & Ammunitions Manufacturing	Military Aircraft Manufacturing Military Clothing & Accessories Military Vehicles Manufacturing
Oil & Gas	Gas Drilling - Onshore Gas Infrastructure Construction Gasoline Stations Integrated Oil & Gas Natural Gas Distribution Natural Gas Exploration & Production - Offshore Natural Gas Exploration & Production - Onshore Natural Gas Pipeline Transportation Natural Gas Utilities Oil & Gas Drilling Oil & Gas Exploration and Production Oil & Gas Refining and Marketing Oil & Gas Storage	Oil & Gas Transportation Services Oil Drilling - Offshore Oil Exploration & Production - Offshore Oil Exploration & Production - Onshore Oil Pipeline Transportation Oil Related - Surveying & Mapping Services Oil Related Equipment Oil Related Services Oil Related Services and Equipment Petroleum Product Wholesale Petroleum Refining Unconventional Oil & Gas Production

Table 1 shows all The Refinitiv Business Classifications which we decided to be part of the respective sin industry. Source: Own Illustration.

3.2.2 Performance of sin stocks

To examine the performance of sin stocks, we first adopt the widely used three-factor model introduced by Fama and French (1992). This approach aligns with the prevailing literature on sin stock analysis, including studies by Sagbakken and Zhang (2021), Fabozzi, Ma, and Oliphant (2008), and Salaber (2007). The multifactor model proposes that stock returns are influenced not only by market risk (beta) as described in the Capital Asset Pricing Model (CAPM) by Sharpe (1964) and Lintner (1965), but also by

two additional factors: a firm's size incorporated with the small-minus-big factor (SMB) and their book-to-market ratio incorporated with the high-minus-low factor (HML). These additional factors aim to capture other dimensions of risk that impact stock returns. In the so-called Fama French three-factor model, the expected return of a portfolio is explained by the following equation:

$$r_p - r_f = \alpha + \beta_m * (r_m - r_f) + \beta_s * SMB + \beta_h * HML \quad (1)$$

Where r_p is the portfolio's expected return rate, r_f is the risk-free rate, r_m is the overall market's return, SMB is the small-minus-big factor, and HML is the high-minus-low factor. The betas represent the loadings of each respective factor. The SMB factor is computed by taking the average return of small-size stocks (measured by market capitalization) and subtracting the average return of large-size stocks. Similarly, the HML factor is calculated by subtracting the average return of stocks with a high book-to-market ratio (measured by dividing a company's book value of equity by its market capitalization) from the average return of stocks with a low book-to-market ratio.

The inclusion of the SMB and HML factors in the CAPM is based on Fama and French's (1992) assertion that smaller companies tend to exhibit higher expected returns compared to larger companies, while companies with lower book-to-market ratios (value stocks) tend to have higher expected returns compared to those with higher book-to-market ratios (growth stocks). Applied to our sin stock data, we calculate the following equations:

$$r_{sUS} - r_{fUS} = \alpha + \beta_m * (r_{US} - r_{fUS}) + \beta_s * SMB_{US} + \beta_h * HML_{US} \quad (2)$$

$$r_{sEURO} - r_{fEURO} = \alpha + \beta_m * (r_{EURO} - r_{fEURO}) + \beta_s * SMB_{EURO} + \beta_h * HML_{EURO} \quad (3)$$

$$r_{sASIA} - r_{fAPAC} = \alpha + \beta_m * (r_{APAC} - r_{fAPAC}) + \beta_a * SMB_{APAC} + \beta_h * HML_{APAC} \quad (4)$$

The return of the sin stock portfolio in the US market is denoted as r_{sUS} , in the European market as r_{sEURO} , and in the Asia-Pacific market as r_{sASIA} . The market risk premium is represented by the market return (r_{US} for the US) minus the respective risk-free rate (r_{fUS} for the US). The SMB and HML factors for each of the three markets are indicated by the corresponding subscript.

However, Carhart (1997) argues that the three-factor model fails to capture all dimensions of risk and return. To address this, Carhart introduced the momentum factor

(MOM) into Fama and French's (1992) three-factor model, providing a more comprehensive framework for understanding stock returns. The MOM factor accounts for the phenomenon where stocks with positive returns in the past, typically over 6 or 12 months, tend to continue performing well, and vice versa. It is calculated by taking the average return of a portfolio of stocks with positive momentum and subtracting the average return of a portfolio of stocks with negative momentum. In the Carhart four-factor model, the expected return is determined by the following equation:

$$r_p - r_f = \alpha + \beta_m * (r_m - r_f) + \beta_s * SMB + \beta_h * HML + \beta_m * MOM \quad (5)$$

In the equation context, the variables are the same as in the Fama-French three-factor model, and MOM represents the momentum factor.

Building on Carhart's (1997) findings, other researchers such as Hou, Xue, and Zhang (2014) and Frazzini and Pedersen (2014) have also suggested that Fama and French's (1992) three-factor model may not fully capture the risk-return relationship of stocks in the market. In response, Fama and French (2014) introduced a five-factor model, which extends the existing three-factor model by incorporating a profitability factor (RMW) and an investment factor (CMA). The RMW factor captures the relationship between stock returns and the profitability of companies relative to their book value of equity. It is calculated by comparing the stock returns of high-profitability companies with those of low-profitability companies. The CMA factor measures the disparity in stock returns between companies with high and low levels of investment. Companies with a high level of investment typically experience a significant change in total assets. The rationale behind this factor is that highly invested companies face higher capital costs due to having less capital available for other purposes, making them perceived as riskier and leading to lower returns. The Fama and French (2014) five-factor model is calculated using the following equation:

$$r_p - r_f = \alpha + \beta_m * (r_m - r_f) + \beta_s * SMB + \beta_h * HML + \beta_r * RWA + \beta_c * CMA \quad (6)$$

This expanded model is essentially the same as the three-factor model, with the inclusion of the RMW and CMA factors and their associated loadings. All factors for the three models are sourced from Kenneth French's online data library.

We include the three-, four-, and five-factor models in our analysis as a robustness test and a way to draw reliable conclusions since the three models incorporate different risk factors. If an alpha persists across all three factor models, it is safe to say there exists a sin premium.

4 Empirical Results

The results section is divided into four subsections. Firstly, we present the outcomes of the classification process, where stocks are categorized as sin stocks. Secondly, we provide descriptive statistics for the markets, as well as for the sin portfolio and the individual sin industries. Thirdly, we discuss the results of the three-, four-, and five-factor model analysis. The final part of this section focuses on analyzing the financial crisis between 2007 and 2009 and the COVID-19 crisis.

4.1 Sin stock classification

Table 2 below presents the annual number of stocks traded in each market, represented by the respective index, and the number of stocks in each identified sin industry. The number of traded stocks extracted from the Russell 3000 stayed relatively stable during the 20 years. However, considering that 6836 stocks were part of the index once, only slightly more than half was traded each year. The traded stocks extracted from the EURO exhibited a slight increase at the beginning of the period. With 3602 stocks included in the index over the whole period, 69% of them were traded in 2022. Contrary to the first two indices, the number of traded stocks extracted from the APAC gradually increased and nearly doubled until 2022. Out of 8,754 stocks traded over the entire period, the majority (86%) were still traded in 2022.

Furthermore, the table analysis reveals a decline in sin stocks in the US market over the last five years of the examined period. Moreover, the sin stocks are predominantly composed of oil & gas companies. This observation is understandable, considering that the oil & gas industry encompasses a significantly larger number of TRBC categories (25) than the other industries (with weapons being the second largest with seven categories). Additionally, the oil & gas industry holds a dominant position in terms of market size, with a global revenue of \$4 trillion, according to Reuters (2023). Notably, starting from 2018 and particularly during the economic downturn triggered by the COVID-19 crisis, there has been a substantial decrease in the number of oil & gas companies traded in the US market. S&P Global (2021) reports that the oil & gas industry was severely impacted by the pandemic, which is the primary driver behind the reduction in the total number of sin stocks traded.

From 2003 to 2011, there was a significant increase in the number of sin stocks in the European market. Although the number of sin stocks traded in 2022 surpasses that of 2003, their proportion relative to the total number of stocks traded has remained relatively stable. Like the US market, sin stocks in Europe are predominantly represented

by oil & gas companies, accounting for an average of 64% of all sin stocks. However, the number of weapon-related stocks is lower in Europe, which could be attributed to stricter gun laws in European countries compared to the US (Schaeffer, 2021). Additionally, the significantly higher military budget of the United States may contribute to a greater presence of weapon-related stocks in the US market (Peter G. Peterson Foundation, 2023). Interestingly, the European market includes a higher percentage of alcohol-related companies, constituting 13% of all sin stocks, compared to the US market, where they account for only 3%. This discrepancy could be attributed to the greater diversity of the European market compared to the US, where the alcohol industry is dominated mainly by the two corporations Anheuser-Busch InBev and Molson Coors (Conway, 2023).

Table 2: Evolution of the Number of Companies per Index and Sin Industry

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Russell3000	3477	3614	3712	3737	3667	3590	3565	3566	3552	3584	3657	3797	3808	3711	3683	3692	3693	3741	3729	3572
Alcohol	8	8	8	9	9	9	9	9	9	9	8	7	7	7	7	7	6	6	7	7
Tobacco	6	6	6	6	6	8	7	7	7	7	7	8	7	8	7	7	8	7	7	7
Gambling	26	27	27	27	25	25	25	23	23	23	21	20	20	22	19	19	19	20	21	20
Weapon	42	45	47	47	45	44	45	44	45	44	44	45	43	43	39	36	35	35	36	36
Oil & Gas	178	179	183	190	197	193	196	192	195	197	201	204	203	192	196	195	185	171	157	148
Total Sin	260	265	271	279	282	279	282	275	279	280	281	284	280	272	268	264	253	239	228	218
	7.5%	7.3%	7.3%	7.5%	7.7%	7.8%	7.9%	7.7%	7.9%	7.8%	7.7%	7.5%	7.4%	7.3%	7.3%	7.2%	6.9%	6.4%	6.1%	6.1%
EURO	1999	2097	2252	2452	2575	2553	2539	2591	2621	2618	2643	2713	2720	2733	2748	2751	2701	2669	2606	2503
Alcohol	22	23	24	24	24	23	23	23	23	23	25	26	26	27	26	25	25	24	21	21
Tobacco	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5
Gambling	11	12	17	18	19	19	19	20	20	19	19	19	19	18	19	17	18	18	15	14
Weapon	19	19	20	21	22	22	23	24	24	22	22	23	24	24	24	22	22	21	21	19
Oil & Gas	79	83	104	121	126	127	126	131	142	140	137	138	128	126	124	124	119	119	118	109
Total Sin	135	141	169	188	195	195	195	202	213	208	207	210	201	200	198	193	189	187	180	168
	6.8%	6.7%	7.5%	7.7%	7.6%	7.6%	7.7%	7.8%	8.1%	7.9%	7.8%	7.7%	7.4%	7.3%	7.2%	7.0%	7.0%	7.0%	6.9%	6.7%
APAC	3968	4291	4515	4867	5260	5367	5616	6002	6227	6404	6567	6738	6932	7064	7244	7402	7525	7629	7592	7505
Alcohol	29	28	29	28	29	31	36	38	39	41	41	44	45	48	48	46	49	49	50	50
Tobacco	8	8	8	8	8	8	8	8	8	8	7	7	6	6	7	7	8	9	9	9
Gambling	23	26	26	30	37	37	42	41	45	44	46	46	46	47	46	45	45	45	44	42
Weapon	16	17	15	16	15	17	16	18	19	18	20	21	25	24	24	29	31	34	34	33
Oil & Gas	143	160	165	178	185	190	199	203	207	212	221	218	220	216	215	212	209	204	200	197
Total Sin	219	239	243	260	274	283	301	308	318	323	335	336	342	341	340	339	342	341	337	331
	5.5%	5.6%	5.4%	5.3%	5.2%	5.3%	5.4%	5.1%	5.1%	5.0%	5.1%	5.0%	4.9%	4.8%	4.7%	4.6%	4.5%	4.5%	4.4%	4.4%

Table 2 shows the number of companies from 2003 to 2022 for the three indices and for each sin industry. Russell3000 stands for the Russell 3000 Index, EURO for the Europe Developed Markets Large & Mid Cap Total Return Index, and APAC for the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index. Source: Own Illustration.

During the examined period, the number of stocks in the Asia-Pacific market nearly doubled. However, the number of sin stocks in the same market did not keep pace with this growth, accounting for 4.4% of the index in 2022, down from 5.5% in 2003. The alcohol industry witnessed a significant increase in stocks, rising from 29 to 50. However, in relation to the overall number of sin stocks, the proportion remained relatively stable, constituting 13% in 2022 compared to 15% in 2003. Additionally, the weapon industry experienced a substantial increase, doubling the number of stocks from 16 in 2003 to 33 in 2022. These trends can be attributed to the rise in alcohol consumption (The World Bank, 2019) and increased military spending, particularly by the Chinese government (The World Bank, 2022).

On average, sin stocks constitute approximately 7.3% of the US market, 7.4% of the European market, and 5.0% of the Asia-Pacific market. It is worth noting that the number of tobacco stocks remains relatively small across all three markets and does not show any clear trend of increase or decrease, despite fluctuations in the overall number of sin stocks.

4.2 Descriptive statistics

As seen in Table 3 below, the US market demonstrates a higher Sharpe ratio than the sin portfolio despite a slightly lower return than the portfolio of all sin stocks. While the alcohol, tobacco, and weapon industries exhibit annual returns of over 10%, the sin portfolio's return stands at 9.06%. This lower return can be attributed to the oil & gas industry, which has a comparatively lower annual return of 7.98% and constitutes a significant market weight of 65.8% of the sin portfolio in 2022 (as seen in Appendix A). Furthermore, the gambling industry displays poor performance, with a return of 6.55%. The gambling industry's wide range of minimum and maximum returns reflects its high standard deviation, resulting in an unfavorable risk-reward trade-off, as seen by its Sharpe ratio of 0.16. In contrast, the tobacco industry exhibits the highest Sharpe ratio at 0.61. Additionally, the US market outperforms the sin portfolio in terms of the Sharpe ratio, primarily due to its lower standard deviation.

Table 3: Descriptive statistics of the Indices, the Sin Industries, and the Sin Portfolio

Asset	Annual Return (%)	Annual STD (%)	Sharpe ratio	Skewness	Excess kurtosis	Jarque Bera Test Statistic	Min Return %	Max Return %
US	8.91	18.20	0.49	-0.48	6.64	11.24***	-36.59	36.04
All Sin	9.06	22.58	0.40	-0.83	7.44	14.54***	-40.63	36.65
Alcohol	10.33	20.10	0.51	-0.52	7.52	14.41***	-31.37	40.78
Tobacco	12.82	20.99	0.61	-0.24	8.83	19.55***	-31.77	35.91
Gambling	6.55	39.95	0.16	0.92	12.82	41.94***	-80.68	82.26
Weapon	10.91	20.77	0.53	-0.47	6.08	9.48***	-39.87	52.28
Oil & Gas	7.98	26.99	0.30	-0.66	5.91	9.17**	-40.51	57.81
Triumvirate	11.14	19.55	0.57	-0.51	6.43	10.60***	-42.40	39.52
European	6.97	17.45	0.40	-1.38	11.52	35.07***	-46.29	41.66
All Sin	8.07	20.26	0.40	-0.69	13.30	44.67***	-39.49	42.92
Alcohol	8.59	18.57	0.46	-0.70	6.90	12.39***	-41.72	65.04
Tobacco	11.82	19.91	0.59	-0.55	8.09	16.68***	-39.60	36.41
Gambling	7.02	22.20	0.32	-0.65	5.90	9.14**	-34.89	59.42
Weapon	11.00	21.98	0.50	-0.43	7.64	14.78***	-35.36	48.14
Oil & Gas	7.82	23.49	0.33	-0.39	11.77	34.77***	-40.76	44.67
Triumvirate	9.39	16.40	0.57	-1.11	9.68	24.63***	-32.42	42.97
Asia-Pacific	9.53	16.57	0.57	-0.71	4.26	5.04*	-52.07	78.38
All Sin	13.07	20.21	0.65	-0.41	4.21	4.59	-51.50	94.09
Alcohol	21.37	24.72	0.86	-0.27	1.68	0.78	-55.80	119.57
Tobacco	11.10	19.60	0.57	-0.58	5.54	8.01**	-32.70	42.21
Gambling	6.16	22.84	0.27	-0.17	2.61	1.73	-53.40	67.68
Weapon	10.72	24.66	0.43	0.08	4.84	5.85*	-53.09	127.51
Oil & Gas	11.94	22.58	0.53	-0.25	3.98	4.02	-51.95	113.05
Triumvirate	14.85	18.18	0.82	-0.58	2.82	2.33	-47.99	68.25

Table 3 shows the annual return, annual standard deviation (annual STD), Sharpe ratio, skewness, excess kurtosis, minimum return, maximum return on a monthly basis from January 01, 2003, to December 31, 2022. A p-value on a 10%, 5%, and 1%-level is indicated by “*”, “**”, “***”. The markets are approximated by the Russell 3000 Index (US), the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index (European), and the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index (Asia-Pacific) respectively. For each index, Alcohol, Tobacco, Gambling, Weapon, and Oil & Gas stand for all the companies operating in the respective industry, the sin portfolio (All Sin) is constituted by all sin companies combined and the portfolio of addictive industries (triumvirate) is constituted by the three industries Tobacco, Alcohol, and Gambling. Source: Own Illustration.

In the European market, the sin portfolio and the market display slight differences in their results compared to the US market. The European market shows the lowest annual return among all portfolios, 1.1% lower than the sin portfolio. Lower volatility explains the lower return, making the Sharpe ratio the same as the sin portfolio. Like the US market, the tobacco and weapon industries exhibit annual returns above 10%, while alcohol and the triumvirate portfolio demonstrate lower annual returns in comparison. This discrepancy may contribute to the lower overall return of the sin portfolio in Europe compared to the US market. Interestingly, the gambling industry in Europe exhibits a comparable annual return but with a significantly lower standard deviation, resulting in a Sharpe ratio that is twice that of the US gambling portfolio. However, it still ranks as the worst-performing portfolio among all options.

In contrast to the US and European markets, the Asia-Pacific market presents distinct outcomes. The sin portfolio in the Asia-Pacific market stands out with an annual return of 13.07%, surpassing the sin portfolios in the European and US markets by 5% and 4.01%. Moreover, the sin portfolio in the Asia-Pacific market achieves the highest Sharpe ratio among the three sin portfolios. The market also demonstrates the highest annual return among the three markets, accompanied by the lowest standard deviation, resulting in a Sharpe ratio of 0.57, the highest across the markets. Similarly to the US and European markets, the gambling industry performs the worst, being the only portfolio with an annual return below 10%. On the other hand, the alcohol industry in the Asia-Pacific market boasts an exceptionally high annual return of 21.37% with only a slight increase in volatility, leading the industry to display the highest Sharpe ratio of 0.86, indicating its potential to outperform the market.

In conclusion, while specific industries demonstrate strong performance across all three markets, the overall sin portfolio exhibits similar performance to the market in the US and Europe, with identical annual returns in the US and matching Sharpe ratios in Europe. However, the sin portfolio diverges in Asia-Pacific, showcasing different annual returns and Sharpe ratios. Furthermore, the Jarque-Bera test rejects the assumption of normality for all portfolios in the US and European markets but only for the tobacco and weapon portfolio in the Asia-Pacific market.

4.3 Results of the whole period

In this section, we present the results of the analysis of sin stocks for the entire period from January 2003 to December 2022. We begin by examining the performance of the sin portfolio as a whole, followed by a discussion of the results for each industry within the sin portfolio.

4.3.1 Results Sin Portfolio

Table 4 below displays the regression results for the sin portfolio across the US, European, and Asia-Pacific markets. In line with the descriptive statistics, the Asia-Pacific market was anticipated to exhibit stronger performance, and the regression outcomes substantiate this expectation. For the three-factor model, the sin portfolio displays a positive alpha of 0.09 at a significance level of 10%. The alpha rises to 0.13 on a weekly basis in the five-factor model at a significance level of 5%. When annualized, the sin portfolio's outperformance amounts to 5.06% in the three-factor model and a more substantial 6.93% using the five-factor model. Notably, the five-factor model demonstrates a higher level of outperformance despite incorporating additional factors compared to the other models.

The results for the US and European markets do not show any outperformance for the sin portfolio. By breaking down the sin portfolio into its constituent industries, we aim to provide further insights into the findings discussed in this section.

Table 4: Factor models for the Sin Portfolio in the US, European and Asia-Pacific Market

Sin Portfolio	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
US								
FF3	0.029	0.937***	0.086*	0.434***				0.703
Carhart 4	0.019	0.968***	0.086**	0.514***	0.148***			0.712
FF5	-0.067	0.983***	0.168***	0.319***		0.264***	0.307***	0.712
EURO								
FF3	0.316	0.927***	-0.270	-0.637**				0.624
Carhart 4	0.316	0.925***	-0.269	-0.645**	-0.007			0.628
FF5	0.298	0.658***	-0.450**	-0.434		0.173	-1.08***	0.653
APAC								
FF3	0.095*	0.905***	0.141***	0.227***				0.638
Carhart 4	0.081	0.907***	0.124***	0.237***	0.063*			0.639
FF5	0.129**	0.874***	0.110**	0.101*		-0.29***	-0.073	0.646

Table 4 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the sin portfolio of the US, European and Asia-Pacific market. The sin portfolios were constructed by extracting all companies operating in the respective industry from the Russell 3000 Index (US), the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index (European), and the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index (Asia-Pacific). Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in January 2003 and ending in December 2022 was used. A p-value on a 10%, 5%, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

4.3.2 Results Sin Industries

The results of the factor-model analysis, specifically examining individual sin industries throughout the entire period, are presented in Appendix B-D.

Upon examining the US regression results, all industries, except tobacco, display non-significant alphas. For the tobacco industry, a significant alpha of 0.16 at a 5% significance level is observed in the three-factor model and a similar alpha of 0.15 in the four-factor model on a weekly basis. However, the tobacco industry no longer exhibits a significant alpha when incorporating additional variables such as profitability and investment. Furthermore, it is worth noting that the adjusted R-squared is low for the tobacco industry, suggesting that the significant alpha observed may be spurious, and

the results may not be reliable. Consequently, investors cannot achieve market outperformance by investing in sin stocks within the US market.

In contrast to the European market's sin portfolio, which does not demonstrate a significant alpha, the analysis of individual industries reveals the presence of a sin premium. Similar to the US market, the tobacco industry in the European market displays a statistically significant intercept, and this significance persists even in the five-factor model. It is important to note that the adjusted R-squared, at only 0.26 for the five-factor model, is relatively low. In addition to the tobacco industry, significant outperformance is observed in the triumvirate portfolio. It exhibits a statistically significant outperformance at the 10% significance level, with a weekly alpha of 0.09, corresponding to an annual outperformance of 5.00%. Thus, contrary to the US market, an investor in the European market can achieve an outperformance by investing in a market-weighted portfolio of alcohol, tobacco, and gambling stocks.

The sin portfolio within the Asia-Pacific market demonstrates a significant positive alpha in the five-factor model. This can largely be attributed to the alcohol and tobacco industries, which exhibit significant positive intercepts at the 1% (alcohol) and 5% (tobacco) significance levels across all three factor models. Particularly noteworthy is the alcohol industry, which displays a substantial sin premium with a weekly alpha of 0.36 in the five-factor model, corresponding to an impressive annual outperformance of 21.86%. Considering the significance of the alcohol and tobacco industries, the triumvirate portfolio also demonstrates a significant sin premium ranging between 0.17% and 0.20% per week across the factor models.

For the gambling, weapon, and oil & gas industries, we found no consistently significant alphas across the three factor models and markets. This indicates that the stocks are correctly priced according to the factor models.

4.4 Results during the Financial Crisis and the COVID-19 Crisis

This section analyzes two major crises: the financial crisis and the COVID-19 crisis. The addictive behavior associated with sin stocks motivates this analysis, as it provides a stable customer base even during economic downturns. Examining the period from October 2007 to March 2009 allows us to understand the financial crisis while focusing on March 2020 to March 2021 reveals insights into the COVID-19 crisis and its impact on sin industries. By studying the financial performance of sin industries during these crises, we gain valuable insights into their resilience and performance during economic and global turmoil.

4.4.1 Results Sin Portfolio Financial Crisis

During the financial crisis, the sin portfolio did not significantly outperform or underperform across the three markets using the three different factor models. Table 5 below shows a positive alpha in eight of nine regressions, but the statistical significance is insufficient. Thus, the analysis of the individual industries will give further insights.

Table 5: Factor models for the Sin Portfolio in the US, European and Asia-Pacific Market during the Financial Crisis

Sin Portfolio	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
US								
FF3	0.184	1.161***	-0.322*	-0.451***				0.793
Carhart 4	0.206	1.268***	-0.25	-0.198	0.278***			0.810
FF5	-0.175	1.049***	-0.38**	-0.067		0.983***	-1.521***	0.834
EURO								
FF3	0.316	0.927***	-0.27	-0.637**				0.794
Carhart 4	0.316	0.925***	-0.269	-0.645**	-0.007			0.791
FF5	0.298	0.658***	-0.45**	-0.434		0.173	-1.08***	0.816
APAC								
FF3	0.152	1.032***	0.107	0.348*				0.741
Carhart 4	0.142	1.054***	0.103	0.38*	0.119			0.740
FF5	0.180	0.917***	0.069	0.542*		0.139	-0.484	0.742

Table 5 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the US, European and Asia-Pacific market approximated by the Russell 3000 Index (US), the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index (European), and the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index (Asia-Pacific) respectively. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in October 2007 and ending in March 2009 was used. A p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

4.4.2 Results Industries Financial Crisis

All results regarding the financial crisis are summarized in Appendix E-G. The US market experienced no significant alphas within its industry portfolios. However, looking at the market beta can give insight into the behavior of the portfolios compared to the market, as low-beta stocks tend to be less cyclical and less volatile during economic recessions. A notable disparity was observed across the portfolios. Specifically, the

gambling industry exhibited an average market beta of 1.78 across three different factor models, indicating a considerably higher volatility level than the overall market. On the other hand, the tobacco industry displayed an average market beta of 0.74, suggesting that American tobacco stocks yielded lower volatility than the market. The remaining four portfolios exhibited betas close to one, implying that they moved in line with the US stock market.

Like the US, the European market did not demonstrate significant outperformance within the individual sin industries. However, contrary to the US market, all European sin industries displayed market betas lower than one (with one exception in the Carhart four-factor model for oil & gas with a beta of 1.003). Gambling stocks exhibited the lowest market beta among these industries, averaging 0.44. The lower market betas observed in Europe, particularly in the addictive industries, highlight their relatively stable nature during market fluctuations.

In contrast to the European and US markets, the tobacco and gambling industries in the Asian-Pacific market exhibited notable alphas during the financial crisis. On a weekly basis, tobacco stocks outperformed the market by an average of 0.71, which was statistically significant at the 5% level for the Fama French three-factor model and the 10% level for the four- and five-factor models. This performance can potentially be attributed to the Chinese government's control over the tobacco industry and the recession-resistant nature of tobacco products (Chatjuthamard et al., 2020). Conversely, the gambling industry underperformed the market during the financial crisis, with an average weekly alpha of -0.50, significant at the 5% level for both the Fama French models and the 10% level for the Carhart four-factor model. The decline in consumers' discretionary income during the crisis likely contributed to this negative performance. However, adjusted R-squared values were generally low, suggesting that external factors may have influenced the industries during the financial crisis.

4.4.3 Results Sin Portfolio COVID-19 Crisis

During the year following the outbreak of COVID-19 in February 2020, the sin portfolio in the US experienced significant underperformance compared to the market, as indicated by the three-, four-, and five-factor models. This underperformance was statistically significant at a 10% level for both Fama-French models, with a weekly underperformance of -0.55%. The Carhart four-factor model demonstrated an even more significant weekly underperformance of -0.90% (at a 1% significance level).

However, no significant underperformance or outperformance of sin stocks compared to the market was observed in the European and Asia-Pacific markets.

Table 6: Factor models for the Sin Portfolio in the US, European and Asia-Pacific Market during the COVID-19 Crisis

Sin Portfolio	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
US								
FF3	-0.555*	1.073***	0.46***	0.523***				0.893
Carhart 4	-0.902***	1.162***	0.300**	-0.045	-0.551***			0.930
FF5	-0.552*	1.088***	0.411**	0.468***		-0.397	0.352	0.900
EURO								
FF3	-0.029	0.814***	-0.585*	0.519***				0.773
Carhart 4	0.021	0.805***	-0.647*	0.619	0.068			0.768
FF5	0.217	0.950***	-0.027	-0.033		1.15*	2.072***	0.803
APAC								
FF3	0.321	0.803***	0.542***	0.112				0.805
Carhart 4	0.328	0.793***	0.483**	0.149	0.093			0.804
FF5	0.326	0.856***	0.597***	-0.179		-0.209	0.379	0.802

Table 6 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the US, European and Asia-Pacific market approximated by the Russell 3000 Index (US), the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index (European), and the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index (Asia-Pacific) respectively. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in February 2020 and ending in February 2021 was used. A p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

4.4.4 Results Industries COVID-19 Crisis

During the COVID-19 crisis in the US, when examining individual industries, significant weekly alphas were observed for the weapon industry (-0.64% on a 10% significance level) and the oil & gas industry (-1.31% on a 1% level) when utilizing the Carhart four-factor model. It is worth noting that the Fama-French regressions yielded insignificant results for these industries. All results are summarized in Appendix H-J. The oil & gas industry faced a demand decline in the early stages of the pandemic, leading to lower oil prices and oversupply due to a price war (Gharib et al., 2021). This prompted cost-cutting measures, layoffs, and an accelerated shift toward renewable energy sources. Similarly, reduced defense spending and supply chain disruptions impacted weaponry & defense stocks (Deloitte, 2020). The substantial weighting of oil & gas stocks and

weaponry stocks within the sin portfolio (65.8% & 19.9% in 2022, Appendix A) significantly contributed to its negative alpha.

Although the gambling industry did not exhibit a significant alpha, it is notable that the average market beta across the three factor models was 1.50, significantly higher than one. This suggests higher volatility of the portfolio compared to the overall market. The COVID-19 pandemic significantly impacted the gambling and betting industry, especially during the initial stages when lockdown measures were implemented, and casinos and betting shops were closed. The cancellation of sports events also contributed to a decline in revenue for many operators (American Gaming Association, 2021). However, there was an increase in online gambling and betting as people spent more time at home, leading to a surge in activity for some operators (University of Bristol, 2021). These contrasting factors help explain the volatility observed in the gambling industry.

During the specified period, the European market did not exhibit a significant alpha for any individual sin industries, consistent with the findings from the sin portfolio. Notably, the tobacco industry displays a low beta value of 0.44, suggesting significantly lower return volatility than the market. Tobacco products are considered essential items and are less likely to be affected by changes in consumer behavior. Furthermore, tobacco companies implemented marketing strategies to promote their products and enhance their public image during the pandemic, further bolstering investor confidence (Geller & Cavale, 2020). Additionally, the low adjusted R-squared value of 0.25 could be attributed to policy changes or other factors specific to the tobacco industry that had a distinct impact on its performance and could not be fully explained by the factors.

A closer examination of the performance of individual sin industries in the Asian-Pacific market during the COVID-19 pandemic reveals that the alcohol industry significantly outperformed the market. The industry exhibited an average weekly alpha of 1.26, significant at a 1% level. The notable outperformance of the alcohol industry in the Asian-Pacific market can potentially be attributed to increased demand during the pandemic. As stricter lockdown measures were implemented in Asia-Pacific countries compared to the US and Europe, individuals may have turned to alcohol consumption to cope with heightened stress and anxiety (Choo & Elangovan, 2021).

The positive impact of alcohol stocks' performance is further reflected in the triumvirate portfolio. The portfolio demonstrated a significant average weekly alpha of 0.83 across all three factor models, indicating an overall positive performance. Notably, the alpha of the triumvirate portfolio was significant at a 1% level. However, no significant under- or overperformance was found for the tobacco and gambling industries.

The adjusted R-squared values for the tobacco and weapon regressions in the Asian-Pacific market during the COVID-19 pandemic were below 0.2. These lower R-squared values suggest that external shocks may have influenced the industries. For example, in April 2020, the government of Thailand launched an anti-smoking campaign to encourage smokers to quit and reduce their risk of severe COVID-19 symptoms (World Health Organization, 2020). Further, South Korea increased its defense budget by 10% in 2021 and invested in domestic defense industries to boost their economies (Macrotrends, 2023).

Consequently, we conclude that sin stocks do not exhibit constant non-cyclical properties since we do not find a constant alpha across the three markets, and most significant alphas can be attributed to external shocks.

5 Conclusion

This master's thesis tries to analyze so-called sin stocks. Investors actively neglect stocks operating in controversial businesses due to their negative association. However, the negative association of sin stocks may vary between different countries as different countries exhibit different beliefs. This leads us to include three major markets in our analysis: the US, Europe, and Asia-Pacific.

Using a Fama-French three- and five-factor model (1992; 2014) and a Carhart four-factor model (1997), we analyze whether sin stocks exhibit a positive alpha and, consequently, an outperformance. Over the sample period of 20 years between 2003 and 2022, there is no sin premium in the US market across all industries. In the European market, only the tobacco industry and the triumvirate exhibit a constant significant sin premium over all three factor models, with an annual outperformance of 8.61% for the tobacco and 5% for the triumvirate. In the Asia-Pacific market, the triumvirate shows an outperformance mainly driven by a statistically significant outperformance of the alcohol (21.86% annually) and tobacco (9.05% annually) industries. Interestingly the oil & gas industry does not show signs of outperformance in any of the three markets, indicating that the markets price the stocks correctly according to the factor models.

Further, we investigated the state-varying behavior of sin stocks during the economic downturns in the financial crisis between 2007 and 2009 and the COVID-19 crisis between 2020 and 2021. No sin premium occurs during the financial crisis in the US and European markets. In the Asia-Pacific market, only the tobacco industry shows a sin premium. Interestingly the gambling industry in the Asia-Pacific showed a significant underperformance with an average weekly return of -0.50% over all three factor models. Looking at the triumvirate of sin stocks, which, due to their addictive behavior and thus stable customer base, are expected to exhibit a sin premium during crises, we do not find an outperformance in the US or the European market. Contrary, we find an average positive weekly alpha of 0.83 in the Asia-Pacific market for the alcohol industry. Consequently, the triumvirate portfolio shows a significant sin premium of 0.83 weekly.

During the COVID-19 crisis, the regression results reveal variations compared to the financial crisis. According to the five-factor model, the sin portfolio exhibited a significant weekly underperformance of -0.55% in the United States. However, the individual industries within the portfolio did not demonstrate significant alphas. In Europe, all portfolios exhibited intercepts that lacked statistical significance. In the Asia-Pacific region, the alcohol sector significantly outperformed the market with a weekly

alpha of 1.25. This contributed to the overall outperformance of the triumvirate portfolio. Despite the notable positive alpha observed in the alcohol portfolio, the sin portfolio did not exhibit significant outperformance.

In conclusion, the US market has no sin premium as the factor models sufficiently explain the sin stock return. In the European market, investors were able to outperform the market by investing in the alcohol and tobacco industries. The Asia-Pacific region shows the most signs of sin premium, with mainly the alcohol industry exhibiting high outperformance. Therefore, we conclude that there is no evidence of a consistent sin premium over all three markets. We observed slight performance differences between the two economic downturns. Notably, the US sin portfolio underperformed the market during the COVID-19 crisis. Further, we conclude that state-dependent behavior exists in some industries and no consistent sin premium over the two crises. The differing results could be attributed to a different perception of sin stocks. However, other reasons, such as different characteristics and regulations of the industries between the markets, must be considered.

These findings are gratifying to see as investors who try to follow their ethical and moral beliefs do not pay the price in terms of opportunity costs by actively excluding sin stocks from their investment horizon. This may lead to increased investment in sustainable, environmentally friendly, and “good” investments tackling the climate crisis and preventing people from addiction and its health consequences.

Further research can lay an increased focus on the oil & gas industry as the topic of global warming becomes increasingly important. Additionally, different models could be applied to investigate the sin premium, as regressions only capture linear dependencies. Lastly, the alcohol, tobacco, and gambling industries are strongly regulated and influenced by policy changes. Thus, including policy changes of these industries in different markets in the financial analysis can provide further explanation for their return.

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Appendix

Appendix A: Evolution of the Marketweights of All Sin Stocks per Index and Sin Industry

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Russell 3000																				
Alcohol	2.0	1.7	1.8	1.6	1.4	1.7	1.5	1.7	1.4	1.7	1.9	2.0	3.0	2.6	3.2	3.2	3.5	5.5	4.2	3.0
Tobacco	11.3	10.0	9.9	9.9	7.4	9.7	8.9	9.0	10.7	10.8	9.5	10.8	14.3	13.1	11.0	9.5	9.6	11.4	9.9	7.8
Gambling	3.7	5.4	3.7	4.6	4.2	1.4	2.0	3.1	2.9	3.0	3.9	3.1	3.0	3.3	4.4	3.8	4.8	7.3	5.9	3.4
Weapon	16.1	14.6	12.5	13.1	12.9	12.5	13.0	11.9	10.9	10.9	12.8	15.2	17.3	16.1	19.3	20.3	24.9	26.3	22.5	19.9
Oil & Gas	67.0	68.2	72.1	70.7	74.0	74.8	74.6	74.3	74.1	73.5	72.0	69.0	62.4	64.9	62.0	63.2	57.2	49.6	57.4	65.8
Triumvirate	16.9	17.2	15.4	16.1	13.1	12.8	12.5	13.7	15.0	15.5	15.2	15.8	20.3	19.0	18.7	16.5	17.9	24.1	20.0	14.3
EURO																				
Alcohol	10.7	10.4	7.7	7.7	7.5	7.8	9.5	10.5	10.5	13.7	14.7	18.3	21.8	16.9	18.2	16.4	17.0	20.4	18.9	19.7
Tobacco	5.0	5.2	4.2	3.6	4.1	5.3	4.6	5.1	6.0	5.8	5.6	7.3	8.6	7.1	8.0	5.0	5.2	5.9	5.1	6.8
Gambling	2.0	2.4	2.8	1.5	1.3	1.5	1.1	1.0	0.9	1.1	1.3	1.4	1.8	1.5	1.6	1.1	1.6	4.4	3.8	3.8
Weapon	3.7	4.0	4.2	3.5	3.6	3.8	3.5	4.1	3.7	4.4	5.8	6.4	6.8	5.9	6.5	6.3	6.9	7.3	6.1	8.7
Oil & Gas	78.5	77.9	81.2	83.7	83.5	81.6	81.3	79.2	78.9	75.0	72.7	66.7	60.9	68.6	65.6	71.2	69.4	62.1	66.1	61.0
Triumvirate	17.8	18.1	14.6	12.8	12.9	14.5	15.2	16.6	17.5	20.6	21.5	27.0	32.3	25.5	27.8	22.5	23.8	30.6	27.9	30.4
APAC																				
Alcohol	3.9	3.8	3.7	5.4	5.5	6.3	8.1	9.2	10.7	9.9	7.5	9.0	11.9	12.6	18.3	16.2	27.0	37.7	42.0	37.5
Tobacco	4.3	4.5	4.4	3.6	2.0	3.3	2.9	3.5	4.5	5.0	4.4	5.0	5.0	4.9	4.7	5.1	3.7	4.3	3.8	3.8
Gambling	4.7	6.2	5.7	6.6	3.8	3.6	5.5	8.0	9.9	12.0	18.7	13.3	10.4	11.3	12.4	10.9	10.7	7.3	5.6	6.0
Weapon	2.1	1.7	1.6	1.7	1.1	1.5	2.0	2.3	2.1	2.1	2.7	4.1	6.0	4.7	3.8	3.8	3.6	5.0	6.1	5.6
Oil & Gas	85.1	83.8	84.5	82.7	87.5	85.2	81.5	77.0	72.8	71.1	66.7	68.5	66.6	66.5	60.7	63.9	55.0	45.7	42.6	47.0
Triumvirate	12.8	14.4	13.9	15.7	11.4	13.3	16.5	20.7	25.1	26.8	30.6	27.3	27.3	28.8	35.5	32.3	41.4	49.3	51.3	47.3

Appendix 10 presents the composition of sin industries in percentage of all sin stocks within the three indices from 2003 to 2022. The table includes data for the Russell 3000 Index (Russell 3000), Europe Developed Markets Large & Mid Cap Total Return Index (EURO), and Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index (APAC). Source: Own Illustration.

Appendix B: 3-, 4-, 5-factor model for each Sin Industry in the US Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	0.068	0.823***	0.041	0.009				0.548
Carhart 4	0.063	0.837***	0.041	0.046	0.067**			0.550
FF5	0.023	0.879***	0.145***	-0.100**		0.392***	0.276***	0.570
Tobacco								
FF3	0.156**	0.647***	-0.309***	0.035				0.291
Carhart 4	0.151**	0.663***	-0.309***	0.077	0.077**			0.294
FF5	0.099	0.736***	-0.226***	-0.091*		0.342***	0.659***	0.328
Gambling								
FF3	-0.040	1.506***	0.722***	0.478***				0.602
Carhart 4	-0.020	1.443***	0.722***	0.317***	-0.297***			0.614
FF5	-0.008	1.421***	0.796***	0.557***		0.120	-0.993***	0.623
Weapon								
FF3	0.058	0.924***	0.090**	0.232***				0.723
Carhart 4	0.052	0.942***	0.090**	0.277***	0.082***			0.726
FF5	0.021	0.974***	0.160***	0.105***		0.240***	0.372***	0.738
Oil & Gas								
FF3	0.026	0.946***	0.175***	0.632***				0.580
Carhart 4	0.014	0.980***	0.175***	0.722***	0.165***			0.588
FF5	-0.011	0.992***	0.258***	0.491***		0.252***	0.349***	0.589
Triumvirate								
FF3	0.080	0.827***	-0.026	0.069**				0.589
Carhart 4	0.077	0.835***	-0.026	0.089**	0.036			0.589
FF5	0.043	0.877***	0.054	-0.023		0.293***	0.297***	0.604

Appendix 1 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The sin industries were constructed by extracting all companies operating in the respective industry from the Russel3000 Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in January 2003 and ending in December 2022 was used to run the regression and a p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix C: 3-, 4-, 5-factor model for each Sin Industry in the European Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	0.116**	0.546***	-0.626***	-0.293***				0.491
Carhart 4	0.128**	0.536***	-0.611***	-0.329***	-0.071**			0.493
FF5	0.078	0.561***	-0.576***	-0.092		0.532***	0.190*	0.498
Tobacco								
FF3	0.217***	0.310***	-0.785***	-0.228***				0.244
Carhart 4	0.191**	0.332***	-0.817***	-0.150**	0.151***			0.251
FF5	0.159**	0.358***	-0.701***	-0.029		0.730***	0.468***	0.260
Gambling								
FF3	0.051	0.758***	0.445***	-0.186***				0.376
Carhart 4	0.047	0.761***	0.440***	-0.174**	0.022			0.376
FF5	0.072	0.765***	0.427***	-0.360***		-0.337**	0.003	0.378
Weapon								
FF3	0.137**	0.675***	-0.227***	0.261***				0.489
Carhart 4	0.137**	0.676***	-0.228***	0.263***	0.005			0.488
FF5	0.106	0.720***	-0.173**	0.282***		0.333**	0.385***	0.494
Oil & Gas								
FF3	0.088	0.694***	-0.444***	0.396***				0.542
Carhart 4	0.068	0.711***	-0.469***	0.456***	0.118***			0.545
FF5	0.009	0.672***	-0.385***	0.916***		1.124***	-0.028	0.571
Triumvirate								
FF3	0.129***	0.502***	-0.577***	-0.29***				0.530
Carhart 4	0.127***	0.503***	-0.579***	-0.284***	0.011			0.530
FF5	0.094*	0.529***	-0.524***	-0.150**		0.463***	0.273***	0.538

Appendix 2 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4 applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in January 2003 and ending in December 2022 was used to run the regression and a p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix D: 3-, 4-, 5-factor model for each Sin Industry in the Asia-Pacific Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	0.344***	0.531***	0.385***	0.136*				0.142
Carhart 4	0.310***	0.535***	0.346***	0.160*	0.148**			0.146
FF5	0.365***	0.532***	0.375***	-0.073		-0.298**	0.111	0.145
Tobacco								
FF3	0.170**	0.403***	0.082	-0.022				0.147
Carhart 4	0.155**	0.405***	0.065	-0.012	0.065			0.148
FF5	0.175**	0.434***	0.084	-0.207**		-0.209**	0.268**	0.153
Gambling								
FF3	-0.010	0.821***	-0.239***	0.047				0.484
Carhart 4	0.012	0.818***	-0.214***	0.031	-0.096**			0.486
FF5	-0.000	0.842***	-0.225***	-0.064		-0.171*	0.193**	0.485
Weapon								
FF3	0.159*	0.608***	0.621***	0.242***				0.190
Carhart 4	0.118	0.613***	0.573***	0.271***	0.180***			0.196
FF5	0.184*	0.584***	0.592***	0.069		-0.274**	-0.054	0.192
Oil & Gas								
FF3	0.062	0.992***	0.186***	0.351***				0.594
Carhart 4	0.053	0.993***	0.175***	0.358***	0.041			0.594
FF5	0.092	0.953***	0.151***	0.274***		-0.218***	-0.144*	0.598
Triumvirate								
FF3	0.188***	0.593***	0.099*	0.036				0.356
Carhart 4	0.170***	0.596***	0.077	0.050	0.082**			0.361
FF5	0.199***	0.609***	0.105*	-0.114		-0.200**	0.163*	0.364

Appendix 3 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in January 2003 and ending in December 2022 was used to run the regression and a p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix E: 3-, 4-, 5-factor model for each Sin Industry during the Financial Crisis in the US Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	-0.159	0.871***	0.076	-0.146				0.680
Carhart 4	-0.145	0.939***	0.122	0.014	0.176			0.686
FF5	-0.043	0.975***	0.160	-0.235		-0.117	1.269***	0.717
Tobacco								
FF3	0.149	0.664***	-0.261	-0.339**				0.459
Carhart 4	0.170	0.766***	-0.193	-0.097	0.266**			0.485
FF5	0.349	0.776***	-0.239	-0.422**		-0.374	1.317***	0.514
Gambling								
FF3	-0.617	1.886***	2.036***	0.745**				0.749
Carhart 4	-0.642	1.763***	1.953***	0.454	-0.321			0.750
FF5	-1.103	1.702***	1.956***	0.658*		1.040	-2.064**	0.759
Weapon								
FF3	-0.085	1.018***	0.335**	-0.202**				0.845
Carhart 4	-0.080	1.042***	0.351**	-0.147	0.061			0.844
FF5	-0.182	1.033***	0.353**	-0.179		0.364	0.165	0.849
Oil & Gas								
FF3	0.318	1.236***	-0.502**	-0.532***				0.702
Carhart 4	0.344	1.366***	-0.415*	-0.223	0.340**			0.722
FF5	-0.163	1.072***	-0.586***	-0.007		1.282***	-2.205***	0.766
Triumvirate								
FF3	-0.229	0.850***	0.124	-0.193**				0.768
Carhart 4	-0.219	0.897***	0.156	-0.083	0.121			0.771
FF5	-0.076	0.939***	0.148	-0.333***		-0.301	1.096***	0.796

Appendix 4 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Russell 3000 Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in October 2007 and ending in March 2009 was used to run the regression and a p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix F: 3-, 4-, 5-factor model for each Sin Industry during the Financial Crisis in the European Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	0.077	0.683***	-0.047	0.241				0.592
Carhart 4	0.079	0.581***	-0.004	-0.203	-0.375**			0.614
FF5	0.121	0.665***	-0.112	0.089		-0.358	-0.149	0.583
Tobacco								
FF3	0.446	0.412***	-0.689***	0.305				0.518
Carhart 4	0.444	0.520***	-0.735***	0.774*	0.395**			0.541
FF5	0.638	0.604***	-0.758***	-0.419		-1.502***	0.504	0.577
Gambling								
FF3	-0.010	0.535***	0.467**	0.189				0.404
Carhart 4	-0.007	0.372***	0.536***	-0.519*	-0.597***			0.530
FF5	0.041	0.402***	0.325	0.048		-0.388	-0.673*	0.411
Weapon								
FF3	0.036	0.618***	-0.306	0.129				0.629
Carhart 4	0.040	0.432***	-0.227	-0.678**	-0.681***			0.717
FF5	0.114	0.545***	-0.441*	-0.091		-0.590	-0.428	0.630
Oil & Gas								
FF3	0.365	0.995***	-0.288	-0.794***				0.764
Carhart 4	0.365	1.003***	-0.291	-0.759**	0.030			0.761
FF5	0.318	0.671***	-0.481**	-0.468		0.393	-1.263***	0.794
Triumvirate								
FF3	0.175	0.577***	-0.203	0.253				0.68
Carhart 4	0.175	0.545***	-0.189	0.111	-0.120			0.679
FF5	0.276	0.628***	-0.278	-0.122		-0.805**	0.047	0.693

Appendix 5 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in October 2007 and ending in March 2009 was used to run the regression and a p-value on a 10%, 5%, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix G: 3-, 4-, 5-factor model for each Sin Industry during the Financial Crisis in the Asia-Pacific Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	-0.005	0.571***	0.576*	0.685*				0.110
Carhart 4	0.007	0.546***	0.581*	0.650*	-0.133			0.101
FF5	0.020	0.217	0.375	1.273**		0.492	-1.460**	0.160
Tobacco								
FF3	0.714**	0.584***	0.315*	0.564***				0.337
Carhart 4	0.712*	0.589***	0.314*	0.571***	0.027			0.327
FF5	0.710*	0.692***	0.371*	0.418		-0.048	0.364	0.325
Gambling								
FF3	-0.492**	0.589***	0.090	0.254*				0.621
Carhart 4	-0.480*	0.562***	0.095	0.216	-0.145			0.628
FF5	-0.517**	0.484***	0.008	0.349		0.034	-0.341	0.621
Weapon								
FF3	0.100	0.597***	0.513**	0.453				0.218
Carhart 4	0.122	0.549***	0.521**	0.384	-0.259			0.227
FF5	0.095	0.413**	0.395	0.714*		0.221	-0.735	0.217
Oil & Gas								
FF3	0.197	1.103***	0.061	0.323				0.731
Carhart 4	0.184	1.131***	0.056	0.363	0.148			0.730
FF5	0.229	0.997***	0.033	0.508		0.128	-0.452	0.729
Triumvirate								
FF3	-0.068	0.578***	0.365**	0.506***				0.391
Carhart 4	-0.060	0.559***	0.369**	0.480**	-0.099			0.388
FF5	-0.067	0.405***	0.258	0.773***		0.225	-0.697**	0.414

Appendix 6 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in October 2007 and ending in March 2009 was used to run the regression and a p-value on a 10%, 5%, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix H: 3-, 4-, 5-factor model for each Sin Industry during the COVID-19 Crisis in the US Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	-0.165	1.112***	0.202	0.065				0.804
Carhart 4	-0.226	1.128***	0.174	-0.035	-0.097			0.801
FF5	-0.147	1.077***	0.18	0.087		0.006	-0.482	0.804
Tobacco								
FF3	0.011	0.84***	-0.473**	0.195				0.649
Carhart 4	-0.019	0.848***	-0.487**	0.146	-0.048			0.642
FF5	0.025	0.942***	-0.641**	0.394**		-0.829**	1.013***	0.709
Gambling								
FF3	-0.124	1.537***	0.646*	0.616***				0.803
Carhart 4	-0.388	1.605***	0.525	0.185	-0.418			0.809
FF5	-0.236	1.345***	1.145***	0.171		1.770***	-1.779***	0.872
Weapon								
FF3	-0.514	1.085***	-0.009	0.490***				0.865
Carhart 4	-0.638*	1.117***	-0.067	0.286	-0.198			0.868
FF5	-0.544	1.095***	0.019	0.499***		-0.210	0.167	0.861
Oil & Gas								
FF3	-0.717	1.060***	0.953***	0.669***				0.793
Carhart 4	-1.305***	1.210***	0.682***	-0.293	-0.933***			0.869
FF5	-0.692	1.086***	0.832**	0.542**		-0.677	0.674	0.806
Triumvirate								
FF3	-0.089	1.061***	-0.089	0.238***				0.895
Carhart 4	-0.199	1.088***	-0.139	0.059	-0.174			0.899
FF5	-0.100	1.067***	-0.082	0.265**		-0.083	0.046	0.890

Appendix 7 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Russell 3000 Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in February 2020 and ending in February 2021 was used to run the regression and a p-value on a 10%, 5%, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix I: 3-, 4-, 5-factor model for each Sin Industry during the COVID-19 Crisis in the European Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	0.082	0.711***	-0.827***	0.289				0.732
Carhart 4	-0.367	0.791***	-0.274	-0.621*	-0.612***			0.774
FF5	0.223	0.816***	-0.440	-0.216		-0.048	1.379*	0.740
Tobacco								
FF3	-0.291	0.442***	-0.131	0.014				0.219
Carhart 4	-0.211	0.427***	-0.229	0.176	0.109			0.204
FF5	-0.109	0.458***	0.068	0.270		2.834***	0.925	0.319
Gambling								
FF3	0.279	1.157***	0.732*	-0.579**				0.664
Carhart 4	0.322	1.150***	0.679	-0.492	0.059			0.657
FF5	0.380	1.219***	0.939*	-0.943*		0.281	0.865	0.653
Weapon								
FF3	-0.400	1.142***	0.303	1.001***				0.862
Carhart 4	-0.667	1.189***	0.632	0.461	-0.364			0.866
FF5	-0.549	1.047***	-0.086	1.428***		-0.519	-1.366	0.864
Oil & Gas								
FF3	0.057	0.836***	-0.731	0.651**				0.659
Carhart 4	0.261	0.800***	-0.983*	1.066*	0.279			0.657
FF5	0.379	1.013***	0.002	-0.060		1.560	2.707**	0.696
Triumvirate								
FF3	-0.007	0.688***	-0.513**	0.118				0.738
Carhart 4	-0.274	0.736***	-0.184	-0.423	-0.364**			0.754
FF5	0.141	0.775***	-0.168	-0.244		0.541	1.277*	0.750

Appendix 8 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Bloomberg Europe Developed Markets Large & Mid Cap Total Return Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in February 2020 and ending in February 2021 was used to run the regression and a p-value on a 10%, 5%, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.

Appendix J: 3-, 4-, 5-factor model for each Sin Industry during the COVID-19 Crisis in the Asia-Pacific Market

	Alpha	MKT	SMB	HML	MOM	RML	CWA	Adj. R ²
Alcohol								
FF3	1.253***	0.559***	0.180	-0.214				0.392
Carhart 4	1.276***	0.528***	-0.004	-0.099	0.289			0.406
FF5	1.252***	0.601***	0.248	-0.403		-0.169	0.261	0.370
Tobacco								
FF3	0.335	0.502***	0.778	-0.067				0.184
Carhart 4	0.321	0.521***	0.891*	-0.138	-0.178			0.174
FF5	0.319	0.710***	0.929*	-1.362**		-1.296*	1.436*	0.229
Gambling								
FF3	-0.371	0.957***	-0.818***	-0.420				0.757
Carhart 4	-0.404	1.003***	-0.549*	-0.589**	-0.425**			0.783
FF5	-0.372	0.983***	-0.700**	-0.230		0.331	0.285	0.743
Weapon								
FF3	0.888	0.722***	1.136*	0.610				0.141
Carhart 4	0.939	0.652***	0.723	0.869	0.652*			0.181
FF5	0.888	0.856***	1.234*	-0.269		-0.828	0.909	0.118
Oil & Gas								
FF3	-0.169	0.945***	0.914***	0.389				0.644
Carhart 4	-0.169	0.945***	0.911***	0.391	0.005			0.636
FF5	-0.157	0.985***	0.932***	0.108		-0.167	0.298	0.623
Triumvirate								
FF3	0.831***	0.647***	0.065	-0.230				0.629
Carhart 4	0.841***	0.633***	-0.018	-0.178	0.130			0.628
FF5	0.827***	0.704***	0.152	-0.481		-0.228	0.381	0.621

Appendix 9 shows the regression results as weekly returns of the Fama-French three- and five-factor model (FF3 and FF5), and the Carhart four-factor model (Carhart 4) applied to the five sin industries, as well a combination of tobacco, alcohol and gambling (Triumvirate). The portfolios were constructed by extracting all companies operating in the respective industry from the Bloomberg APAC ex Japan Large, Mid & Small Cap Total Return Index. Alpha is the intercept of the regression, MKT is the market factor, SMB the small-minus-big factor, HML the high-minus-low factor, MOM the momentum factor, RML the profitability factor, and CWA the investment factor. Weekly return data beginning in February 2020 and ending in February 2021 was used to run the regression and a p-value on a 10%-, 5%-, and 1%-level is indicated by “*”, “**”, “***”. Source: Own Illustration.