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When Ethics Clash with Cash: The Sin Stock Dilemma

An empirical study of Sin Stock Anomalies in Europe Over the Past Two Decades

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Abstract

In this thesis, we study the performance of sin stocks in the European market over the period from 2004 to 2024. Sin stocks are defined as equities of companies operating in traditionally controversial industries, specifically alcohol, tobacco, and gambling. We also extend our analysis to include weapon and defence stocks, motivated by their paradoxical role in profiting from conflict while serving national security interests, a dynamic highlighted by the Russia-Ukraine war. To analyse the performance of sin stocks, we employ time-series regressions using CAPM and Fama-French factor models. We examine both excess returns over the risk-free rate and implement a long-short strategy comparing sin stocks against their industry comparables.

Our findings demonstrate that European sin stocks have historically generated statistically significant abnormal returns over the period from 2004 to 2024. This suggests that investors holding sin stock portfolios have been compensated with returns exceeding those predicted by traditional asset pricing models. While sin stocks achieved higher cumulative returns than their comparable companies over the period, this outperformance is not statistically significant after adjusting for risk factors. These results imply that socially responsible investors could have replicated the strong returns of sin stocks by exposing their portfolio to certain risk factors. Ultimately, our findings suggest that investors do not need to compromise their ethical standards to achieve strong returns, as the return differential cannot be attributed to a distinct "sin premium".

Keywords – Sin Stocks, European Stock Market, Alcohol, Tobacco, Gambling, Weapon & Defence, Russia-Ukraine War, Fama-French, ESG Exclusions, Institutional Investor, Portfolio Management, Abnormal Returns.

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1 Introduction

1.1 Background

Investment practices have evolved in recent years, with ESG considerations increasingly shaping investment decisions. The Norwegian Government Pension Fund Global, one of the world's largest sovereign wealth funds with over USD 1.7 trillion in assets, exemplifies this trend (Norges Bank Investment Management, 2024a). Following ethical guidelines set by the Ministry of Finance, the fund monitors investments and excludes companies involved in controversial activities. This widespread adoption of screening practices by major financial institutions has shaped the investment landscape, creating a growing distinction between "acceptable" and "controversial" investments.

However, these ethical screening practices can come at a substantial financial cost. The Financial Times reported in 2016 that the Norwegian oil fund's decision to exclude tobacco stocks had a cost of USD 1.9 billion in foregone returns between 2006 and 2015 (Marriage, 2016). This highlights the potential trade-off between ethical considerations and financial performance in investment decisions, leading some market observers to question whether ethical screening might create investment opportunities.

In a 2019 interview, Petter Hermanrud, Chief Strategist at SpareBank 1 Markets, offered such a perspective. He observed that many investors were divesting from industries like tobacco, alcohol, weapons, and pornography as ESG considerations gained prominence. However, Hermanrud suggested that these increasingly shunned stocks might actually present attractive opportunities, as their widespread exclusions had driven valuations lower (Revfem, 2019). This introduces the concept of "sin investing", where investors actively seek opportunities in controversial industries.

What constitutes controversial investments is not straightforward. This complexity has become particularly evident within the defence sector amid the Russia-Ukraine war. While some view funding in this arena as financing warfare, others see it as supporting essential national security needs. This debate has gained renewed relevance as global military spending reaches record levels in response to growing security threats (Romano, 2023).

The potential for higher stock returns in controversial industries has not gone unnoticed

in academic research. Studies offer several explanations for why these companies might outperform. One common explanation is that these stocks are often underpriced due to avoidance by ethical investors, creating opportunities for those willing to go against social norms to earn a "*reputation risk premium*" (Blitz & Fabozzi, 2017). Additionally, these industries face heightened litigation risks, which can lead to higher expected returns for investors willing to accept such risks (Hong & Kacperczyk, 2009). Another possible explanation is the inherent characteristics of these industries. The demand for addictive products is inelastic, ensuring a steady stream of customers and making these industries more resilient to economic downturns. Moreover, social and regulatory barriers prevent new competitors from entering the market, limiting competition and helping to secure higher profit margins and stable earnings over time (Kenton, 2022).

A fundamental principle in financial theory is that investors are compensated for bearing systematic risk, which cannot be eliminated through diversification. This raises a compelling question: just as investors expect a premium for taking on market risk, could they also be compensated for bearing ethical risks tied to investing in controversial industries? Specifically, can investors who are willing to invest in companies that others shun for ethical reasons capture a return premium?

1.2 Motivation and problem formulation

Given the evolution of global markets and ESG criteria in recent times, prior research on sin investing may not fully capture current trends. This study seeks to reexamine the so-called "sin stock premium", investigating whether these controversial industries truly deliver positive abnormal returns for investors. More generally, do you need to be a sinner to become a stock winner? Based on this, we have formulated the following research question:

"*Do European companies in controversial industries, known as sin stocks, generate abnormal returns and outperform their comparable companies, and can socially unconstrained investors capitalise on these anomalies?*"

In this study, we define sin stocks as the equities of companies operating in traditionally controversial industries: alcohol, tobacco, and gambling, following Hong and Kacperczyk (2009). We also include weapon and defence stocks, following Blitz and Fabozzi (2017).

This is an extension particularly relevant as the Russia-Ukraine war has highlighted the defence industry's paradoxical role: profiting from conflict while serving national security interests.

Our methodology involves constructing two distinct sin portfolios: one comprising traditional sin stocks, including companies in the alcohol, tobacco, and gambling industries, and another focused exclusively on the weapon and defence sector. For each portfolio, we identify comparable companies within the same broad industry group, focusing on sub-groups that are similar but avoid controversial activities. To analyse the return performance of these portfolios, we employ two approaches using European market data from 2004 to 2024. First, we conduct time-series return regressions utilising the CAPM, Fama-French three-factor model, Fama-French five-factor model, and the Fama-French five-factor model with a momentum extension, with the dependent variable being the portfolio returns of sin stocks net of the risk-free rate. Second, to examine whether sin stocks outperform their comparables, we implement a long-short strategy where the risk-free rate is replaced with the returns of the respective comparable portfolio.

Our findings suggest that European sin stocks generate statistically significant abnormal returns beyond what can be explained by the Fama-French risk factors. We also find significant abnormal returns for comparable stocks. While sin stock portfolios delivered higher cumulative returns over the 2004–2024 period relative to their comparables, this outperformance has diminished in recent years and varied considerably across different sub-periods. Moreover, when analysing outperformance through time-series regressions, we find no robust evidence of outperformance after controlling for the various risk factors. This suggests that the apparent return differential between sin stocks and their comparables can be attributed to the sin portfolios' factor exposures rather than a distinct "sin premium" associated with controversial industries.

Our thesis contributes to the current research on sin stocks in several ways. First, we provide an examination of the European market, a region that has received less attention compared to the U.S. market. Second, our analysis spans from 2004 to 2024, offering insights into how sin stock performance has evolved during a period marked by increasing ethical awareness and major geopolitical events. Third, we conduct a separate analysis of weapon and defence stocks, particularly relevant given recent geopolitical tensions

and the Russia-Ukraine war in Europe. By also isolating the period following Russia's invasion of Ukraine in 2022, we offer unique insights into the performance of these stocks during times of war. We employ comprehensive screening criteria and utilise institutional exclusion data to identify and confirm the investable universe of European sin stocks. Furthermore, we build on established methodologies by employing multiple approaches to test for abnormal returns.

The remainder of this thesis is structured as follows: Chapter 2 reviews the theoretical framework and relevant literature on sin stock performance. Chapter 3 presents our hypotheses, followed by Chapter 4, which describes our data sources and portfolio construction approach. Chapter 5 details our methodology, employing the Fama-French multi-factor framework. Chapter 6 presents our analysis and discusses the findings, while Chapter 7 concludes with implications and suggestions for future research.

2 Theory and Literature Review

This chapter provides the theoretical foundation and empirical context for our thesis. We begin with an introduction to sin stocks (2.1), defining their characteristics, and explaining why certain industries are classified as sinful. We then explore common explanations proposed in the academic literature for the existence of a sin stock premium (2.2). The chapter ends with a review of empirical studies examining sin stock performance and their findings (2.3).

2.1 An introduction to sin stocks

2.1.1 Traditional sin stocks

In financial markets, sin stocks refer to publicly traded companies whose core business activities are widely perceived as unethical or morally controversial. These firms operate in industries seen as profiting from activities harmful to society or exploiting human vices (Kenton, 2022). Among these, the term "*Triumvirate of Sin*" has become widely recognised in academic research. This classification, featured in Hong and Kacperczyk's (2009) study, encompasses three industries: alcohol, tobacco, and gambling.

The designation of these industries as "sinful" is primarily due to their potential negative societal impacts and health consequences. Alcohol and tobacco products are associated with addictive properties and substantial health risks, including liver disease, various cancers, and cardiovascular disorders (World Health Organization, 2024a, 2024b). Gambling operations raise concerns due to their potential to foster addiction and financial harm (National Council on Problem Gambling, 2024). The combination of addiction potential and social costs has led many investors who prioritise ethical considerations to systematically exclude these stocks from their portfolios (Financial Exclusions Tracker, 2023).

2.1.2 Expanding the sin stock definition

While the triumvirate of sin provides a foundational framework, the definition of sin stocks in academic literature remains ambiguous and subjective. Due to this lack of a

universally accepted definition, researchers have employed varying classifications in their studies. Blitz and Fabozzi (2017) include weapons in their analysis, defining sin companies as "*companies directly involved in the alcohol, tobacco, gambling, or weapons industries*". Similarly, Fabozzi et al. (2008) expand upon the traditional sin categories by incorporating defence, biotechnology and adult services into their research. It is also important to note that the classification of sin stocks is dynamic, evolving with societal norms and values, as illustrated by the transformation of tobacco's public perception following the scientific evidence of health risks emerging in the 1950s (Doll & Hill, 1956).

2.1.3 Insights from institutional investors

When examining common investor practices, weapon and defence stocks stand out as a notable addition to the traditional sin stocks. These stocks are often subject to ethical exclusions due to their association with controversial weapons that violate humanitarian principles (Norwegian Ministry of Finance, 2022). Institutional investors across Europe have established clear frameworks for excluding weapon-related investments from their portfolios. The core exclusion criteria focus on "*weapons that violate fundamental humanitarian principles through their normal use*" (Council on Ethics, 2017). The main categories comprise nuclear weapons, cluster munitions, anti-personnel mines, and biological or chemical weapons (Norwegian Ministry of Finance, 2022).

Norwegian institutional investors, led by particularly NBIM, offer detailed ethical guidelines that have become a reference point for exclusion practices. NBIM employs both product-based and conduct-based exclusions in their screening process (Norwegian Ministry of Finance, 2022). Product exclusions target companies producing specific items like tobacco, while conduct-based screening addresses severe environmental damage or human rights violations. Notably, while tobacco is strictly excluded, NBIM does not automatically exclude alcohol or gambling companies unless their conduct violates other ethical guidelines (Norges Bank Investment Management, 2024b). Nuclear weapons are included in their framework among other weapons such as biological weapons, chemical weapons, non-detectable fragments, incendiary weapons, blinding laser weapons, antipersonnel mines and cluster munitions (Norwegian Ministry of Finance, 2022). Companies are excluded not only for direct production but also for developing key components specifically designed for these weapon systems (Norwegian Ministry of Finance, 2022). These well-defined

categories and thresholds for controversial weapons provide institutional investors with clear guidelines for implementing ethical exclusions in their investment practices.

2.2 Common explanations of the "sin stock premium"

The literature presents several theoretical explanations for why sin stocks may deliver excess returns in financial markets. Hong and Kacperczyk (2009) document that these stocks are less held by norm-constrained institutions, such as pension funds, and receive less analyst coverage. They find that sin stocks have higher expected returns than comparable stocks, attributing this to both investor neglect and elevated litigation risk heightened by social norms.

Sin industries also benefit from unique market characteristics that influence their returns. Fabozzi et al. (2008) note that while these industries face strict monitoring and social scrutiny, they often experience limited price regulation. This, combined with high barriers to entry, enables companies that successfully establish themselves to earn "*monopolistic returns*". Kenton (2022) emphasises that the nature of sin businesses ensures a steady stream of customers, with relatively inelastic demand making them more recession-proof than other companies. He further notes that social and regulatory barriers discourage new competitors, helping established firms maintain stable profits and strong margins.

Beyond these industry-specific characteristics, the practice of excluding sin stocks has broader portfolio implications. As established by Markowitz (1952), constraining the investment universe has fundamental consequences for portfolio efficiency. When portfolios are constructed under the mean-variance framework from a restricted set of assets, they typically cannot achieve the same level of risk-adjusted performance as unconstrained portfolios. These exclusions limit diversification opportunities, shifting portfolios below the efficient frontier and resulting in lower returns for a given level of risk.

2.3 Literature review

Hong and Kacperczyk's (2009) research paper, "*The Price of Sin: The Effects of Social Norms on Markets*", explores the impact of societal norms on sin stock prices. The authors argue that social norms discourage norm-sensitive investors, such as pension funds, from

investing in sin stocks, leading to their neglect and reduced analyst coverage. They further contend that this neglect, along with the higher litigation risk faced by sin stocks, contributes to higher expected returns for sin stocks relative to comparable non-sin stocks.

Hong and Kacperczyk utilise time-series regressions to analyse an equally-weighted portfolio constructed as a long position in sin stocks (alcohol, tobacco, and gaming) and a short position in comparable non-sin stocks. Their methodology adjusts for well-known return predictors, including the market risk factor, size, value, and momentum. The results indicate that sin stocks outperform their comparables by approximately 26 basis points per month in the most conservative model, demonstrating consistent outperformance across the benchmark period (1965-2006). These findings imply that norm-constrained investors who exclude sin stocks to conform to societal expectations incur an economic opportunity cost by foregoing higher returns.

While Hong and Kacperczyk's study remains the most cited work on sin stock performance, it has been subject to criticism. Adamsson and Hoepner (2015) question their reliance on an equally-weighted portfolio of sin stocks regressed on Fama-French factors, which are derived from value-weighted portfolios. This mismatch in weighting, they argue, may introduce a small-cap performance bias, as equally-weighted portfolios give greater weight to smaller stocks. This critique is grounded in the empirical observation that smaller stocks tend to outperform larger ones, as established by Fama and French (1993).

Expanding on Hong and Kacperczyk's research, Fabozzi et al. (2008) conducted a more comprehensive study of sin stock returns, broadening both the geographical scope and the definition of sin industries. Their paper, "*Sin Stock Returns*", examined markets not only in the United States but also in Europe, Oceania, and Asia. The paper encompasses six sin categories: alcohol, tobacco, gaming, defense, biotech, and adult services. To ensure an investible sample, the authors applied specific criteria, excluding stocks that fell below a certain price threshold in the month following their IPO or those with insufficient liquidity. Analysing data from January 1970 to June 2007, Fabozzi et al. verified Hong and Kacperczyk's findings, reporting that their sin portfolio produced an annual return of 19%, outperforming common benchmarks in terms of both magnitude and frequency.

The authors attributed the positive excess returns in sin stocks to several factors. They argued that an economic gain might accrue from not conforming to social norms as

adhering to such norms imposes both implicit and explicit costs on firms. Additionally, they suggested that sin industries often operate in monopolistic environments with less regulation of pricing, which enables them to generate "*positive monopolistic returns*". Fabozzi et al. concluded that screening out sin stocks to align investment portfolios with social values imposes opportunity costs and may be one of the least effective ways to achieve such goals.

In contrast to earlier studies that documented significant abnormal returns for sin stocks, Blitz and Fabozzi's (2017) study, "*Resolving the Sin Stock Anomaly*", challenges this notion through an extended asset pricing framework. Their research examined the returns of alcohol, tobacco, gambling, and weapon stocks in the US, European, and Japanese markets from 1963 to 2016. The performance of sin stocks was analysed using time-series regressions, with the dependent variable defined as the return on sin stocks minus the corresponding market return.

While their initial findings using the CAPM showed significant positive alphas, their key contribution emerged through progressive factor analysis. As Blitz and Fabozzi incorporated additional risk factors into their models, the abnormal returns measured through alpha progressively decreased. When applying the Fama-French five-factor model, which includes profitability and investment factors, the alphas disappeared entirely. They concluded that the performance of sin stocks can be fully explained by their exposures to these factors, resolving the so-called "*sin stock anomaly*". However, Blitz and Fabozzi noted that excluding sin stocks from portfolios still has implications for performance, as sin stocks tend to have positive exposures to factors that are rewarded with premiums. They suggested that investors compensating for this exclusion could maintain portfolio performance by increasing weights in non-sin stocks with similar factor exposures.

More recently, Sagbakken and Zhang (2022) analysed sin stocks in the European market from 2006 to 2020. They constructed two value-weighted portfolios: one of traditional sin stocks (alcohol, tobacco, gambling, and defence) and another of "new sin stocks" (oil and gas, metals and mining, uranium, and coal). To assess performance, they ran time-series regressions on portfolio returns net of the risk-free rate using CAPM, the Fama-French three-factor model, the Carhart four-factor model, and the Fama-French five-factor model. For traditional sin stocks, alphas were significant under CAPM, the three-factor, and the

four-factor models but became insignificant with the five-factor model. This suggests the apparent sin premium is driven by profitability and investment factors, and not because these stocks are sinful or riskier, aligning with Blitz and Fabozzi´s findings. Additional tests for outperformance relative to comparables in the same broad industry found no robust evidence for an obvious sin premium.

3 Hypotheses

To address our research question regarding abnormal returns and sin stock outperformance in the European market, we formulate five hypotheses.

H1A: Traditional sin stocks generate positive abnormal returns

Our first hypothesis focuses on the "*Triumvirate of Sin*" (alcohol, gambling, and tobacco stocks), as outlined by Hong and Kacperczyk (2009). We hypothesise that a portfolio of these sin stocks will generate positive abnormal returns. To test this, we perform time-series return regressions where the portfolio's returns net of the risk-free rate serves as the dependent variable, and various Fama-French factors are included as independent variables.

H1B: Traditional sin stocks outperform their comparables

Building on H1A, we hypothesise that sin stocks will outperform their comparable portfolio on a risk-adjusted basis. To test this, we employ a long-short portfolio approach, going long in sin stocks and short in comparables, following Hong and Kacperczyk (2009). This methodology allows us to isolate any return premium of controversial companies relative to their comparables through regression against the Fama-French factors.

H2A: Weapon and defence stocks generate positive abnormal returns

Building on prior research that includes weapon and defence stocks in sin stock analysis (Blitz & Fabozzi, 2017; Fabozzi et al., 2008), we extend our investigation to this sector. While these studies include weapon and defence stocks as part of a broader sin portfolio, we analyse this sector separately to isolate its specific performance characteristics. Given the trend of increasing military spending and geopolitical tensions in Europe over the last decade, we hypothesise that these stocks will generate positive abnormal returns using the same methodological framework as H1A.

H2B: Weapon and defence stocks outperform their comparables

Following the same long-short portfolio methodology as H1B, we hypothesise that weapon and defence stocks will outperform their comparable portfolio on a risk-adjusted basis.

H2C: Weapon and defence stocks generate positive abnormal returns and outperform their comparables during the Russia-Ukraine war period

This hypothesis tests the widely held belief that wars create exceptional opportunities for investors in these industries. Specifically, we investigate whether these stocks generated abnormal returns and outperformed their comparables during the Russia-Ukraine war period, spanning from February 2022 to June 2024, using the most recent data available at the time of analysis. This hypothesis challenges the narrative that geopolitical conflict inherently drives superior stock performance.

4 Data

This chapter provides an overview of the data sources, selection criteria, and processes used to construct the sin and comparable portfolios for our study. Beginning with data selection and financial screening criteria (Section 4.1), we outline the data tools applied to ensure inclusion of relevant companies. Following this, we describe our approach to categorising sinful companies and selecting comparables (Sections 4.2 - 4.5). The chapter then details our portfolio construction approach (Section 4.6), covering both value-weighted and equally-weighted portfolios, and includes a description of our Fama-French factor data sources (Section 4.7). Finally, we discuss important considerations and potential limitations related to our data in Section 4.8.

4.1 Data selection

We extracted financial data using Eikon through LSEG Workspace, which provided stock returns and financial metrics for our European sample (LSEG, 2024a). To analyse the performance of these stocks, we utilised the Fama-French models, with the factor data obtained from Kenneth R. French's Data Library (French, 2024). To validate our sin stock selection, we extracted data from the Financial Exclusions Tracker (2023), which monitors companies publicly excluded by institutional investors worldwide. We cleaned the database to isolate the sin stock sample before conducting further analysis. This allowed us to confirm that our selected companies face genuine exclusionary pressures from institutional investors, supporting their classification as sin stocks.

4.1.1 The Refinitiv Business Classification (TRBC)

We utilised The Refinitiv Business Classification (TRBC) system through Eikon's Equity Screener to identify and categorise our sample companies. TRBC is a trusted and granular global industry classification system, organising companies across five hierarchical levels. Regular updates by professional LSEG analysts ensure the system reflects current market structures and remains a reliable tool for academic research (LSEG, 2024b).

TRBC is widely used by investment managers to analyse data, identify comparable companies, and benchmark portfolios (Wikipedia, 2024). Similar to GICS and ICB, it

employs a market-based approach to classify companies. This allows for the identification of firms that have shifted their core business activities since establishment, reflecting how the market views them today. Its accuracy makes it ideal for defining sectors and comparable groups in our study (LSEG, 2024b).

The TRBC classification system organises companies into five hierarchical levels, each capturing a distinct aspect of business activity. At the top is the Economic Sector, which broadly categorises companies based on their primary area of economic activity (e.g., Energy, Healthcare). The Business Sector further divides these broad categories into more specific sectors (e.g., Oil, Gas, and Coal within Energy). The Industry Group and Industry levels refine the classification further, identifying distinct segments and subsegments of industries (e.g., Exploration & Production within Oil, Gas, and Coal). At the most granular level, the Activity classification specifies a company's core operations (e.g., Crude Petroleum & Natural Gas Extraction) (LSEG, 2024b).

4.1.2 Financial screening criteria

To ensure the quality and relevance of our data, we applied several screening criteria. First, we required companies to have at least 12 consecutive months of financial data, providing a reliable basis for analysis. We then implemented a minimum market capitalisation threshold of EUR 20 million, based on the average yearly market cap. While this threshold is lower than the typical index construction range of EUR 300 million to EUR 2 billion, our sample's median market cap is approximately EUR 450 million, with an average market cap of EUR 4.5 billion (Saxo Group, 2024). MSCI Europe Small Cap Index also follows a similar screening criterion, including liquid smaller stocks in their index, with the smallest being USD 29 Million (MSCI, 2024b). To further address liquidity concerns and ensure a realistically tradable portfolio, we employed a dual-threshold approach: companies needed to demonstrate either a monthly average turnover exceeding EUR 400,000 or a monthly average turnover velocity above 1%. This dual approach ensured that relatively small-cap companies could be included if they were sufficiently tradable, providing a fair screening process. This screening process enabled us to construct a robust and tradable portfolio, while maintaining consistency across our sin and comparable stock samples.

4.2 Selection of sin stocks

We aligned our selection of sin stock industries with existing sin stock literature and prior studies (Hong & Kacperczyk, 2009; Sagbakken & Zhang, 2022). Specifically, we adopted and refined the TRBC hierarchy framework used by Sagbakken and Zhang. Table 4.1 provides an overview of the broader industry definitions used to identify sin stocks, comparing our approach with those of previous studies.

Table 4.1: Comparison of sin industry definitions

Sin Industry	**Hong & Kacperczyk (2009)**	**Sagbakken & Zhang (2022)**	**Definition used in this thesis**
Alcohol	Fama-French Industry group 4 (Beer or Alcohol).	TRBC industries: "Distilleries & Wineries", "Brewers".	TRBC industries: "Distilleries & Wineries", "Brewers" (+ "Beer, Wine & Liquor Stores" Activity from the "Food & Drug Retailing" TRBC Industry).
Tobacco	Fama-French Industry group 5 (Smoke or Tobacco).	TRBC Industry: "Tobacco".	TRBC industries: "Tobacco" (+ "Cannabis Product Retailers" Activity from the "Drug Retailers" TRBC Industry).
Gambling	NAICS codes: 7132, 71312, 713210, 71329, 713290, 72112, and 721120.	TRBC Industry: "Casinos & Gaming".	TRBC Industry: "Casinos & Gaming".
Weapon & Defence	Not included.	TRBC Industry: "Aerospace & Defense".	TRBC Industry: "Aerospace & Defense".

4.2.1 Alcohol

In line with Sagbakken and Zhang (2022), we selected companies from the TRBC industries "*Distilleries & Wineries*" and "*Brewers*" for our alcohol sample, as their activities are directly linked to the production and distribution of alcoholic beverages. This selection encompasses well-known brands such as Carlsberg, Anheuser-Busch InBev, and Heineken. Additionally, we included companies within the TRBC Activity "*Beer, Wine & Liquor Stores*" from the "*Food Retail & Distribution*" TRBC Industry. After conducting individual analyses, we found that most of these companies produce, market, and sell their own brands of alcoholic beverages, while some focus primarily on selling or distributing products from various brands. Regardless, their direct involvement in the sale of alcohol justified their inclusion in a sinful portfolio. For a visual example of this selection, Figure 4.1 shows how we selected our alcohol companies within the TRBC hierarchy.

Figure 4.1: TRBC hierarchy

ECONOMIC SECTOR	BUSINESS SECTOR	INDUSTRY GROUP	INDUSTRY	ACTIVITY	PermID
Consumer Non-Cyclicals					4294952895
	Food & Beverages				4294952894
		Beverages			4294952893
			Brewers		4294952892
				Brewers (NEC)	4294951476
				Craft & Micro Brewers	4294951475
			Distillers & Wineries		4294952891
				Distillers & Wineries (NEC)	4294951474
				Wineries	4294951473
				Distilleries	4294951472
				Malt Producers	4294951471
			Non-Alcoholic Beverages		4294952890
				Non-Alcoholic Beverages (NEC)	4294951470
				Carbonated Soft Drinks	4294951469
				Fruit Drinks	4294951468
				Energy Drinks	4294951467
				Bottled Water & Ice	4294951466

Notes: The figure provides a practical visualisation of the TRBC hierarchy while illustrating the relationship between alcohol companies and their industry comparables. "*Brewers*" and "*Distillers & Wineries*" were chosen as industries for the alcohol sample, while "*Non-Alcoholic Beverages*" was selected as the alcohol comparable industry.

4.2.2 Tobacco

For our tobacco sample, we focused on companies categorised under the TRBC Industry "*Tobacco*", which includes major tobacco producers. Additionally, we considered companies under the TRBC Activity "*Tobacco Stores*" within the broader "*Food Retail & Distribution*" Industry; however, these did not meet our financial screening criteria. We also included companies classified under the TRBC Activity "*Cannabis Product Retailers*" from the "*Drug Retailers*" Industry. We classified these companies as sinful due to their core involvement in cannabis production, which remains socially and ethically controversial despite its medicinal focus. Our final sample features prominent companies such as Imperial Brands, British American Tobacco, and the Scandinavian Tobacco Group.

4.2.3 Gambling

Our gambling stock selection was based on the companies classified under the TRBC Industry "*Casinos & Gaming*". We've included well-known Scandinavian companies such as Betsson, Evolution AB, and Kindred Group PLC. This selection ensures an accurate representation of the gambling industry within our sample.

4.2.4 Weapon and defence

For our weapon and defence sample, we conducted a thorough screening of companies within the TRBC Industry "*Aerospace & Defense*". Since this industry contains many companies with dual-purpose operations, we conducted individual company assessments. Our primary criterion was that companies must derive a considerable portion of their revenue from defence, weapon, and/or military industries. We evaluated each company's marketing, revenue sources, and overall controversial nature. The resulting sample primarily consists of companies producing products related to weapons, armored military vehicles and fighter jets. We've also included software and hardware companies directly linked to warfare, missile systems, or other controversial defence applications. Our final sample includes well-known names such as Bae Systems, Thales, Kongsberg Gruppen, Rheinmetall, and Rolls-Royce, as presented in Table 4.3.

4.2.5 Verifying sin stock classifications through institutional exclusion data

To validate our sin stock classification, we examined the extent to which institutional investors exclude companies in our sample from their investment universes, utilising data from the Financial Exclusion Tracker database (Financial Exclusions Tracker, 2023). This database monitors and records public exclusions by institutional investors worldwide. Institutional investors often serve as key arbiters of socially acceptable investment practices, balancing return objectives with ethical considerations. Their exclusion decisions typically reflect careful evaluation of companies' activities and social impact, making institutional exclusions a meaningful proxy for sin stock classification.

Our analysis reveals substantial institutional exclusion rates across our sin stock portfolios. The Weapon & Defence Portfolio shows the highest exclusion rate at 92%, followed by Tobacco (88%), Gambling (86%), and Alcohol (68%). In aggregate, our Sin Trio Portfolio comprises 77% excluded companies, while our complete sin stock sample shows an 81% exclusion rate. When institutional investors choose to exclude companies, they sacrifice potential returns in favour of ethical considerations. Such decisions typically reflect serious concerns about company activities or sector involvement rather than minor controversies. The widespread institutional exclusions of our sample companies provides

strong validation for their classification as sin stocks, supporting both our theoretical framework and subsequent hypothesis testing.

Table 4.2: Exclusion overview

Industry	Excluded (%)	Excluded (count)	Not excluded (count)	Total companies
Alcohol	68%	21	10	31
Gambling	86%	18	3	21
Tobacco	88%	7	1	8
Trio Sin Portfolio	77%	46	14	60
Weapon & Defence Portfolio	92%	22	2	24
Total sample	**81%**	**68**	**16**	**84**

Table 4.3 provides an overview of the companies included in the Weapon & Defence Portfolio, along with the number of divestments from institutional investors. A similar overview for the Sin Trio Portfolio can be found in Table H.1 in the Appendix.

Table 4.3: Weapon & Defence Portfolio overview

Company	Exclusions	Country of Exchange	Industry
Aerostar SA	2	Romania	Weapon & Defence
Airbus SE	49	France	Weapon & Defence
Avio SpA	7	Italy	Weapon & Defence
Babcock International Group PLC	41	United Kingdom	Weapon & Defence
BAE Systems PLC	59	United Kingdom	Weapon & Defence
Chemring Group PLC	6	United Kingdom	Weapon & Defence
Colt CZ Group SE	4	Czech Republic	Weapon & Defence
Dassault Aviation SA	34	France	Weapon & Defence
Hensoldt AG	8	Germany	Weapon & Defence
Invisio AB	2	Sweden	Weapon & Defence
Kongsberg Gruppen ASA	11	Norway	Weapon & Defence
Leonardo SpA	43	Italy	Weapon & Defence
Melrose Industries PLC	9	United Kingdom	Weapon & Defence
MilDef Group AB	3	Sweden	Weapon & Defence
MTU Aero Engines AG	10	Germany	Weapon & Defence
QinetiQ Group PLC	6	United Kingdom	Weapon & Defence
Rheinmetall AG	17	Germany	Weapon & Defence
Rolls-Royce Holdings PLC	32	United Kingdom	Weapon & Defence
Safran SA	49	France	Weapon & Defence
Scandinavian Astor Group AB		Sweden	Weapon & Defence
Saab AB	7	Sweden	Weapon & Defence
Thales SA	49	France	Weapon & Defence
Tonner Drones SA		France	Weapon & Defence
Turbomecanica SA	1	Romania	Weapon & Defence

Notes: The table displays the count of institutional investors that have divested from or excluded each respective company. The data is derived from the Financial Exclusion Tracker dataset.

4.3 Selection of comparable stocks

Similarly to our sin stock selection, we aligned our choice of comparable companies with prior research to facilitate meaningful comparisons with earlier findings. Table 4.4 outlines our industry selection approach for comparables alongside those used in previous studies.

Table 4.4: Comparison of comparable industry definitions

Related Sin Industry	**Hong & Kacperczyk (2009)**	**Sagbakken & Zhang (2022)**	**Definition used in this thesis**
Alcohol	Fama-French Industry group 3 (Soda).	TRBC Industry "Non-Alcoholic Beverages".	TRBC Industry "Non-Alcoholic Beverages".
Tobacco	Fama-French Industry group 2 (Food).	TRBC Industry "Food Processing".	TRBC Industry "Food Processing".
Gambling	Fama-French Industry group 7 (Fun) and group 43 (Meals and Hotels).	TRBC industries: "Leisure & Recreation", "Hotels, Motels & Cruise Lines".	TRBC industries: "Leisure & Recreation", "Hotels, Motels & Cruise Lines".
Weapon & Defence	Not included.	TRBC industries: "Industrial Machinery & Equipment", "Heavy Machinery & Vehicles", "Electrical Components & Equipments".	TRBC industries: "Industrial Machinery & Equipment", "Heavy Machinery & Vehicles", "Heavy Electrical Equipment", "Shipbuilding".

Figure 4.1 illustrates the connection between alcohol companies and their comparables. Within the broader TRBC Industry Group "*Beverages*", which includes the two sin industries selected for our alcohol sample ("*Brewers*" and "*Distilleries & Wineries*"), the TRBC Industry "*Non-Alcoholic Beverages*" served as a natural comparable.

For tobacco comparables, we based our selection on Sagbakken and Zhang (2022), choosing companies from the broad TRBC Industry "*Food Processing*". This category provides an appropriate comparable benchmark as products like coffee, chocolate, snack foods, and confectionery share key attributes with tobacco: high consumer frequency and a focus on sensory satisfaction. These products, similar with tobacco, are often viewed as non-cyclical, with consistent customer demand irrespective of economic conditions. Additionally, both sectors exhibit strong brand-driven consumer loyalty, where well-established names dominate market share. They also face regulatory considerations due to health-related concerns, such as sugar content in food products versus nicotine in tobacco. We excluded commodity-related businesses producing vegetable oil, starch, fertilisers, and those involved in flour milling. This was done because of their exposure to environmental risks and weather volatility, which could compromise the reliability of

our analysis. Additionally, we removed sports supplements, meat processing, seafood packaging, and pet food manufacturers, as these do not closely align with tobacco in terms of end-user experience.

For gambling comparables, we followed Sagbakken and Zhang (2022), focusing on companies within the TRBC industries "*Leisure & Recreation*" and "*Hotels, Motels & Cruise Lines*". From these industries, we excluded companies classified under TRBC activities such as "*Travel Agents*", "*Gyms, Fitness & Spa Centers*", "*Marinas*", and "*Campsite Operators*", as their operations do not closely align with the characteristics of the gambling industry. Furthermore, to maintain a clear distinction between our sin portfolio and its comparable, we identified and excluded any companies directly involved in casino operations or gambling activities.

For weapon and defence comparables, we built on Sagbakken and Zhang (2022) methodology while introducing some refinements. We selected companies from the TRBC industries "*Industrial Machinery & Equipment*", "*Heavy Machinery & Vehicles*", "*Heavy Electrical Equipment*", and "*Shipbuilding*". Our approach differed in two key ways. First, we included "*Heavy Electrical Equipment*" rather than "*Electrical Components & Equipment*" to better reflect the industrial scale of defence manufacturing. Second, we incorporated "*Shipbuilding*", as commercial shipbuilders are a natural counterpart to military vessel manufacturers, given their shared technical and operational characteristics. To maintain the integrity of our comparable portfolio, we thoroughly screened and excluded companies engaged in military contracts or defence-related operations.

4.4 Geographical scope

We have chosen a sample of European stocks to examine the possible sin premium in a continent that has underperformed the global index in the recent decade. Comparing the global market to the European market, we observe that the MSCI Europe Index has achieved a cumulative return of 205% since 2009, compared to the MSCI World's performance of 448% (MSCI, 2024a). The European economy and stock market distinguish themselves through stricter regulations and a greater focus on ethical behaviour, with institutional investors taking stronger measures to exclude sinful companies (Financial Exclusions Tracker, 2023). Given Europe's underperformance relative to global markets,

as well as its emphasis on responsible investing, analysing the performance of sinful European stocks provides an intriguing basis for our research. These unique European characteristics offer an interesting context to explore whether the sin premium exists in a market environment shaped by heightened ethical standards, investor scrutiny, and poor relative stock performance.

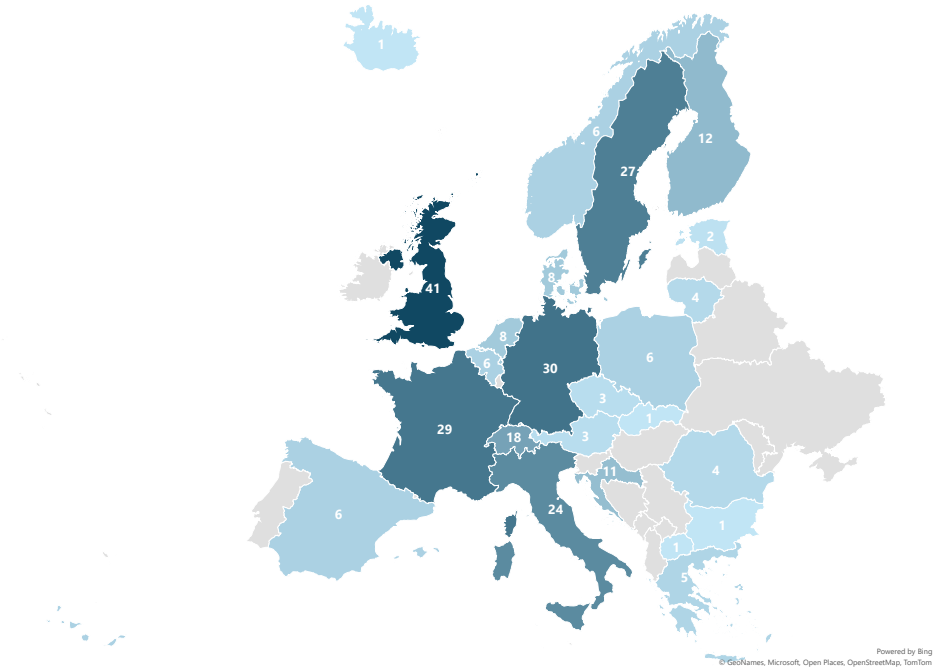
We investigated European countries with EU or NATO membership, including Switzerland due to its strong European presence and membership to intergovernmental organisations such as EFTA. This selection provided us with a sample of comparable countries operating within a similar economic ecosystem, allowing us to focus precisely on the potential effects of sin stocks. The EU countries provided a comparable data sample due to their intertwined economies and cross-border integration. We found it relevant to include European NATO countries in our sample, enabling us to examine how defence-related stocks respond to periods of military expansion and contraction, including current geopolitical tensions such as the Russia-Ukraine war. Our initial sample comprised the 27 EU countries before additional screening.

Based on our financial selection criteria, we've refined our geographical scope. Albania, Luxembourg, and Liechtenstein were excluded due to the absence of data in the Eikon dataset. Several EU countries initially considered, including Cyprus, Hungary, Latvia, Malta, Portugal, and Slovenia, did not meet our financial screening criteria. Montenegro, the only NATO country that didn't pass our financial screening, was also excluded. Our final sample consists of the 25 countries, portrayed in Table 4.5 and Figure 4.2.

Table 4.5: List of countries included and their membership status

Country	NATO	EU	EFTA
Austria	No	Yes	No
Belgium	Yes	Yes	No
Bulgaria	Yes	Yes	No
Croatia	Yes	Yes	No
Czech Republic	Yes	Yes	No
Denmark	Yes	Yes	No
Estonia	Yes	Yes	No
Finland	Yes	Yes	No
France	Yes	Yes	No
Germany	Yes	Yes	No
Greece	Yes	Yes	No
Iceland	Yes	No	Yes
Ireland	No	Yes	No
Italy	Yes	Yes	No
Lithuania	Yes	Yes	No
Netherlands	Yes	Yes	No
North Macedonia	Yes	No	No
Norway	Yes	No	Yes
Poland	Yes	Yes	No
Romania	Yes	Yes	No
Slovakia	Yes	Yes	No
Spain	Yes	Yes	No
Sweden	Yes	Yes	No
Switzerland	No	No	Yes
United Kingdom	Yes	No	No

Figure 4.2: Geographic sample distribution



Notes: Countries are shaded according to the number of included companies, with darker shades representing higher counts. The numbers indicate the total number of companies included per country.

4.5 Time frame

Our analysis covers the period from January 2004 to June 2024, encompassing 246 months. Our study focuses on this specific period to capture the evolving perception of sin stocks over the two recent decades. This time frame encompasses several significant economic events, including the global financial crisis of 2008, the Eurozone crisis, and the COVID-19 pandemic, allowing us to analyse the performance of sin and comparable stocks during various market conditions. The period is particularly relevant for our analysis of weapon and defence stocks, as it includes significant geopolitical developments such as the 2014 NATO budget agreement midway through our sample period, and more recent events like Russia's invasion of Ukraine in 2022. To examine performance during different market conditions, we divided our sample into distinct sub-periods, allowing us to analyse how sin stocks perform during different periods of market stress and stability.

4.6 Portfolio construction

Using data extracted from Eikon, we retrieved monthly total returns and market capitalisations for all companies in our sample, with capitalisation values denominated in euros. We constructed portfolios for both our sin stocks and their respective comparables. Specifically, we created a Sin Trio Portfolio consisting of the traditional sin stocks (alcohol, tobacco, and gambling) and its comparable portfolio, as well as a Weapon & Defence Portfolio and its corresponding comparable portfolio.

In line with Hong and Kacperczyk (2009), we constructed equally-weighted portfolios to ensure comparability with their approach. However, in response to Adamsson and Hoepner's (2015) critique of Hong and Kacperczyk's reliance on equally-weighted portfolios, we also constructed value-weighted portfolios. This method, which weights stocks by market capitalisation, gives greater influence to larger, more liquid companies and aligns with market index construction methodology. We included both weighting approaches for a comprehensive analysis, but our main focus was on the value-weighted approach, as this mitigates potential biases and reflects real-world portfolio management practices.

4.6.1 Total return

For our analysis, we used total monthly return data. The total monthly return incorporates both the price change and dividend payments for each stock, assuming all dividends are reinvested (LSEG, 2024a). This approach captures the complete return an investor would receive from holding the stock, where dividends are automatically reinvested in the same security. It can be expressed as,

$$\text{Total Monthly Return} = \frac{(P_1 - P_0) + D_1}{P_0}. \tag{4.1}$$

In this equation, P_0 represents the stock price at the beginning of the period ($t = 0$), P_1 represents the stock price at the end of the period ($t = 1$), and D_1 represents the dividend paid during the period.

4.6.2 Value-weighted portfolios

For our value-weighted portfolios, we assigned weights based on each stock's relative market capitalisation within its respective portfolio, with market capitalisation values extracted on the last trading day of each month. For each month t, we calculated the value-weighted monthly portfolio return by multiplying each stock's return by its weight, which represents its fraction of the total portfolio. The value-weighted monthly portfolio return is calculated as

$$r_{pt} = \sum_{i=1}^{N_t} (w_{it} \cdot r_{it}). \tag{4.2}$$

In this equation, r_{pt} is the value-weighted portfolio return at time t, r_{it} is the return of stock i at time t, w_{it} is the weight of stock i at time t, and n_t is the number of active stocks in the portfolio at time t.

Each stock's weight is calculated as

$$w_{it} = \frac{mv_{it}}{\sum_{i=1}^{N_t} mv_{it}}. \tag{4.3}$$

In this equation, mv_{it} is the market capitalisation of stock i at time t, and $\sum_{j=1}^{n} mv_{jt}$ is the total market capitalisation of all stocks in the portfolio at time t.

4.6.3 Equally-weighted portfolios

We constructed equally-weighted portfolios by assigning uniform weights to all stocks within each respective portfolio. For each month t, we calculated the equally-weighted portfolio return by multiplying each stock's return by $1/N_t$, where N_t represents the number of active companies in the portfolio during that month. This approach dynamically adjusts to changes in the sample, as N_t fluctuates when companies enter or exit the market. The equally-weighted portfolio return is calculated as

$$r_{pt} = \sum_{i=1}^{N_t} \left(\frac{1}{N_t} \cdot r_{it} \right). \tag{4.4}$$

In this equation, r_{pt} is the equally-weighted portfolio return at time t, r_{it} is the return of stock i at time t, and N_t is the number of active companies in the portfolio at time t.

4.7 Fama-French factors

The Fama-French factors used in our analysis are retrieved from the Kenneth French Data Library. For our study, we used the European factors, which are constructed using six value-weighted portfolios formed on size and book-to-market, six value-weighted portfolios formed on size and operating profitability, and six value-weighted portfolios formed on size and investment (2x3) (French, 2024). These monthly factors are specifically calculated for developed European markets (see Table A.1 in the Appendix). The risk-free rate is based on the one-month U.S. Treasury bill rate. We rely on this as the risk-free rate because it is part of the Fama-French European factor dataset, ensuring consistency with their trusted and widely accepted methodology. Later in our thesis, when presenting descriptive statistics comparing portfolio performance against the market, the market returns are constructed by adding the risk-free rate to the "Mkt-Rf" factor from Kenneth French's Data Library to isolate the market returns.

4.8 Data limitations

4.8.1 Eikon

Our analysis relies on LSEG Eikon (LSEG, 2024a), and while the database may not capture every listed company across all exchanges, it serves as a comprehensive and reliable source widely trusted by academics and institutional investors. To ensure data quality within our sample, we implemented multiple screening measures, including requirements for consecutive monthly returns, market capitalisation thresholds, and liquidity criteria.

For industry classification, we utilised the TRBC system and refined our selection process through additional keyword searches to enhance accuracy. While alternative systems like ICB (Industry Classification Benchmark) or GICS (Global Industry Classification Standard) are available, they present similar considerations when classifying complex, multi-business companies. Our approach of combining TRBC classifications with additional verification steps provided a systematic and effective method for identifying relevant companies.

Our dataset expands over the study period, reflecting an increasing number of available companies. To avoid survivorship bias, we included both currently active and delisted companies in our sample. We also reviewed and addressed occasional data quality instances, such as removing a few extreme monthly returns caused by data errors.

4.8.2 Geography

A key consideration in our study is its focus on European markets, while many prominent sin stocks operate in other regions. The U.S. market, in particular, hosts numerous large sinful companies and represents a substantial portion of global market capitalisation. Additionally, major tobacco producers like China and India, and notable defence contractors from the U.S. and Russia, are not captured in our sample.

Our screening based on "Country of Exchange" presents another consideration, as we do not capture dual-listed companies that may have their primary listing outside Europe. Some European companies might choose to be listed on other exchanges like the NYSE or NASDAQ, potentially excluding them from our sample. However, this approach ensured

we analysed companies primarily exposed to European market dynamics and investor behaviour.

Despite these considerations, our European focus offered several advantages that helped mitigate these limitations. The integrated nature of European markets, with shared regulatory frameworks and trading systems, provided a consistent environment for analysing sin stock effects. Furthermore, our sample was particularly relevant for studying exclusionary effects, as European institutional investors are leading drivers of ethical investment decisions (Financial Exclusions Tracker, 2023). The similarity of European markets also allowed us to examine sin stock behaviour in economies with similar development levels, investment activities, and social norms, reducing the potential noise from varying market conditions that could affect a more globally diverse sample.

A potential concern with our sample could be the initial assumption of liquidity variations across different countries and exchanges. However, the majority of our sample is listed on major exchanges such as Euronext, Deutsche Börse, Nasdaq Nordics, Nasdaq Baltic, and the London Stock Exchange Group, all of which provide sufficient liquidity. Combined with our dual financial screening process, this ensured that liquidity concerns were effectively mitigated.

Additionally, we analysed the distribution of sin stocks versus comparable companies across countries, addressing potential concerns about imbalance, as seen in Table A.2 and A.3 in the Appendix. In cases where certain countries have sin stocks but lack comparables, questions regarding the validity of the comparison could arise. While there is some skewness, with certain countries having more comparable companies than sin stocks, this is expected given the broader market's preference for ethical businesses. Importantly, the distribution does not present any considerable issues, as most countries maintain a reasonable balance between sin stocks and comparables.

Another consideration stems from varying national attitudes toward sin industries across European countries, which could lead to different levels of exclusionary pressure. Nordic countries traditionally have stricter ethical investment guidelines than some Southern European nations, potentially creating geographic disparity in the sin premium effect within our European sample (Financial Exclusions Tracker, 2023).

4.8.3 Time frame

Our analysis covers the period from January 2004 to June 2024. This period encompasses several pivotal market events that warrant consideration. The 2008 financial crisis, Eurozone crisis, and COVID-19 pandemic could potentially affect our results through abnormal market conditions and volatility. The latter part of our sample period includes considerable market disruptions. The COVID-19 pandemic created unusual market conditions, affecting certain industries like hospitality and travel, potentially distorting the typical sin-comparable relationship. Similarly, Russia's invasion of Ukraine triggered exceptional market movements, notably in defence-related stocks and energy prices, which may have amplified certain portfolio returns beyond typical market mechanisms. To address this, we later analyse this sub-period using daily data to capture any disproportionate effects, as detailed in Section 6.2.3.

The number of companies in our dataset increases over time, introducing a consideration about result consistency between earlier and later periods. However, our extended study period provides valuable insights into sin stock performance through diverse market conditions and economic cycles.

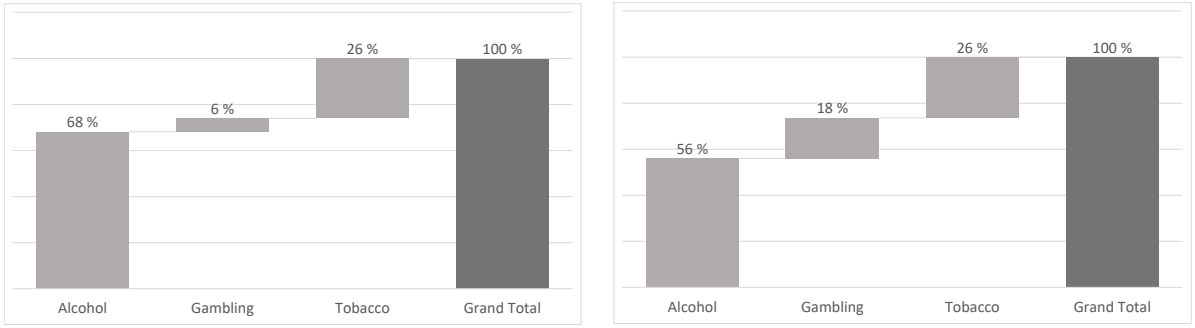
4.8.4 Industry composition: Sin Trio Portfolio vs comparables

The composition of our Sin Trio Portfolio presents some considerations regarding the distribution of market capitalisation across alcohol, tobacco, and gambling stocks. While alcohol companies represent 68% of the sin trio's market capitalisation, tobacco and gambling compose 26% and 6% respectively. This internal variation might affect our portfolio's characteristics. However, when comparing the aggregate Sin Trio Portfolio to its comparable, the overall market capitalisations are reasonably balanced. The internal skewness is also evident in the comparable portfolio, with industry weights closely matching those of the sin portfolio. This balance at the aggregate level helps mitigate concerns about size-based biases in our sin versus comparable regressions.

Table 4.6: Number of companies and market cap (in million Euros) for each portfolio

	Sin companies	**Comparable companies**	**Grand total**
Number of companies:			
Alcohol	31	8	39
Gambling	21	41	62
Tobacco	8	40	48
Total Trio	60	89	149
Weapon & Defence	24	87	111
Grand total	**84**	**176**	**260**
Average market cap:			
Alcohol	249 960	197 056	
Gambling	21 790	61 689	
Tobacco	95 429	92 782	
Total Trio	367 179	351 527	
Weapon & Defence	156 978	140 421	

Figure 4.3: Trio industry composition

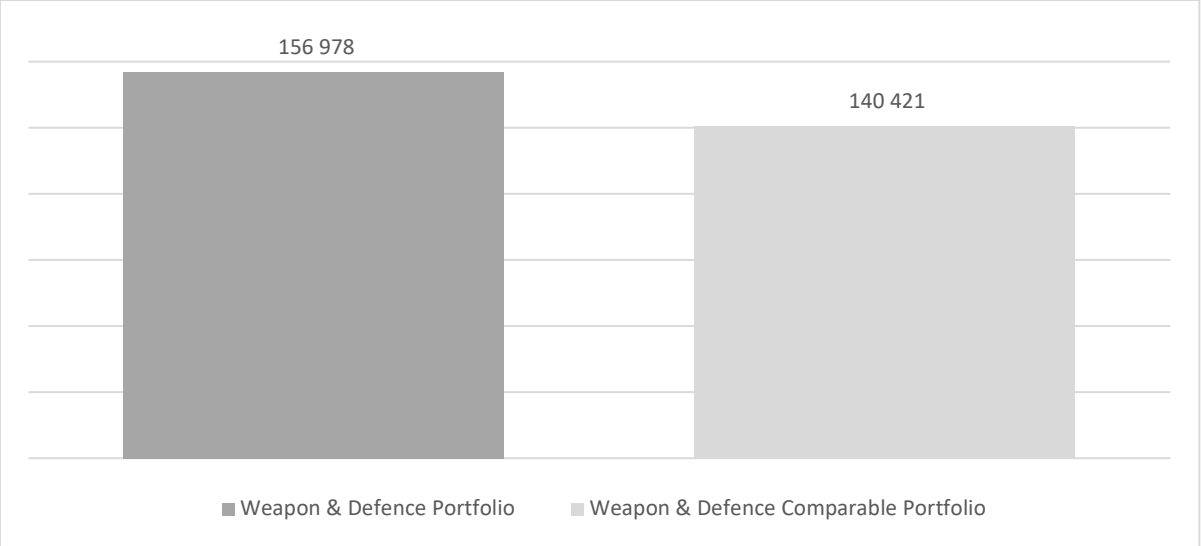


(a) Sin Trio Portfolio **(b)** Trio Comparable Portfolio

4.8.5 Industry composition: Weapon & Defence Portfolio vs comparables

A consideration in our weapon and defence analysis is the difference in portfolio size, with the Weapon & Defence Portfolio comprising 24 companies compared to 87 in the comparable portfolio. This disparity reflects the concentrated nature of the defence industry compared to the broader industrial comparables. While the difference in the number of companies in each portfolio could potentially affect the comparability of returns, the total market capitalisation indicates a balanced sample.

Figure 4.4: Weapon and defence industry composition



Notes: Left side exhibits the Weapon & Defence Portfolio, and the right side shows Weapon & Defence Comparable Portfolio. Market capitalisation in million euros.

5 Methodology

This chapter outlines the methodological framework employed to analyse portfolio returns across sin stocks portfolios and their comparable portfolios. We begin by introducing the Capital Asset Pricing Model (CAPM) and Jensen's Alpha as foundational tools for return measurement (Section 5.1). The analysis then extends to more advanced methodologies, employing multi-factor models that progress from the Fama-French three-factor model to the five-factor model with momentum extension (Section 5.2) These models are applied to evaluate potential abnormal returns for both the Sin Trio Portfolio and the Weapon & Defence Portfolio, alongside their comparable portfolios. To further examine whether sin stocks outperform their comparables on a risk-adjusted basis, we implement a long-short strategy by taking long positions in each sin stock portfolio and short positions in their respective comparable portfolios (Section 5.3). The chapter concludes with model validation tests and a discussion of methodological limitations (Sections 5.4 and 5.5).

5.1 Capital Asset Pricing Model and Jensen´s Alpha

The Capital Asset Pricing Model (CAPM), developed by Sharpe (1964), Lintner (1965), Treynor (1962), and Mossin (1966), is one of the most fundamental frameworks in asset pricing theory. It describes the relationship between an asset's systematic risk and its expected return (Kenton, 2024). The model implies that investors should be compensated for taking on higher levels of systematic risk, also known as market risk. In CAPM, systematic risk is quantified by beta, which is a measure of the volatility of an asset's returns relative to the overall market. For proper implementation, CAPM rely on several assumptions. Assumptions such as risk-averse investors, market efficiency, the ability to borrow and lend at the risk-free rate, and a linear relationship between risk and return are commonly considered (Kenton, 2024).

The model's practical application was enhanced when Jensen (1968) introduced "Jensen's Alpha". This metric, represented by the intercept term (a) in the CAPM regression, quantifies the excess returns obtained by a portfolio above the returns implied by CAPM.

The CAPM with Jensen's Alpha can be expressed as follows in a time-series regression,

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \epsilon_{it}. \tag{5.1}$$

In this equation,

- R_{it}: Return of portfolio i at time t,
- R_{ft}: Return of the risk-free rate at time t,
- α_i: Jensen's Alpha, capturing abnormal returns for portfolio i,
- β_{iM}: Exposure to the market risk factor for portfolio i
- R_{Mt}: Market return at time t,
- ϵ_{it}: Error term for portfolio i at time t.

5.2 Fama-French multi-factor models

5.2.1 Fama-French three-factor model

The Fama-French three-factor model, introduced by Fama and French (1993), expands upon the traditional CAPM by incorporating two additional risk factors to better explain stock returns. While CAPM relies solely on market risk, the three-factor model adds size and value as additional factors. This addition was motivated by Fama and French's research, which found that small-cap stocks tend to outperform large-cap stocks over the long term. Similarly, value stocks, characterised by high book-to-market ratios, typically generate higher returns than growth stocks (Hayes, 2024). By considering both size and value alongside market risk, the Fama-French three-factor model explains a greater portion of return variation than CAPM, offering a more comprehensive understanding of stock performance.

The size factor, referred to as SMB (*Small Minus Big*), captures the historical tendency of small-cap companies to outperform large-cap companies. The value factor, referred to as HML (*High Minus Low*), represents the value premium, which is the return spread between companies with high book-to-market ratios (value stocks) and those with low book-to-market ratios (growth stocks). The Fama-French three-factor model can be

expressed in the following way in a time-series regression,

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}\text{SMB}_t + \beta_{ih}\text{HML}_t + \epsilon_{it}. \tag{5.2}$$

In this equation,

- β_{is}: Exposure to the size factor for portfolio i,
- SMB_t: The size premium (Small Minus Big) at time t,
- β_{ih}: Exposure to the value factor for portfolio i,
- HML_t: The value premium (High Minus Low) at time t.

5.2.2 Fama-French five-factor model

Fama and French (2015) extended their three-factor model by introducing two additional risk factors: profitability and investment. These additions were motivated by evidence that variations in stock returns could not be fully explained by the market, size, and value factors alone. Fama and French concluded that the five-factor model outperformed the three-factor model, providing a more comprehensive framework for explaining stock return variations.

The profitability factor, RMW (*Robust Minus Weak*), captures the return difference between firms with high operating profitability and those with low operating profitability. The investment factor, CMA (*Conservative Minus Aggressive*), measures the return difference between firms that invest conservatively and those that invest aggressively. The Fama-French five-factor model can be expressed in the following way in a time-series regression,

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}\text{SMB}_t + \beta_{ih}\text{HML}_t + \beta_{ir}\text{RMW}_t + \beta_{ic}\text{CMA}_t + \epsilon_{it}. \tag{5.3}$$

In this equation,

- β_{ir}: Exposure to the profitability factor for portfolio i,
- RMW_t: The profitability premium (Robust Minus Weak) at time t,
- β_{ic}: Exposure to the investment factor for portfolio i,

- CMA_t: The investment premium (Conservative Minus Aggressive) at time t.

5.2.3 Fama-French five-factor model with momentum extension

To further enhance the explanatory power of the Fama-French five-factor model, the momentum factor, denoted as WML (*Winners Minus Losers*), is included. The momentum factor is based on the empirical observation that stocks performing well over the past 3 to 12 months tend to maintain their positive trend, while underperforming stocks often continue to underperform. This persistent pattern in stock returns, first documented by Jegadeesh and Titman (1993), is a widely recognised anomaly in asset pricing literature. The Fama-French five-factor model, extended with the momentum factor, can be expressed as follows in a time-series regression,

$$R_{it}-R_{ft} = \alpha_i+\beta_{iM}(R_{Mt}-R_{ft})+\beta_{is}\text{SMB}_t+\beta_{ih}\text{HML}_t+\beta_{ir}\text{RMW}_t+\beta_{ic}\text{CMA}_t+\beta_{iw}\text{WML}_t+\epsilon_{it}. \tag{5.4}$$

In this equation,

- β_{iw}: Exposure to the momentum factor for portfolio i,
- WML_t: The momentum premium (Winners Minus Losers) at time t.

5.2.4 Assumptions when interpreting alpha

In all asset pricing models, in which the dependent variable is expressed as excess returns over the risk-free rate, the intercept term alpha (a) should theoretically be zero when all relevant systematic risk factors are adequately captured. A statistically significant alpha, however, suggests the presence of return patterns not explained by the included risk factors. According to Fama and French (2015), the intercept will equal zero for all securities and portfolios if the exposures to the five factors capture all variations in expected returns. Since our thesis focuses on the Fama-French five-factor model as the most comprehensive framework for explaining stock returns, we assume this model to be true. Consequently, any significant alpha identified in our analysis would be interpreted as evidence of abnormal returns.

5.3 The Difference Portfolio: a long-short approach

We construct "difference portfolios" through a self-financing trading strategy, taking simultaneous long positions in sin stock portfolios and equivalent short positions in their respective comparable portfolios. Following Hong and Kacperczyk (2009) we replace the risk-free rate with the comparable portfolio return on the left-hand side of the regression equation. In this framework, alpha represents the excess return of the sin stock portfolio over the comparable portfolio after controlling for the various risk factors. The following equation is used to estimate outperformance for the difference portfolios,

$$R_{\text{sin},it} - R_{\text{comp},it} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}\text{SMB}_t + \beta_{ih}\text{HML}_t + \beta_{ir}\text{RMW}_t + \beta_{ic}\text{CMA}_t + \beta_{iw}\text{WML}_t + \epsilon_{it}. \tag{5.5}$$

In this equation,

- $R_{\text{sin},it}$: Return of sin stock portfolio i at time t,
- $R_{\text{comp},it}$: Return of comparable portfolio i at time t,
- α_i: Captures the excess return of the sin stock portfolio i over the comparable portfolio i after controlling for the included risk factors.

As explained in this chapter, alpha has two distinct interpretations in our analysis. In the traditional asset pricing framework, where excess returns are calculated by subtracting the risk-free rate, alpha represents abnormal returns relative to the model's predicted risk-adjusted performance. In our long-short approach, where comparable portfolio returns replaces the risk-free rate, alpha measures the risk-adjusted outperformance of sin stocks relative to their comparable portfolios. We use the alpha of the difference portfolio as a proxy to determine whether a "sin stock premium" exists. This term is applied when the excess return of sin stocks, relative to their comparables, can be attributed to their controversial or "sinful" nature.

5.4 Model testing

Following is a summary of the six Classical Linear Model (CLM) assumptions for time-series regression applications. Assumptions TS.1 through TS.5 are the time-series equivalents of the Gauss-Markov assumptions, ensuring that OLS estimators are the Best Linear

Unbiased Estimators (Wooldridge, 2012). These assumptions include,

- TS.1: Linear in parameters,
- TS.2: No perfect collinearity,
- TS.3: Zero conditional mean,
- TS.4: Homoskedasticity,
- TS.5: No serial correlation,
- TS.6: Normality of error terms.

The independent factors used in our models are widely recognised and have been proven to influence stock returns (Carhart, 1997). This suggests that assumptions TS.1 (linear parameters) and TS.2 (no perfect collinearity) are naturally fulfilled. However, we also tested for multicollinearity by examining a Pearson correlation matrix and calculating Variance Inflation Factors (VIF). All values fell below accepted thresholds, confirming no significant multicollinearity. Assumption TS.3 (zero conditional mean) relies on correct model specification, which we address through the inclusion of the well-documented Fama-French risk factors, reducing the possibility of omitted variable bias.

For assumptions TS.4 (homoskedasticity) and TS.5 (no serial correlation), we employed Breusch-Pagan and Durbin-Watson tests. The Breusch-Pagan test revealed heteroskedasticity in some multi-factor models. As a result, the regressions were re-estimated using Huber-White standard errors to ensure robust inference. The Durbin-Watson test results confirmed no serial correlation in the residuals, supporting the models' reliability. For assumption TS.6 (normality of error terms), analysis of residual histograms showed distributions reasonably centered around zero, and Q-Q plots indicated close alignment with normality, particularly in the central ranges. These findings support valid statistical inference.

Beyond the six assumptions, stationarity is an essential requirement for time-series data analysis (Wooldridge, 2012). Non-stationary data can lead to spurious regression results and invalid conclusions. Our augmented Dickey-Fuller test for unit roots confirmed the stationarity of our sample data, validating our analytical approach. Detailed test results and comments are available under Section B "Model testing" in the Appendix.

5.5 Model weakness

While the progression from CAPM to the Fama-French five-factor model with its momentum extension aims to improve predictions of stock returns, it has received critique from academic professionals. Daniel and Titman (1997) suggest that the value premium observed in financial markets stems from firm-specific traits, such as elevated book-to-market ratios. They argue that these characteristics reflect investor preferences rather than serving as proxies for risk factors, as posited in the Fama-French model.

The introduction of the five-factor framework sparked academic debate. Fama and French themselves acknowledge that the model struggles to capture the low average returns of small stocks that invest heavily despite having low profitability (Fama & French, 2015). Blitz et al. (2024) argues that the additional factors in the five-factor model increase its complexity without substantially enhancing its predictive capabilities. They also question why the model does not incorporate the momentum factor, which has been widely acknowledged over the past decades for its role in explaining stock returns.

Momentum has been added to extended versions of the model to capture short-term return continuation, but Daniel and Moskowitz (2016) demonstrates that momentum strategies can experience severe crashes during market rebounds, particularly following periods of market turbulence.

6 Analysis

In this chapter, we will present our empirical findings. The chapter is structured to systematically address each hypothesis through descriptive statistics and time-series regressions, providing evidence for our findings.

6.1 Analysis of traditional sin stocks (H1A and H1B)

We begin by analysing the traditional sin stocks, with the hypothesis that these stocks generate positive abnormal returns (H1A) and outperform their comparable portfolio on a risk-adjusted basis (H1B).

6.1.1 Descriptive analysis

We start by studying descriptive statistics of the Sin Trio Portfolio and its respective comparable portfolio. First, we present the descriptive statistics for the full period from January 2004 to June 2024, followed by a time-series plot illustrating the cumulative returns. Following this, we delve into separated time periods to evaluate return patterns within each sub-period.

6.1.1.1 Total period

Table 6.1: Total period overview for value-weighted portfolios (2004-2024)

Portfolio	Mean Return (%)	Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)	Annualised Return (%)
Sin Trio	1.09	4.15	0.81	-11.78	15.59	1067.10	12.79
Trio Comparable	0.83	3.38	0.72	-11.88	7.73	559.64	9.68
Alcohol	0.98	4.64	0.64	-12.91	17.70	757.58	11.10
Gambling	1.75	6.65	0.85	-20.11	25.12	4092.68	20.08
Tobacco	1.04	5.22	0.61	-16.65	13.99	816.02	11.46
Alcohol Comparable	0.74	3.79	0.56	-9.86	12.81	409.41	8.30
Gambling Comparable	0.93	7.29	0.39	-30.79	40.81	418.81	8.40
Tobacco Comparable	0.88	3.61	0.73	-14.88	9.58	626.83	10.20

Notes: Mean return represents the arithmetic monthly average. Standard deviation shows monthly values. The Sharpe Ratio is annualised. Returns are value-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest monthly returns observed during the respective period.

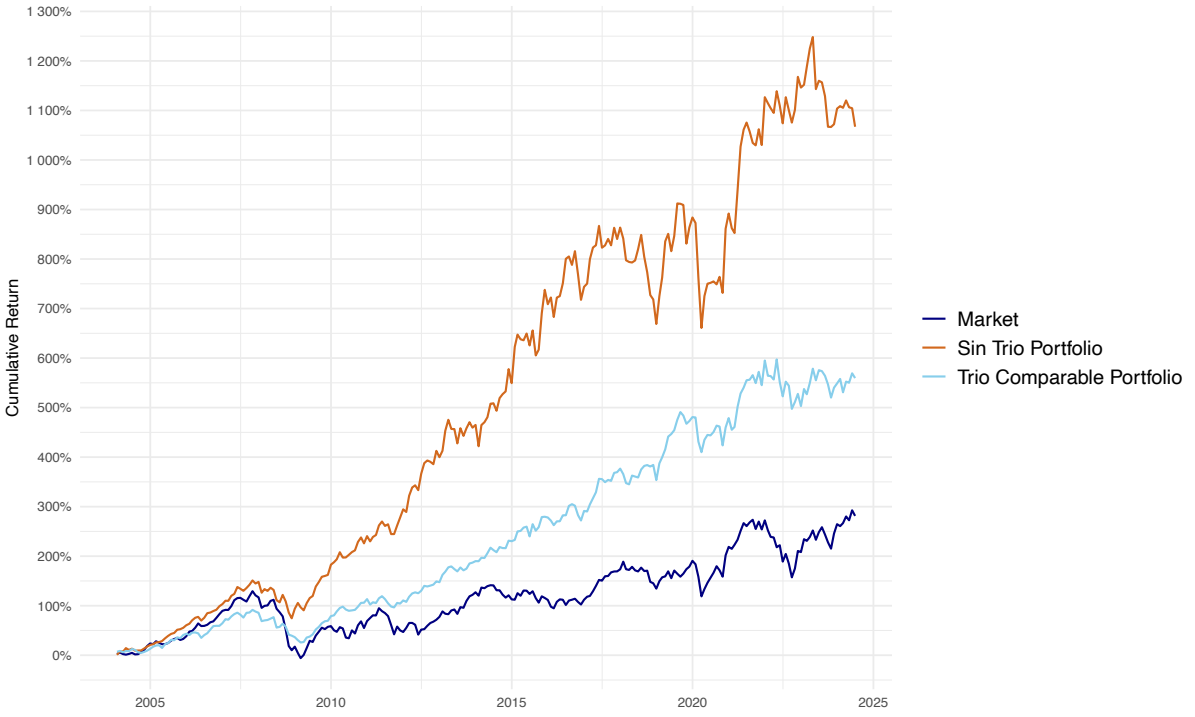
Table 6.1 reveals that the Sin Trio Portfolio outperformed its comparable portfolio over the 246-month period, delivering a total return of 1067% compared to 560%. Although the Sin Trio Portfolio exhibited a higher standard deviation, reflecting greater volatility, its superior Sharpe ratio indicates a more favourable risk-reward profile.

Within the Sin Trio Portfolio, gambling stocks emerged as the standout performers, delivering an extraordinary total return of 4093%, far surpassing the 758% for alcohol and 816% for tobacco. Gambling also showcased superior risk-adjusted performance, achieving the highest Sharpe ratio of 0.85.

Interestingly, we note that the gambling comparable portfolio exhibited the highest standard deviation, making it the most volatile. Additionally, it experienced the greatest downside risk, with its worst monthly return recorded at -30.79%. Upon closer examination, this occurred in March 2020, a period impacted by COVID-19 shutdowns, which severely affected industries represented in the comparable portfolio, such as hotels and cruise lines.

Figure 6.1 clearly illustrates the dominant performance of the Sin Trio Portfolio, with its steeper growth trajectory outperforming both its comparable portfolio and the broader European market. Furthermore, the graph highlights the Sin Trio Portfolio's greater volatility relative to the comparable portfolio and the market, reflecting the higher standard deviations reported in Table 6.1. The descriptive findings indicate that traditional sin stocks outperform both the market and their comparables on absolute and risk-adjusted measures, providing initial evidence of a sin stock premium.

Figure 6.1: Cumulative returns for the total period (2004–2024)



Notes: This figure shows the cumulative returns for the value-weighted Sin Trio Portfolio, Trio Comparable Portfolio and the European market over the entire period from January 2004 to June 2024.

6.1.1.2 Sub-periods

To capture the performance dynamics of the portfolios over time, we divide the total period into five sub-periods. This segmentation allows us to uncover variations in performance across different market conditions and gain insights into how traditional sin stocks have evolved in more recent years.

Table 6.2: Period-divided overview for value-weighted portfolios

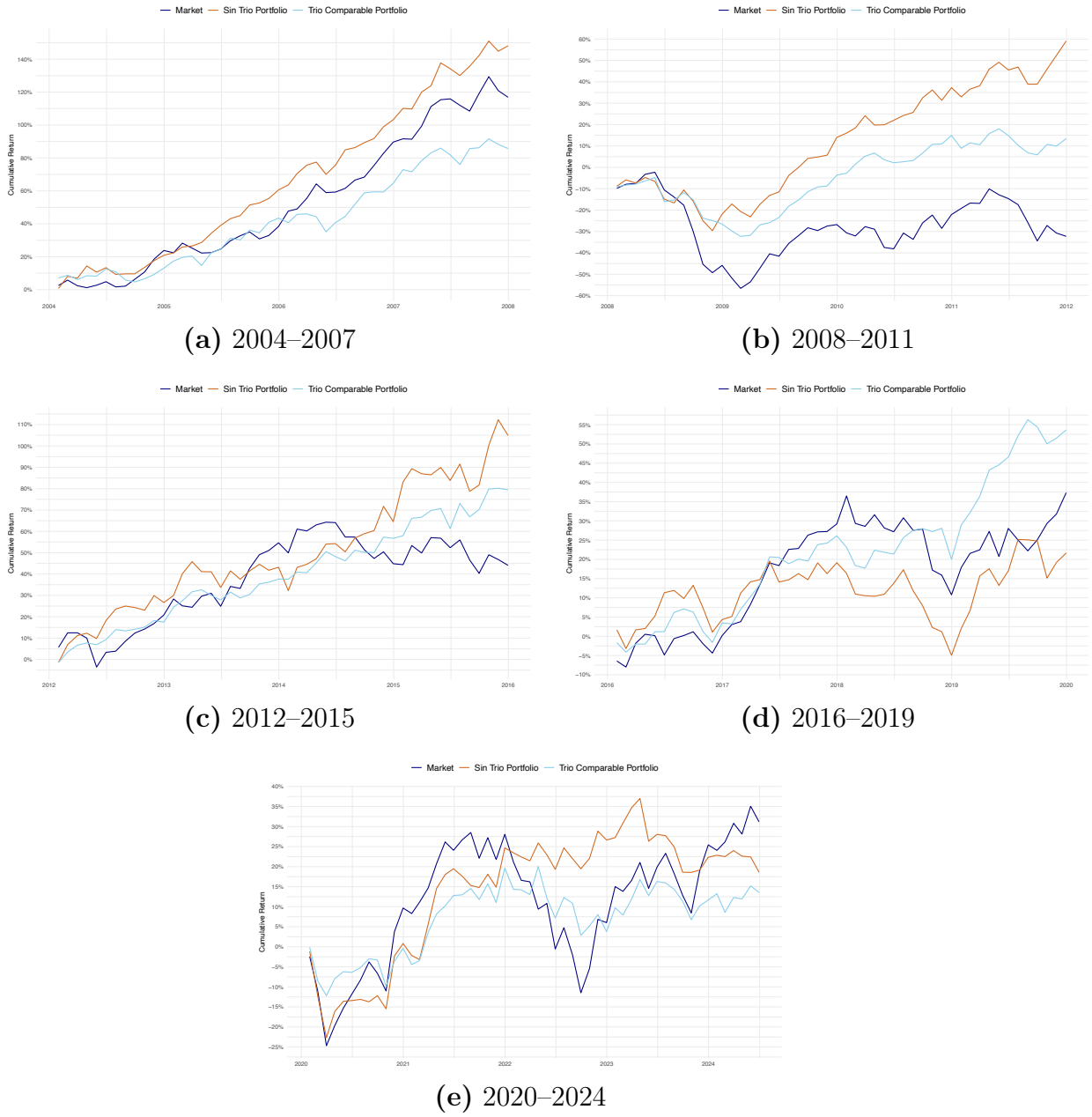
Panel	Portfolio	Monthly Mean Return (%)	Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)	Annualised Return (%)
Panel A: 2004-2007								
	Sin Trio	1.94	2.54	2.27	-4.19	7.28	148.11	26.12
	Trio Comparable	1.35	3.11	1.19	-6.35	7.05	85.73	17.13
	Alcohol	1.63	2.90	1.62	-5.61	7.83	113.65	21.40
	Gambling	2.38	5.15	1.41	-10.18	15.29	191.30	31.40
	Tobacco	2.33	3.22	2.20	-5.57	7.42	194.53	31.77
	Alcohol Comparable	1.19	3.90	0.81	-8.35	12.81	70.53	14.61
	Gambling Comparable	0.91	4.70	0.47	-11.72	10.52	46.83	10.31
	Tobacco Comparable	1.92	3.23	1.76	-5.91	8.21	143.36	25.50
Panel B: 2008-2011								
	Sin Trio	1.09	4.82	0.75	-10.84	11.03	59.07	12.59
	Trio Comparable	0.35	4.11	0.26	-11.88	7.11	13.45	3.28
	Alcohol	1.05	5.84	0.60	-12.78	12.87	52.60	11.40
	Gambling	-0.57	7.90	-0.27	-20.11	14.18	-34.91	-10.39
	Tobacco	1.17	4.76	0.82	-8.66	10.20	65.81	13.79
	Alcohol Comparable	0.38	3.89	0.31	-9.86	8.18	15.83	3.83
	Gambling Comparable	0.24	8.47	0.08	-19.21	24.95	-4.86	-1.27
	Tobacco Comparable	0.21	4.95	0.12	-14.88	8.19	4.09	1.03
Panel C: 2012-2015								
	Sin Trio	1.60	4.35	1.27	-7.63	11.28	104.93	20.11
	Trio Comparable	1.26	2.60	1.68	-5.46	7.26	79.45	16.11
	Alcohol	1.76	4.71	1.29	-7.93	12.86	119.51	22.24
	Gambling	3.24	4.93	2.28	-10.16	14.97	338.75	45.89
	Tobacco	1.07	4.86	0.76	-7.36	10.78	57.99	12.39
	Alcohol Comparable	0.99	3.15	1.09	-7.16	7.95	57.04	12.22
	Gambling Comparable	1.98	3.87	1.77	-5.20	10.96	147.41	26.03
	Tobacco Comparable	1.32	2.93	1.56	-4.85	9.58	83.83	16.82
Panel D: 2016-2019								
	Sin Trio	0.48	3.91	0.34	-7.74	8.46	21.65	5.13
	Trio Comparable	0.94	2.85	1.02	-6.32	7.46	53.64	11.59
	Alcohol	0.51	3.97	0.36	-8.84	7.46	22.98	5.43
	Gambling	1.44	5.58	0.83	-11.14	12.75	84.53	16.94
	Tobacco	0.15	6.38	0.02	-15.37	13.99	-2.56	-0.66
	Alcohol Comparable	1.05	3.57	0.92	-6.60	8.09	60.34	12.82
	Gambling Comparable	0.75	4.52	0.49	-9.70	9.54	36.31	8.23
	Tobacco Comparable	0.76	2.71	0.84	-6.41	6.00	41.36	9.24
Panel E: 2020-2024								
	Sin Trio	0.42	4.58	0.19	-11.78	15.59	18.62	3.95
	Trio Comparable	0.31	3.91	0.12	-8.39	7.73	13.55	2.92
	Alcohol	0.08	5.13	-0.06	-12.91	17.70	-2.56	-0.59
	Gambling	2.21	8.31	0.85	-18.43	25.12	173.10	25.56
	Tobacco	0.55	6.09	0.21	-16.65	13.91	21.85	4.58
	Alcohol Comparable	0.13	4.30	-0.03	-7.22	10.50	2.42	0.54
	Gambling Comparable	0.79	11.38	0.19	-30.79	40.81	10.13	2.21
	Tobacco Comparable	0.25	3.62	0.07	-8.70	8.54	10.41	2.27

Notes: Mean return represents the arithmetic monthly average. Standard deviation shows monthly values. The Sharpe Ratio is annualised. Returns are value-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest monthly returns observed during the respective period.

The sub-period 2008-2011 is characterised by heightened market volatility, as reflected in the elevated standard deviations, which aligns with our expectations due to the 2008 financial crisis and the subsequent recession. Despite the stock market crash and market turmoil, the Sin Trio Portfolio managed to recover quickly and continued to outperform its

comparable portfolio, achieving a total period return of 59% compared to 13%. On a risk-adjusted basis, the Sin Trio Portfolio excelled, with a Sharpe ratio of 0.75 versus 0.26 for the comparable portfolio. The alcohol and tobacco sectors demonstrated particular resilience during this market turbulence, with tobacco stocks delivering a strong total return of 66%. This aligns with Kenton's (2022) observation about the recession-proof nature of these industries, where inelastic demand ensures stable cash flows even during economic downturns. In contrast, gambling stocks did not show the same resilience, declining by -34.91%. Across the five sub-periods, the Sin Trio Portfolio generally outperformed its comparable portfolio, though with notable variations in recent years. During 2016-2019, it underperformed both in absolute returns and risk-adjusted metrics. However, the portfolio recovered in 2020-2024, again surpassing its comparable portfolio.

Figure 6.2: Cumulative returns (sub-periods)



(a) 2004–2007 **(b)** 2008–2011

(c) 2012–2015 **(d)** 2016–2019

(e) 2020–2024

Notes: (a) Cumulative returns for the period 2004–2007, (b) cumulative returns for the period 2008–2011, (c) cumulative returns for the period 2012–2015, (d) cumulative returns for the period 2016–2019, (e) cumulative returns for the period 2020–2024.

Figure 6.2 provides visual confirmation of the findings. From 2004 to 2007, the Sin Trio Portfolio outperformed both its comparable portfolio and the broader European market. During the 2008-2012 period, the financial crisis caused sharp declines across all portfolios. However, the Sin Trio Portfolio showed notable resilience, rebounding faster than its comparable and the market. In the 2016-2020 sub-period, a shift occurred, with the comparable portfolio delivering higher returns. Interestingly, in the final two sub-periods,

the portfolio of traditional sin stocks lagged behind the broader European market.

6.1.2 Regression results

While our descriptive analysis highlights the historically strong performance of sin stocks, recent declining trends suggest a more balanced competitive landscape. To formally test our hypothesis, we run time-series return regressions on the portfolio returns of sin stocks net of the risk-free rate. Specifically, we apply the CAPM, Fama-French three-factor model, Fama-French five-factor model, and the five-factor model with a momentum extension. The regressions are conducted on both value-weighted and equally-weighted portfolio returns, although our primary focus is on the value-weighted portfolio under the five-factor specification. We test for abnormal returns in both the Sin Trio Portfolio and the Trio Comparable Portfolio; however, the results for the comparable portfolio have been included in Section D in the Appendix.

Second, to assess whether sin stocks outperform their comparables, we implement a long-short strategy, replacing the risk-free rate with the returns of the respective comparable portfolio, consistent with the methodology employed by Hong and Kacperczyk (2009).

6.1.2.1 Total period

We begin our regression analysis by examining the full sample period from January 2004 to June 2024, encompassing 246 months. The regression results, where the dependent variable is the Sin Trio Portfolio's monthly returns less the risk-free rate, are presented in Table 6.3. A positive and significant constant term represents average monthly abnormal returns in percentage terms.

Table 6.3: Regression results for the Sin Trio Portfolio (Robust SEs)

	Model Specification: Value-Weighted				*Model Specification: Equally-Weighted*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	0.7088***	0.7221***	0.4203*	0.4730*	0.6860***	0.6168***	0.5502***	0.6140***
	(0.2216)	(0.2173)	(0.2272)	(0.2517)	(0.1955)	(0.1704)	(0.1742)	(0.1796)
Mkt-Rf	0.4591***	0.5109***	0.5623***	0.5548***	0.6053***	0.5859***	0.5270***	0.5180***
	(0.0464)	(0.0490)	(0.0572)	(0.0571)	(0.0527)	(0.0418)	(0.0401)	(0.0404)
SMB		−0.2853**	−0.1776	−0.1702		0.7546***	0.7079***	0.7169***
		(0.1453)	(0.1389)	(0.1402)		(0.1039)	(0.0927)	(0.0921)
HML		−0.2439**	−0.0267	−0.0775		−0.0320	0.2751**	0.2135*
		(0.1077)	(0.1695)	(0.1732)		(0.0643)	(0.1092)	(0.1194)
RMW			0.8144***	0.8095***			0.2880	0.2821
			(0.2429)	(0.2435)			(0.1848)	(0.1832)
CMA			0.4113*	0.4560**			−0.4605***	−0.4064***
			(0.2230)	(0.2315)			(0.1535)	(0.1555)
WML				−0.0612				−0.0740
				(0.0814)				(0.0598)
Observations	246	246	246	246	246	246	246	246
R^2	0.3393	0.3737	0.4166	0.4183	0.5455	0.6421	0.6599	0.6622
Adjusted R^2	0.3366	0.3659	0.4044	0.4037	0.5437	0.6376	0.6528	0.6538

Notes: The table presents time-series regression results for the Sin Trio Portfolio over the period from January 2004 to June 2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable is the monthly portfolio return net of the risk-free rate, $r_{sin,t} - r_{rf,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

We observe that the value-weighted (VW) Sin Trio Portfolio generates positive and statistically significant monthly abnormal returns across all models. However, the statistical significance of these returns diminishes as additional risk factors are introduced, aligning with Blitz and Fabozzi's (2017) argument that extended factors are essential for explaining sin stock returns. In the CAPM model, the estimated monthly abnormal return is 0.7088%, which is statistically significant at the 1% level. The market risk factor displays a positive and highly significant loading at the 1% level, highlighting the portfolio's sensitivity to market fluctuations. Importantly, this positive market exposure is consistently observed across all model specifications.

The three-factor model shows a slightly higher monthly abnormal return of 0.7221%.

Additionally, it reveals a negative loading on the SMB factor, significant at the 5% level, suggesting a tilt toward large-cap stocks. The HML factor also has a negative loading, significant at the 5% level, indicating a tilt towards low book-to-market companies. In the five-factor specification, monthly abnormal returns decline to 0.4203%, with statistical significance reduced to the 10% level. The RMW factor is positive and strongly significant, suggesting that sin stocks benefit from robust profitability characteristics. This finding supports Fabozzi et al.'s (2008) argument that the monopolistic structures and high barriers to entry in these industries enable established firms to sustain strong profitability. The CMA factor is also positive and significant, further supporting Blitz and Fabozzi's (2017) conclusion that profitability and investment factors are critical in explaining sin stock returns.

Adding momentum to the model leaves these findings largely unchanged. Abnormal returns increase slightly to 0.4730%, maintaining statistical significance at the 10% level. Across models, the adjusted R^2 values improve from 0.3366 to 0.4044, though a considerable portion of return variation remains unexplained.

These results offer interesting comparisons to previous research on the European market. Consistent with Sagbakken and Zhang (2022), the sin stock portfolio generates highly significant abnormal returns in both CAPM and three-factor specifications. However, while their study reports no significance in the five-factor model, our analysis demonstrates abnormal returns that are statistically significant at the 10% level. Nonetheless, a direct comparison is challenging, as their broader definition of traditional sin stocks includes weapon and defence companies, which we have categorised into a distinct portfolio to be analysed separately.

Turning to the equally-weighted (EW) Sin Trio Portfolio, we observe several distinct characteristics compared to its value-weighted counterpart. In the five-factor model specifications, we observe larger abnormal returns with stronger statistical significance. Unlike the VW portfolio, the SMB factor is positive and significant at the 1% level, indicating a tilt toward small-cap stocks and implying a higher contribution to portfolio performance from smaller companies, which aligns with the rationale behind equal-weighting that reduces the influence of large-cap stocks. Notably, the CMA factor shifts to a negative loading, which is significant at the 1% level. This negative CMA loading

is also consistent with the nature of equal-weighting, as it assigns higher weights to early-stage companies that typically engage in more aggressive investment strategies to support growth. Additionally, the EW portfolio shows slightly higher adjusted R^2 values compared to the VW portfolio, reflecting improved explanatory power.

Regression results of the Trio Comparable Portfolio also reveal statistically significant abnormal returns across all model specifications (see Table D.1 in the Appendix for regression results and further comments).

6.1.2.2 Sub-periods

Following our full period analysis, we examine whether sin stock performance varies across the five sub-periods.

Table 6.4: Regression results for the Sin Trio Portfolio across different sub-periods (Robust SEs)

	Model Specification: Value-Weighted					*Model Specification: Equally-Weighted*				
	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)
Constant (a)	0.8221**	1.1644*	0.9908***	0.0234	−0.2312	0.3043	0.6349	1.7559***	0.0533	0.1441
	(0.4004)	(0.6611)	(0.3382)	(0.4616)	(0.3587)	(0.3588)	(0.4919)	(0.3462)	(0.3093)	(0.3173)
Mkt-Rf	0.3267***	0.4821***	0.7407***	0.6775***	0.5761***	0.4892***	0.4927***	0.4835***	0.6324***	0.5672***
	(0.1117)	(0.1044)	(0.1039)	(0.1503)	(0.0887)	(0.1122)	(0.0806)	(0.0971)	(0.1030)	(0.0627)
SMB	−0.2653	0.1121	−0.9858***	−0.8476**	0.1374	0.6764***	0.9309***	0.2745*	0.4390**	0.6165***
	(0.1889)	(0.2716)	(0.1874)	(0.3765)	(0.2089)	(0.2065)	(0.2080)	(0.1548)	(0.1785)	(0.2091)
HML	0.8992*	−0.4022	−0.9405***	−1.2346**	0.3758	1.2174**	0.3937*	−0.7285**	−0.3963	0.2918
	(0.5240)	(0.3414)	(0.3579)	(0.5865)	(0.2592)	(0.5115)	(0.2184)	(0.3217)	(0.3152)	(0.2322)
RMW	−0.1283	−0.0633	0.3521	0.0398	1.2451***	−0.1465	0.3437	−0.9785**	−0.0185	0.4414
	(0.4830)	(0.5076)	(0.4006)	(0.7096)	(0.3513)	(0.4062)	(0.4059)	(0.3921)	(0.3543)	(0.3353)
CMA	−0.0910	0.0678	0.1583	1.0037	0.5565	−0.7228***	−0.7958***	−0.6014	0.3912	−0.0829
	(0.3463)	(0.4444)	(0.3701)	(0.6938)	(0.4480)	(0.2655)	(0.2337)	(0.4337)	(0.4151)	(0.3996)
Observations	48	48	48	48	54	48	48	48	48	54
R^2	0.2670	0.4590	0.6999	0.4854	0.6598	0.6704	0.7772	0.4836	0.5864	0.7545
Adjusted R^2	0.1797	0.3946	0.6642	0.4241	0.6244	0.6312	0.7507	0.4221	0.5372	0.7290

Notes: The table presents time-series regression results for the Sin Trio Portfolio across five distinct time periods: 2004-2007, 2008-2011, 2012-2015, 2016-2019, and 2020-2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly portfolio return net of the risk-free rate, $r_{sin,t} - r_{rf,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

From table 6.4, we see that the VW Sin Trio Portfolio demonstrates strong performance, particularly in the early years. The most notable periods are 2008-2011, with monthly abnormal returns of 1.1644% that are statistically significant at the 10% level, and

2012-2015, with abnormal returns of 0.9908% significant at the 1% level. However, this outperformance fades after 2015, with no statistically significant abnormal returns observed in recent years. This aligns with our descriptive findings, highlighting the same declining trend.

The EW Sin Trio Portfolio exhibits a more focused pattern of outperformance, with significant abnormal returns exclusively in the 2012-2015 period. The SMB loading remains consistently positive and significant across periods, reinforcing our full-sample findings about small-cap tilts when equally-weighing the portfolio.

Regression results of the Trio Comparable Portfolio during these sub-periods reveals that 2012-2015 stands out with the highest significant abnormal returns (see Table D.2 in the Appendix). Notably, while the sin portfolio shows no significant abnormal returns after 2015, its counterpart continues to deliver significant abnormal returns in 2016-2019. This finding aligns with our descriptive statistics which highlight 2016-2019 as a particularly strong period for comparable stock, in relative terms.

6.1.2.3 Difference Portfolio

Having identified significant abnormal returns for both the Sin Trio Portfolio and the Trio Comparable Portfolio, we now assess their relative performance. The coefficients now reflect differences in factor exposures between the two portfolios, while a positive and significant constant term indicates that traditional sin stocks outperform their comparables after adjusting for various risk factors. Table 6.5 summarises the regression results.

Table 6.5: Regression results for the Trio Difference Portfolio (Robust SEs)

	Model Specification: Value-Weighted				*Model Specification: Equally-Weighted*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	0.2197	0.2338	0.0658	0.0635	0.2878*	0.2633*	0.2867*	0.2508
	(0.1950)	(0.1945)	(0.2175)	(0.2332)	(0.1553)	(0.1487)	(0.1579)	(0.1702)
Mkt-Rf	0.0742*	0.0823*	0.0966	0.0969*	0.0329	0.0728**	0.0254	0.0305
	(0.0432)	(0.0422)	(0.0591)	(0.0583)	(0.0384)	(0.0345)	(0.0344)	(0.0337)
SMB		−0.1655	−0.1199	−0.1203		0.1313	0.0794	0.0744
		(0.1393)	(0.1372)	(0.1373)		(0.0950)	(0.0911)	(0.0916)
HML		−0.0150	0.1587	0.1610		−0.2543***	−0.1111	−0.0765
		(0.0936)	(0.1739)	(0.1863)		(0.0661)	(0.1061)	(0.1118)
RMW			0.4752**	0.4754**			0.0036	0.0069
			(0.2168)	(0.2179)			(0.1570)	(0.1587)
CMA			0.1164	0.1145			−0.3724***	−0.4028***
			(0.2455)	(0.2567)			(0.1295)	(0.1354)
WML				0.0027				0.0416
				(0.0668)				(0.0603)
Observations	246	246	246	246	246	246	246	246
R^2	0.0169	0.0265	0.0498	0.0498	0.0052	0.0830	0.1099	0.1123
Adjusted R^2	0.0129	0.0144	0.0300	0.0260	0.0011	0.0716	0.0913	0.0900

Notes: The table presents time-series regression results for the Trio Difference Portfolio for the period from January 2004 to June 2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly sin portfolio return net of the comparable portfolio return, $r_{sin,t} - r_{comp,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

The VW Difference Portfolio reveals no statistically significant alpha across any model specifications, indicating a lack of sin stock outperformance after accounting for risk factors. The positive market factor is significant at the 10% level in most specifications, suggesting traditional sin stocks exhibit higher market sensitivity than their comparables. Notably, the consistently positive and significant RMW factor in both five-factor specifications indicate stronger profitability characteristics in sin stocks, aligning with the theory that high barriers to entry and limited price regulation enable these companies to maintain robust profitability (Fabozzi et al., 2008).

The EW Difference Portfolio offers a contrasting perspective, showing positive alphas significant at the 10% level in most specifications, with monthly abnormal returns around

0.29% in the five-factor model. This outperformance aligns with Hong and Kacperczyk's (2008) findings, extending their three-factor approach and demonstrating that it persists even when additional risk factors are introduced.

The outperformance observed with the equally-weighted approach likely reflects the greater influence of smaller companies, particularly within the gambling sector, identified in our descriptive analysis as the strongest performer. The equal-weighted methodology elevates the gambling setcor's influence relative to the value-weighted approach, as it compensates for the sector's lower market capitalisation compared to alcohol and tobacco companies. To assess the robustness of this result, we tested whether the significant outperformance would persist after excluding gambling stocks and their comparables. For this purpose, we constructed an "EW Duo Portfolio" that omitted the gambling sector (see Table E.1 in the Appendix). In this revised portfolio, the statistically significant outperformance disappeared, confirming that the gambling sector's strong performance was the primary driver of the EW Difference Portfolio.

Lastly, we observe that the regressions consistently exhibit lower R^2 values compared to the individual portfolio analyses. This suggests that the models are less effective at explaining the relative performance between sin stocks and their comparables. This limitation should be considered when interpreting the findings.

6.1.3 Partial conclusion

Our analysis of traditional sin stocks in the European market reveals that they generate significant abnormal returns over the period from 2004 to 2024, supporting hypothesis 1A. We observe that these abnormal returns persist across both our weighting approaches and remain significant after controlling for the various risk factors in the Fama-French five-factor model. These findings contrast with those of Sagbakken and Zhang (2022), who report that alphas for traditional sin stocks become insignificant under the five-factor model. We also note that when value-weighting the portfolio, traditional sin stocks have positive and significant factor loadings on the profitability and investment factors, supporting Blitz and Fabozzi's (2017) argument that these factors are critical in explaining some of the high sin stock returns observed. However, our results contradict Blitz and Fabozzi's conclusion that abnormal returns disappear after controlling for these factors.

While traditional sin stocks demonstrate significant abnormal returns over the full period, this diminishes over time. These sin stocks exhibited strong abnormal returns in the earlier years of our time frame, but their performance declined in later years. Most notably, we find no statistically significant abnormal returns for traditional sin stocks after 2015.

Regarding hypothesis 1B, our findings provide no clear evidence that traditional sin stocks consistently outperform their comparables. Although the EW Difference Portfolio exhibited abnormal returns significant across most model specifications, aligning with Hong and Kacperczyk's (2009) findings, the results appear to lack robustness. Specifically, the significance level is marginal, at the 10% level. Moreover, additional robustness tests revealed that removing the gambling sector eliminated any evidence of outperformance, suggesting that the observed abnormal returns may be primarily driven by the strong performance of gambling stocks. The robustness of the equally-weighted approach should be interpreted with caution, as Adamsson and Hoepner (2015) highlight limitations stemming from the use of value-weighted Fama-French factors as independent variables. More importantly, we did not find any evidence of outperformance when using the value-weighted approach. These findings challenge the notion of a sin stock premium arising specifically from their unethical nature, or the existence of a distinct "reputational risk premium" associated with defying social norms.

6.2 Analysis of weapon and defence stocks (H2A, H2B and H2C)

Our analysis now turns to the weapon and defence industry, examining whether these stocks generate positive abnormal returns (H2A) and outperform their comparable portfolios on a risk-adjusted basis (H2B). Additionally, we test whether these stocks exhibit extraordinary returns during the Russia-Ukraine war period (H2C), exploring the widely held belief that wars create stock opportunities for investors in these industries.

6.2.1 Descriptive analysis

6.2.1.1 Total period

Table 6.6 shows a descriptive performance overview for the Weapon & Defense Portfolio, and its comparables. The Weapon & Defence Portfolio demonstrates an incredible performance over the 246-month period, achieving a total return of 2590%, while its comparable portfolio delivered similar returns of 2430%. The marginal outperformance of the Weapon & Defence Portfolio is also reflected in its slightly superior risk-adjusted performance, with Sharpe ratios of 0.81 versus 0.78. The cumulative return graph reinforces this pattern of similar performance, with both portfolios tracking each other relatively closely throughout the sample period, with occasional divergences. Both portfolios exhibited exceptional performance, clearly outperforming the broader European market during this timeframe.

Table 6.6: Total period overview for value-weighted portfolios (2004-2024)

Portfolio	Mean Return (%)	Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)	Annualised Return (%)
Weapon & Defence	1.53	6.00	0.81	-32.92	35.18	2589.96	17.50
Weapon & Defence Comparable	1.52	6.16	0.78	-27.87	16.64	2429.66	17.15

Notes: Mean return represents the arithmetic monthly average. Standard deviation shows monthly values. The Sharpe Ratio is annualised. Returns are value-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest monthly returns observed during the respective period.

Figure 6.3: Cumulative returns for the total period (2004–2024).

Notes: This figure shows the cumulative returns for the value-weighted Weapon & Defence Portfolio, Comparable Portfolio and the European market over the entire period from January 2004 to June 2024.

6.2.1.2 Sub-periods

The first sub-period is characterised by economic expansion, culminating in the bull market peak of December 2007. Despite the Weapon & Defence Portfolio's strong performance, delivering 125% growth, it trailed behind the remarkable 375% return of its comparable portfolio. This underperformance extends to risk-adjusted metrics, with the sinful portfolio achieving a Sharpe ratio of 1.21 compared to 2.18 for the comparable portfolio.

Table 6.7: Period-divided overview for value-weighted portfolios

Panel	Portfolio	Monthly Mean Return (%)	Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)	Annualised Return (%)
Panel A: 2004-2007								
	Weapon & Defence	1.80	4.36	1.21	-9.74	9.93	124.96	23.01
	Weapon & Defence Comparable	3.42	4.98	2.18	-7.92	15.78	375.29	48.90
Panel B: 2008-2011								
	Weapon & Defence	0.61	6.31	0.31	-13.98	15.28	21.74	5.15
	Weapon & Defence Comparable	-0.03	8.83	-0.02	-27.87	16.64	-18.73	-5.16
Panel C: 2012-2015								
	Weapon & Defence	1.97	4.61	1.48	-6.78	10.36	143.42	25.51
	Weapon & Defence Comparable	1.16	4.42	0.91	-9.94	12.78	66.56	13.92
Panel D: 2016-2019								
	Weapon & Defence	1.53	4.29	1.16	-9.56	11.08	99.04	19.22
	Weapon & Defence Comparable	1.42	4.77	0.96	-9.59	10.63	86.36	17.23
Panel E: 2020-2024								
	Weapon & Defence	1.71	8.84	0.60	-32.92	35.18	102.73	17.37
	Weapon & Defence Comparable	1.60	6.42	0.77	-15.33	13.02	110.98	18.43

Notes: Mean return represents the arithmetic monthly average. Standard deviation shows monthly values. The Sharpe Ratio is annualised. Returns are value-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest monthly returns observed during the respective period.

The subsequent period (2008-2011), encompassing the 2008 financial crisis and the Great Recession, demonstrates the defensive characteristics of weapon and defence stocks. The Weapon & Defence Portfolio delivered a positive return of 22%, in contrast to the comparable portfolio, which declined by 19%. This disparity highlights the relative resilience of the Weapon & Defence Portfolio during a period when the broader market fell by 30%, suggesting that the comparable portfolio was more affected by market turmoil and volatility. This resilience is further evidenced by the portfolio's downside risk, with maximum monthly losses of -14% compared to -28% for comparables.

During the 2012–2015 period, the Weapon & Defence Portfolio delivered returns of 143%, outpacing their comparables' 67%. In the subsequent period, performance became more aligned, with both portfolios achieving returns of approximately 100%.

The final period marked by both the COVID-19 crisis and the Ukraine invasion, presents complex dynamics. Despite expectations of positive momentum from increased geopolitical tensions, the sinful portfolio underperformed its comparable by 8 percentage points, with higher volatility. The COVID-19 impact was particularly severe for weapon and defence stocks, evidenced by a negative 33% monthly return at the lowest point. While the portfolio showed positive momentum during the recovery phase, Figure 6.4 demonstrate that returns remained in negative territory until 2022, eventually stabilising relative to comparables. Further regression analysis is required to draw meaningful conclusions regarding the potential outperformance.

Figure 6.4: Cumulative returns (sub-periods)

Notes: (a) Cumulative returns for the period 2004–2007, (b) cumulative returns for the period 2008–2011, (c) cumulative returns for the period 2012–2015, (d) cumulative returns for the period 2016–2019, (e) cumulative returns for the period 2020–2024.

6.2.2 Regression results

6.2.2.1 Total period

The regression results for our Weapon & Defence Portfolio, where the dependent variable is the portfolio's monthly returns less the risk-free rate, are presented in Table 6.8.

Table 6.8: Regression results for the Weapon & Defence Portfolio (Robust SEs)

	Model Specification: Value-Weighted				*Model Specification: Equally-Weighted*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	1.0168***	1.0230***	0.7240**	0.8763**	0.7069***	0.6682***	0.4541*	0.4973*
	(0.3128)	(0.3092)	(0.3588)	(0.4053)	(0.2566)	(0.2450)	(0.2657)	(0.2854)
Mkt-Rf	0.6918***	0.6157***	0.6392***	0.6177***	0.7002***	0.6253***	0.6341***	0.6280***
	(0.0975)	(0.0730)	(0.0841)	(0.0842)	(0.0707)	(0.0560)	(0.0606)	(0.0608)
SMB		0.1582	0.2373	0.2587		0.6084***	0.6570***	0.6630***
		(0.2112)	(0.2246)	(0.2265)		(0.1451)	(0.1533)	(0.1543)
HML		0.4075**	0.7239**	0.5770**		0.3155***	0.5714***	0.5298**
		(0.1838)	(0.2989)	(0.2842)		(0.1183)	(0.2042)	(0.2138)
RMW			0.8489**	0.8350**			0.6200**	0.6161**
			(0.4136)	(0.4150)			(0.2776)	(0.2778)
CMA			0.1922	0.3212			0.0749	0.1114
			(0.3093)	(0.3065)			(0.2532)	(0.2573)
WML				−0.1766				−0.0500
				(0.1359)				(0.0987)
Observations	246	246	246	246	246	246	246	246
R^2	0.3697	0.3991	0.4177	0.4247	0.4708	0.5296	0.5416	0.5423
Adjusted R^2	0.3671	0.3917	0.4056	0.4103	0.4686	0.5238	0.5321	0.5308

Notes: The table presents time-series regression results for the Weapon & Defence Portfolio over the period from January 2004 to June 2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable is the monthly sin portfolio return net of the risk-free rate, $r_{sin,t} - r_{rf,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

The value-weighted (VW) Weapon & Defence Portfolio demonstrates strong performance across all model specifications. The CAPM model displays an alpha of 1.0168% at the 1% level, with the market factor also showing strong significance. The three-factor model maintains similar abnormal returns at 1.0230% (1% level), with a positive HML loading indicating a tilt towards value stocks. In the five-factor specification, alpha decreases to 0.724% (5% level), partly explained by the positive RMW loading. The positive RMW loading indicates that the Weapon & Defence Portfolio consists of firms with strong operating profitability. These results support our view that weapon and defence stocks share some of the same characteristics as traditional sin stocks, making them an interesting extension of the sin stock classification.

The equally-weighted (EW) portfolio shows similar directional relationships in factor loadings, but with notable differences. While generating significant abnormal returns, the alphas are consistently lower than those in the value-weighted approach, with significance diminishing in the five-factor specifications. A key distinction arises in the SMB factor, which becomes highly significant, emphasising a stronger influence from smaller companies. The positive RMW and HML loadings persist, underscoring the sector's profitability and value characteristics.

Analysis of the comparable portfolio reveals similar patterns, with significant abnormal returns across all model specifications at magnitudes similar to the Weapon & Defence Portfolio (see Table F.1 in the Appendix). This parallel performance aligns with our descriptive statistics, where both portfolios exhibited strong returns over the full period.

6.2.2.2 Sub-periods

Following our total period regression analysis, we examine whether weapon and defence stock performance varies across the five sub-periods (see Table 6.9).

Table 6.9: Regression results for the Weapon & Defence Portfolio across different sub-periods (Robust SEs)

	Model Specification: Value-Weighted					*Model Specification: Equally-Weighted*				
	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)
Constant (a)	−0.5539	1.1969	1.6004**	1.0381*	0.6277	−0.1246	0.4380	1.4900***	0.4446	0.2814
	(0.5913)	(0.9467)	(0.6483)	(0.5307)	(0.6633)	(0.4722)	(0.6326)	(0.5029)	(0.4268)	(0.6930)
Mkt-Rf	0.4363**	0.4321***	0.6830***	0.7878***	0.9537***	0.5175***	0.5476***	0.5714***	0.8812***	0.7207***
	(0.1823)	(0.1299)	(0.1941)	(0.1718)	(0.1604)	(0.1375)	(0.0946)	(0.1306)	(0.1327)	(0.1318)
SMB	−0.0277	0.2288	−0.4133	−0.4391	0.3033	0.2830	0.7815***	0.1908	0.1572	0.9345**
	(0.3498)	(0.4194)	(0.3313)	(0.3848)	(0.4738)	(0.2904)	(0.2968)	(0.2523)	(0.2879)	(0.4702)
HML	2.5030***	−0.1043	−0.4080	−0.7819	1.2295***	2.0708***	0.4496	−0.3454	−0.3781	0.6815*
	(0.8582)	(0.4158)	(0.4914)	(0.5384)	(0.4246)	(0.6962)	(0.4124)	(0.5145)	(0.4337)	(0.3692)
RMW	0.6335	−0.5758	−0.4384	−0.3087	1.5473**	0.1519	0.1858	−0.6500	−0.0301	1.3029**
	(0.6111)	(0.6807)	(0.6697)	(0.5805)	(0.6030)	(0.4388)	(0.4987)	(0.5916)	(0.4321)	(0.5108)
CMA	−0.8045*	−0.2802	−0.2121	0.1342	0.7122	−0.4177	−0.1511	−0.4894	0.2960	0.9214
	(0.4804)	(0.6399)	(0.6533)	(0.6158)	(0.7222)	(0.3021)	(0.4559)	(0.5296)	(0.5060)	(0.7943)
Observations	48	48	48	48	54	48	48	48	48	54
R^2	0.3780	0.4066	0.4135	0.4295	0.6989	0.5874	0.6873	0.4103	0.5755	0.5817
Adjusted R^2	0.3039	0.3360	0.3437	0.3615	0.6676	0.5383	0.6501	0.3401	0.5250	0.5382

Notes: The table presents time-series regression results for the Weapon & Defence Portfolio across five distinct time periods: 2004-2007, 2008-2011, 2012-2015, 2016-2019, and 2020-2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly portfolio return net of the risk-free rate, $r_{sin,t} - r_{rf,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

First, we observe significant exposure to the market factor across all periods and weighing methods. This persistent market sensitivity aligns with our findings from the whole-period analysis. However, across the sub-periods, the analysis reveals that significant alphas are rare, contrary to the entire time period. Notably, in the first period, there is no positive significant alpha, which is surprising given that the descriptive analysis indicated substantial holding-period returns. The regression demonstrates that returns during this period are primarily driven by the market and HML factors, leaving no alpha after adjusting for risk.

The 2012–2015 sub-period stands out for its exceptional performance, characterised by the highest magnitude of abnormal returns as well as strong statistical significance. This

supports our descriptive overview, which found this period to be the best in terms of holding period returns. The significant performance during this period may partly reflect the broader financial environment, characterised by persistently low interest rates and accommodative monetary policies in response to the lingering effects of the Eurozone crisis. Low interest rates across global markets likely influenced investor behaviour. This environment encouraged greater demand for higher-yielding assets, contributing to the observed equity performance. The outbreak of the Syrian Civil War in March 2011 could also explain the elevated returns of weapon stocks during this period. The last sub-period, however, does not show significant abnormal returns, which may seem surprising given the optimistic narrative surrounding weapon and defence stock performance during periods of war. To investigate further, we narrow our scope in subsequent analysis to test the impact of the Russia-Ukraine war.

Moving to the comparable regression results from Table F.2 in the Appendix, we observe a significant alpha of 1.1205% in the first sub-period for the VW portfolio, supporting the astonishing holding period returns. This alpha, however, cannot be observed in the EW portfolio. Another noteworthy finding is the significant alpha of 0.7238% in the last sub-period of the VW portfolio.

6.2.2.3 Difference Portfolio

To isolate potential returns attributable to the controversial nature of weapon and defence stocks, we follow the same approach as earlier, constructing difference portfolios. Results are presented in Table 6.10.

Table 6.10: Regression results for the Weapon & Defence Difference Portfolio (Robust SEs)

	Model Specification: Value-Weighted				*Model Specification: Equally-Weighted*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	0.1657	0.2047	−0.0793	0.0956	0.1099	0.1501	0.0320	−0.0037
	(0.3403)	(0.3330)	(0.3563)	(0.4069)	(0.2506)	(0.2487)	(0.2689)	(0.2810)
Mkt-Rf	−0.2686**	−0.3512***	−0.2419***	−0.2666***	−0.2444***	−0.2769***	−0.2107***	−0.2056***
	(0.1072)	(0.0809)	(0.0876)	(0.0868)	(0.0512)	(0.0509)	(0.0569)	(0.0575)
SMB		−0.1534	0.0091	0.0337		−0.3114**	−0.2230	−0.2280
		(0.2289)	(0.2460)	(0.2481)		(0.1458)	(0.1571)	(0.1577)
HML		0.5044***	0.4839	0.3153		0.2462**	0.1610	0.1954
		(0.1936)	(0.3193)	(0.2913)		(0.1112)	(0.1873)	(0.2019)
RMW			0.6723	0.6563			0.2477	0.2509
			(0.4219)	(0.4254)			(0.2779)	(0.2778)
CMA			0.8655**	1.0136***			0.5230**	0.4928**
			(0.3476)	(0.3445)			(0.2255)	(0.2436)
WML				−0.2029				0.0414
				(0.1454)				(0.0798)
Observations	246	246	246	246	246	246	246	246
R^2	0.0688	0.1247	0.1649	0.1763	0.0999	0.1415	0.1623	0.1631
Adjusted R^2	0.0650	0.1138	0.1475	0.1556	0.0962	0.1308	0.1448	0.1421

Notes: The table presents time-series regression results for the Weapon & Defence Difference Portfolio for the full period from January 2004 to June 2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly sin portfolio return net of the comparable portfolio return, $r_{sin,t} - r_{comp,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

The regression results for the Difference Portfolio show that there are no statistically significant alphas across any model specifications, indicating an absence of a distinct sin stock premium. This applies to both the value-weighted and equally-weighted approaches, suggesting that any outperformance of the sin portfolio may be attributable to risk factors rather than the controversial nature of their business. The absence of a significant positive alpha is not entirely unexpected, as the comparable portfolio has matched the performance of weapon and defence stocks. While the total period outperformance of 160 percentage points may appear substantial, the Weapon & Defence Portfolio lagged behind its competition during the early years and only caught up in recent years, with the exception of one brief period.

The market risk factor consistently shows a negative and significant coefficient at the 1%

level, indicating that weapon and defence stocks are less sensitive to market fluctuations relative to their comparables. This finding highlights the Weapon & Defence Portfolio's lower relative market sensitivity, aligning with its reputation as a defensive sector supported by government contracts and stable demand.

6.2.3 Russia-Ukraine war period

The market narrative often suggests that wars drive extraordinary profits for defence stocks, with the Russia-Ukraine war being no exception. Investor sentiment and media reports have highlighted the supposed financial benefits for companies within the weapon and defence sector, as heightened military spending and geopolitical tensions increase demand for their products. An article by El Pais reports that the Russia-Ukraine conflict has substantially boosted the value of major arms manufacturers, as European nations ramped up defence spending to address security concerns (González, 2024). Similarly, an article by Euronews discusses the perception that defence stocks have had extraordinary returns during the Russia-Ukraine war, despite ongoing ethical debates about profiting from conflict (Romano, 2023).

However, academic research suggests a more complex relationship between conflicts and defence stock performance. Gurdgiev et al. (2019) find that while direct conflicts can drive immediate positive market reactions, these effects often moderate as markets adjust their initial expectations. According to a policy paper by the French Institute for International and Strategic Affairs (IRIS), European countries have notably increased defence spending following the Ukraine war, with notable surges in nations like Poland and Germany. However, overall expenditures remain below the NATO 2% GDP target as of 2021, lagging by approximately 31%, and long-term alignment with the goal is uncertain due to economic constraints and the return to EU Stability Pact benchmarks (Maulny, 2023). Our analysis tests these contrasting claims, examining whether European weapon and defence stocks exhibit excess returns or a sin premium during the Russia-Ukraine conflict, addressing views that war drives extraordinary profits.

Using daily data from February 2022 to June 2024, we analyse market reactions to both the invasion and the preceding military buildup along Ukraine's borders. The shorter, conflict-intensive time frame necessitates daily returns to ensure robust results, employing

Fama-French factors and value-weighted portfolios.

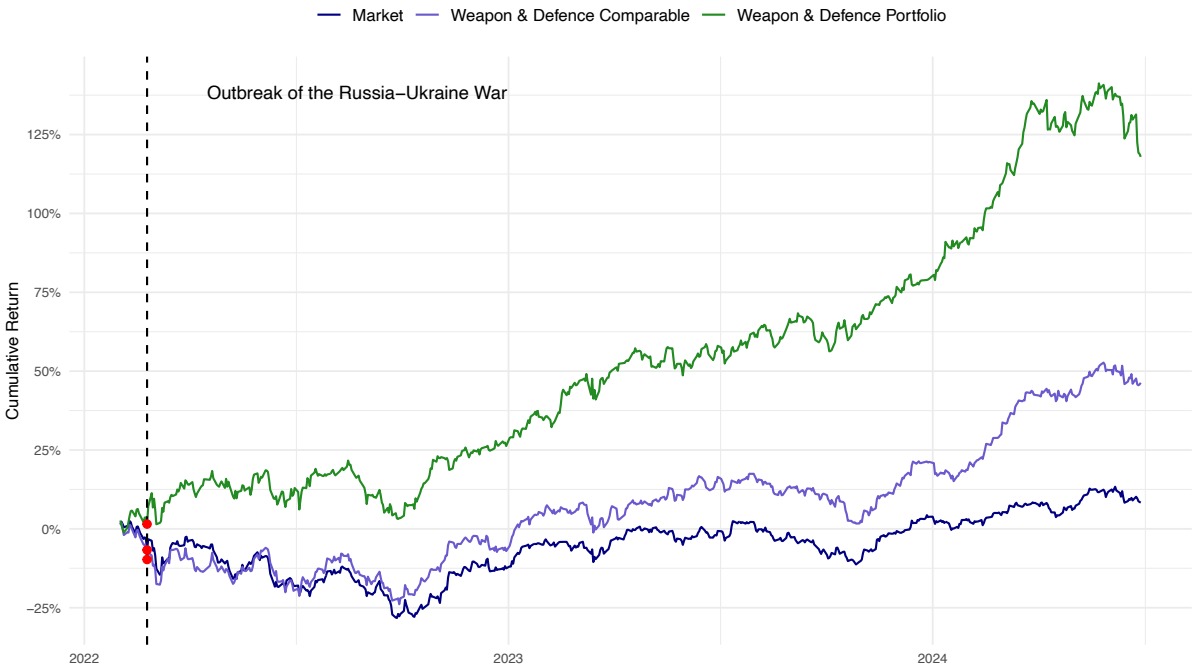
6.2.3.1 Descriptive analysis

Table 6.11: Russia-Ukraine war period overview for value-weighted portfolios

Portfolio	Annualised Mean Return (%)	Annualised Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)
Mkt	4.90	18.45	0.07	-4.59	6.12	8.32
Weapon and Defence	33.83	19.94	1.51	-4.97	5.47	117.95
Weapon and Defence Comparable	17.71	20.80	0.68	-5.33	5.27	46.31

Notes: Mean Returns and standard deviations are annualised. The Sharpe Ratio is annualised and reflects risk-adjusted performance. Returns are value-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest daily return observed during the Russia-Ukraine period.

Figure 6.5: Cumulative returns for the Russia-Ukraine war period



Notes: This figure shows the cumulative returns for the value-weighted Weapon & Defence Portfolio, Comparable Portfolio and the European market over the period from February 2022 to June 2024.

Figure 6.6: Cumulative returns for the Difference Portfolio during the Russia-Ukraine war

Notes: This figure shows the cumulative returns for the value-weighted Difference Portfolio during the period from February 2022 to June 2024.

The descriptive statistics in Table 6.11 reveal superior performance in absolute terms, as weapon and defence stocks outperform their comparables by approximately 72 percentage points during the war period. This exceptional performance is achieved with similar volatility to the market and lower volatility than the comparables, highlighting the portfolio's resilience. The sinful portfolio also has a higher Sharpe ratio relative to the market and comparables. These findings provide initial evidence of outperformance during the Russia-Ukraine war, suggesting that weapon and defence stocks thrive during periods of war.

The Difference Portfolio plot in Figure 6.6 reveals a sharp spike in stock price returns following the onset of the war. Interestingly, from late 2022 onwards, the portfolio undergoes several adjustments. The peak observed at the end of 2022 is followed by a period of heightened volatility in stock price movements, marked by a noticeable slowdown in outperformance. This contrasts sharply with the intense initial market reaction to the war.

6.2.3.2 Regression results

Table 6.12: Regression results for the value-weighted Weapon & Defence Portfolio and Comparable Portfolio during the Russia-Ukraine war period (Robust SEs)

	Model Specification: VW Weapon & Defence Portfolio				*Model Specification: VW Comparable Portfolio*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	0.1154***	0.0915**	0.0936**	0.0945**	0.0494	0.0525*	0.0513*	0.0508*
	(0.0409)	(0.0420)	(0.0417)	(0.0404)	(0.0302)	(0.0304)	(0.0299)	(0.0297)
Mkt-Rf	0.6303***	0.6068***	0.6498***	0.7528***	0.9165***	0.9265***	0.8704***	0.8234***
	(0.0467)	(0.0448)	(0.0543)	(0.0540)	(0.0265)	(0.0294)	(0.0361)	(0.0408)
SMB		−0.5307***	−0.4736***	−0.2230		0.1153	0.0343	−0.0801
		(0.1565)	(0.1666)	(0.1776)		(0.0889)	(0.0948)	(0.1040)
HML		0.2282**	0.0177	−0.1407		0.0102	0.2324***	0.3047***
		(0.1075)	(0.1382)	(0.1357)		(0.0589)	(0.0848)	(0.0860)
RMW			−0.2694	−0.3397*			0.1960	0.2281*
			(0.1841)	(0.1782)			(0.1230)	(0.1222)
CMA			0.3132	0.3117*			−0.4034***	−0.4027***
			(0.1933)	(0.1882)			(0.1459)	(0.1439)
WML				0.3570***				−0.1630***
				(0.0855)				(0.0612)
Observations	617	617	617	617	617	617	617	617
R^2	0.3459	0.3788	0.3859	0.4130	0.6730	0.6739	0.6812	0.6864
Adjusted R^2	0.3449	0.3758	0.3809	0.4072	0.6724	0.6723	0.6786	0.6833

Notes: The table presents time-series regression results for the Weapon & Defence Portfolio and Comparable Portfolio for the period from February 2022 to June 2024. The dependent variable is the daily excess return ($r_{portfolio,t} - r_{f,t}$). The constant ($\alpha$) represents the daily abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggresssive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

The Weapon & Defence Portfolio regression demonstrates statistically significant abnormal returns across all model specifications, seen in Table 6.12. The alphas range around 0.1% across the different models, indicating a large daily outperformance. Notably, a statistically significant momentum factor emerges at the 1% level. The momentum dynamic, absent in previous regressions, suggests that market sentiment played a more influential role during this period and may reflect the belief in extraordinary returns for weapon and defence stocks during war.

Examining the Comparable Portfolio during this period also reveals positive alpha across all specifications. These are only marginally significant at the 10% level, and notably lower

in magnitude than the Weapon & Defence Portfolio. We analyse the Difference Portfolio to determine whether this performance disparity remains significant after accounting for risk factors.

The Difference Portfolio (see Table G.1 in the Appendix) challenges the hypothesis of extraordinary weapon and defence stock returns during periods of warfare. Surprisingly, the Difference Portfolio does not yield a statistically significant alpha, indicating that the Weapon & Defence Portfolio does not outperform its comparable on a risk-adjusted basis. This finding contradicts the widely held belief that wars inherently lead to extraordinary profits for weapon defence stocks. This can be related to research by Gurdgiev et al. (2019), which indicates that the initial gains from war are not sustained in the long term. This may explain the lack of significant outperformance, as initial spikes in defence stock prices driven by conflicts like the Russia-Ukraine war often dissipate. Markets appear to adjust to the realities of long-term government spending and earnings potential, underscoring the importance of fundamental value-drivers over short-term speculative gains.

6.2.4 Partial conclusion

Our analysis of controversial weapon and defence stocks reveals that they deliver significant abnormal returns over the 2004–2024 period, supporting the 2A hypothesis. The Weapon & Defence Portfolio demonstrates impressive performance across multiple time periods, with four periods yielding returns exceeding 100%. While the portfolio diverged from this trend during the period encompassing the 2008 financial crisis and Great Recession, it still achieved a net positive return. Interestingly, the comparable portfolio also generated significant abnormal returns over the total period, though with greater variation across time periods. Its most notable holding period return occurred during the first time period, marked by exceptional yields.

The hypothesis 2B, which examines whether sinful weapon and defence stocks outperform their comparables, yields clear results. Both our VW and EW Difference Portfolios show no evidence of a sin stock premium after controlling for risk factors. Our results build on the difference methodology established by Hong and Kacperczyk (2009), while uniquely isolating weapons and defence stocks, unlike Blitz and Fabozzi (2017), who analysed them within a broader sin stock portfolio. Our findings suggest that although weapon and

defence stocks yield extraordinary cumulative returns, it does not provide a significant outperformance to their comparables, when adjusting for risk factors.

The hypothesis 2C of weapon and defence stocks during the Russia-Ukraine war period reveals significant abnormal returns, but no statistically significant outperformance relative to the comparable portfolio. Despite this, weapon and defence stocks demonstrated extraordinary cumulative returns in our descriptive analysis, dominating both the market and its comparable benchmark. The Difference Portfolio highlights the influence of Fama-French risk factors on these returns, with the positive WML factor suggesting that market sentiment and expectations during the conflict period were key drivers of performance. These findings align with Gurdgiev et al. (2019), who demonstrate that initial war effects on defence stocks are not sustained in the long term.

7 Conclusion and Discussion

This thesis aims to investigate whether sinful stocks yield positive abnormal returns, and if they outperform their comparable counterparts. Building on previous literature, we explored actual tradable European stocks within an updated time span, focusing on a sample perceived as sinful by European institutional investors. The analysis of traditional sin stocks, including alcohol, gambling, and tobacco extended previous research from Hong and Kacperczyk (2009), with a new timeframe and stricter screening method. We used Hong and Kacperzycks traditional examination of a difference portfolio, on a unique sample of weapon and defence stocks, to shed light on this controversial industry. We extended newer research of Blitz and Fabozzi (2017), by isolating the weapon and defence industry.

Table 7.1 summarises the key findings from our thesis, presenting an overview of the alphas obtained from the five-factor model regressions.

Table 7.1: Summary of alphas

Portfolio	Value-weighted		Equally-weighted		Total Period
	Alpha (Rf)	Alpha (Diff)	Alpha (Rf)	Alpha (Diff)	Return (%)
Sin Trio Portfolio	0.4203*	0.0658	0.5502***	0.2867*	1067.1%
Alcohol					757.58%
Gambling					4092.68%
Tobacco					816.02%
Trio Comparable Portfolio	0.3544*		0.2635*		559.64%
Alcohol Comparable					409.41%
Gambling Comparable					418.81%
Tobacco Comparable					626.83%
Weapon & Defence Portfolio	0.7240**	-0.0793	0.4541*	0.0320	2589.96%
Weapon & Defence Comparable	0.8033***		0.4222**		2429.66%

Notes: Alpha (Rf) values are derived from the five-factor model regression, where portfolio returns in excess of the risk-free rate are used as the dependent variable. Alpha (Diff) represents the alphas obtained from the Difference Portfolio approach, with the return difference between sin portfolios and their comparable portfolios serving as the dependent variable. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Our thesis find proof that traditional sin stocks yield positive abnormal returns, beyond the risk factors in the Fama-French models. The total period cumulative returns of 1067%

for alcohol, gambling and tobacco extends beyond the descriptive analysis, proving that the excess return can be attributed also on a statistical level. The total period abnormal returns persist on both a value-weighted and equally-weighted term, offering robust proof that sinful investors get compensated beyond the risk factors. Compared to previous research, our findings on sin excess returns contradict Blitz and Fabozzi (2017). We observe these returns after incorporating the profitability and investment factors, whereas their results only appear in the three-factor model. Notably, we also demonstrate that the Trio Comparable Portfolio itself generates significant abnormal returns.

We do not find robust evidence that traditional sin stocks consistently outperform their comparables in European markets. The value-weighted sinful portfolio shows an excess return of 508 percentage points over its comparables: however, this outperformance lacks statistical significance after controlling for risk factors. In contrast, the equally-weighted portfolio provides evidence of outperformance relative to the comparable portfolio. However, this finding alone does not confirm a sin stock premium, as the effect diminishes through robust testing with the Duo Difference Portfolio that excludes gambling stocks.

One of the main objectives of this thesis is to investigate whether a sin stock premium exists, meaning that the outperformance of our sin stock portfolios can specifically be attributed to their sinful nature. At first glance, one might attribute these excess returns to factors commonly associated with sin stocks, such as neglect, reputational risk, and exclusions by socially responsible investors. However, upon closer examination, the strong performance appears to be largely driven by the exceptional returns of gambling stocks, which gain prominence under an equal-weighting approach. Additionally, the Fama-French risk factors neutralise the significance in the value-weighted portfolio, indicating that excess returns can be attributed to factor exposure.

Furthermore, the empirical analysis of weapon and defence stocks yields interesting insights into their return patterns. Supporting hypothesis 2A, these stocks demonstrate significant positive abnormal returns and remarkable overall performance, substantially exceeding the market benchmark. The Weapon & Defence Portfolio beats the broader European market, and exhibit significant monthly abnormal returns of 0.724%, as seen in Table 7.1. However, our analysis reveals that their industrial comparables also generate significant abnormal returns. Testing hypothesis 2B through our difference portfolio approach, we find no

significant outperformance of weapon and defence stocks relative to their comparables. These findings indicate that while weapon and defence stocks have performed well in Europe over the past two decades, there is no empirical evidence to suggest that this success is driven by their "sinful" nature.

Further examination of daily returns during the Russia-Ukraine conflict reinforces these findings. While Table 6.11 and Figure 6.5 reveal substantial outperformance, with excess returns of 72 and 110 percentage points over comparables and the market, definitive conclusions require supporting regression evidence. While weapon and defence stocks continue to show significant abnormal returns in this period, we find no statistically significant outperformance relative to comparables. During conflicts, demand for crucial defence and military products naturally increases, benefiting weapon and defence companies. However, the results of this thesis paint a more nuanced picture, suggesting that the effect on stock prices is less dramatic than often portrayed. Not all weapons and defence stocks maintain direct contractual exposure to the Russia-Ukraine war. For companies with direct involvement, their sharp price increases followed by stabilisation may indicate that the war exposure was quickly priced into the securities. Our analysis suggests two key points: first, the sector's performance is not uniformly tied to active conflicts, and second, war-related price movements appear temporary rather than enduring. Even during the Russia-Ukraine war period, characterised by euphoric views on weapon and defence stocks, we find no evidence of a sin stock premium.

We end our paper answering the overall question: *do you need to sin, to win?* We do not find enough evidence to conclude on the principle that a portfolio of alcohol, tobacco and gambling offer a sin stock premium. In theory, it should be possible to achieve the same returns for a responsible investor exposing himself to certain Fama-French factors. Weapon and defence stocks deliver exceptional returns, but investors can achieve similar performance through comparable industrial companies. In other words, our results indicate that responsible investors do not need to compromise their ethical standards to capture the strong returns characteristic of these unethical industries.

Bottom line is, that you don't necessarily need to be a sinner to become a stock winner.

7.1 Further Research

We find it interesting to further explore if the degree of sin could contribute to a greater outperformance and/or abnormal returns. The evaluation of sin stocks is subjective, extending beyond a binary categorization. This could be put to the test by constructing a portfolio of "the most sinful stocks of them all". By choosing stocks that are excluded by the most institutional investors, the foundational sin stock literature can be put to the test, to see if people really neglect or avoid these companies, yielding returns for unethical investors. We find the Weapon & Defence Portfolio particularly intriguing to investigate due to its high exclusion rates in Table 4.3 and the relatively limited academic research on this segment. Analysing their performance during both the Ukraine war period and the entire study period could critically test the theory that institutional exclusions create a hidden investor strategy. Notable examples include companies such as BAE Systems, Airbus, Thales, Safran, Leonardo, Rolls-Royce, and Babcock. Remarkably, eight companies face exclusions from over 30 different institutions, an exceptionally high figure. Testing this portfolio of highly excluded weapon companies against their comparables, could reveal whether these "sinful" actors in the weapons industry deliver excess returns.

Furthermore, our thesis findings make it compelling to pursue further investigation into transaction costs. A separate analysis could focus on trading costs to assess the feasibility of a long-short trio portfolio and test whether the sin stock premium exists after accounting for real-world trading expenses. We find this interesting to explore further, as the only significant difference portfolio in our thesis emerged within the equal-weighted approach. A practical implementation of this portfolio would necessitate monthly rebalancing to maintain equal weights, potentially reducing monthly returns. Incorporating transaction costs would provide insight into the potential cost discrepancies between the portfolios, offering a perspective on the challenges of real-life investing.

Additionally, extending the study to analyse sin stock ownership could yield useful insights. By examining the evolution of institutional ownership and comparing it with our exclusion data, it would be possible to determine whether European institutional exclusions simply shift ownership to other funds with fewer ethical constraints. This presents an avenue for further research, as our thesis has identified high exclusion rates but has not found conclusive evidence of a significant sin stock premium. According to existing literature

on sin stocks, high exclusion rates should lead to reputational risks and lower coverage, potentially creating an anomaly in the form of a sin stock premium. With no sin stock premium found in our analysis, we speculate that non-European hedge funds and mutual funds may be investing in these vice companies, effectively neutralising the potential for a premium.

We conclude with a reflection on our findings, considering the market dynamics that may explain the lack of statistical evidence for a sin stock premium. It seems unlikely for such premiums to persist in a large, developed market like Europe, where opportunistic investors are constantly seeking to exploit inefficiencies or anomalies, such as the sin stock premium. While this premium may emerge during specific timeframes due to market sentiment or unusual conditions, over a broader scale and extended period, it is reasonable to expect that market forces and active investment strategies would neutralise its effects.

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Declaration on the use of AI tools in the work on this master's thesis

Name of the AI tool: ChatGPT 4.0.

The purpose of the use of the tool: The AI tool was used to improve formatting, organise data, improve language and enhance the structure of the thesis.

We are aware that we are responsible for all content of this master's thesis, including the parts where AI tools are used. We are responsible for ensuring that the thesis complies with ethical rules for privacy and publication.

Appendices

A Country scope

A.1 Kenneth R. French continent definition

Table A.1: Division of countries into continents in the Kenneth R. French Data Library

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

A.2 Country distributions

Table A.2: Country distribution of companies in the Sin Trio Portfolio and Trio Comparable Portfolio

Country	Sin Trio Portfolio	Trio Comparable Portfolio
Austria		1
Belgium	1	5
Bulgaria	1	
Croatia		9
Czech Republic	1	1
Denmark	4	4
Estonia		1
Finland	2	1
France	9	8
Germany	6	5
Greece	3	2
Ireland; Republic of		3
Italy	5	7
Lithuania		4
Macedonia	1	
Netherlands	2	2
Norway	1	1
Poland	1	3
Romania	1	1
Slovak Republic		1
Spain		2
Sweden	9	5
Switzerland		8
United Kingdom	13	15

Table A.3: Country distribution of companies in the Weapon & Defence Portfolio and Comparable Portfolio

Country	Weapon & Defence	Weapon & Defence Comparable
Austria		2
Croatia		2
Czech Republic	1	
Estonia		1
Finland		9
France	5	7
Germany	3	16
Iceland		1
Italy	2	10
Netherlands		4
Norway	1	3
Poland		2
Romania	2	
Spain		4
Sweden	4	9
Switzerland		10
United Kingdom	6	7

B Model testing

To ensure the validity of our regression models and results, we conduct several tests to confirm that the Classical Linear Model (CLM) assumptions are satisfied.

B.1 Testing for multicollinearity

Table B.1 displays Pearson correlation coefficients between independent variables applied in our regressions. Following the classification of Evans (1996), we find that HML and RMW show a strong negative correlation (-0.78), while HML and CMA exhibit a moderate correlation (0.51). All other relationships fall in the weak or very weak ranges (below 0.39). These patterns suggest potential multicollinearity concerns primarily between HML and RMW factors, while other variables show moderate to minimal correlation risk.

Table B.1: Pearson correlation matrix

	Mkt-Rf	SMB	HML	RMW	CMA	WML
Mkt-Rf	1.00	0.10	0.35	-0.28	-0.23	-0.45
SMB	0.10	1.00	0.00	-0.07	-0.21	-0.02
HML	0.35	0.00	1.00	-0.78	0.51	-0.49
RMW	-0.28	-0.07	-0.78	1.00	-0.42	0.36
CMA	-0.23	-0.21	0.51	-0.42	1.00	0.03
WML	-0.45	-0.02	-0.49	0.36	0.03	1.00

Additionally, we calculate Variance Inflation Factors (VIF) for all independent variables. VIF measures how much coefficient variance is inflated due to correlated independent variables (Verma, 2024). High VIF values can inflate standard errors and reduce the model's ability to detect significant relationships between independent and dependent variables. Values of 5 or higher indicate potentially problematic multicollinearity, while values exceeding 10 signal severe multicollinearity that warrants further investigation.

Table B.2 presents the VIF values for our independent variables. All values fall well below these thresholds, indicating that multicollinearity does not significantly impact our model reliability.

Table B.2: The Variance Inflation Factors

Variable	VIF
Mkt-Rf	1.60
SMB	1.09
HML	4.05
RMW	2.62
CMA	2.10
WML	1.60

B.2 Testing for homoskedasticity

Table B.3 presents the Breusch-Pagan test results for homoscedasticity in our value-weighted regressions. The test is applied to the Sin Trio, Weapon & Defense, and comparable portfolios. The "BP" statistic follows a chi-squared distribution under the null hypothesis of homoscedasticity.

Table B.3: Breusch-Pagan test results by model

	BP-Value	P-value	Rejection?	Conclusion
3 Factor				
VW Sin Trio Portfolio	3.71	0.29	no	Homoscedasticity
VW Trio Comparable Portfolio	8.44	0.04	yes	Heteroscedasticity
VW Weapon & Defence Portfolio	3.06	0.38	no	Homoscedasticity
VW Weapon & Defence Comparable Portfolio	1.92	0.59	no	Homoscedasticity
5 Factor				
VW Sin Trio Portfolio	4.73	0.45	no	Homoscedasticity
VW Trio Comparable Portfolio	11.58	0.04	yes	Heteroscedasticity
VW Weapon & Defence Portfolio	7.74	0.17	no	Homoscedasticity
VW Weapon & Defence Comparable Portfolio	5.94	0.31	no	Homoscedasticity
5 + MOM				
VW Sin Trio Portfolio	12.78	0.05	yes	Heteroscedasticity
VW Trio Comparable Portfolio	11.52	0.07	no	Homoscedasticity
VW Weapon & Defence Portfolio	27.08	0.00	yes	Heteroscedasticity
VW Weapon & Defence Comparable Portfolio	6.39	0.38	no	Homoscedasticity

While most models satisfy the homoscedasticity assumption, ensuring efficient and unbiased OLS estimates, some exhibit heteroscedasticity. To address this, we re-estimated all models using Huber-White robust standard errors to ensure reliable inference and account for potential non-constant variance issues.

B.3 Testing for autocorrelation

Table B.4 presents the Durbin-Watson test results for autocorrelation in our value-weighted regression residuals. The test is applied to both sin and comparable portfolios across the

Fama-French factor models. The null hypothesis assumes no autocorrelation (Bobbitt, 2021).

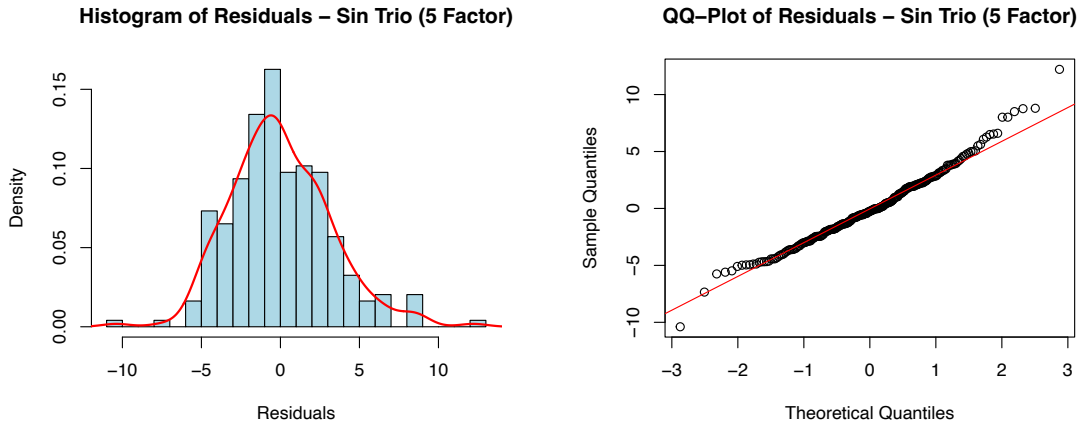
Table B.4: Durbin-Watson test results by model

	DW-Value	P-value	Rejection?	Conclusion
3 Factor				
VW Sin Trio Portfolio	2.02	0.54	no	No Autocorrelation
VW Trio Comparable Portfolio	2.16	0.89	no	No Autocorrelation
VW Weapon & Defence Portfolio	2.05	0.65	no	No Autocorrelation
VW Weapon & Defence Comparable Portfolio	2.01	0.51	no	No Autocorrelation
5 Factor				
VW Sin Trio Portfolio	2.02	0.56	no	No Autocorrelation
VW Trio Comparable Portfolio	2.20	0.94	no	No Autocorrelation
VW Weapon & Defence Portfolio	2.03	0.57	no	No Autocorrelation
VW Weapon & Defence Comparable Portfolio	1.99	0.44	no	No Autocorrelation
5 + MOM				
VW Sin Trio Portfolio	2.03	0.58	no	No Autocorrelation
VW Trio Comparable Portfolio	2.19	0.93	no	No Autocorrelation
VW Weapon & Defence Portfolio	2.00	0.48	no	No Autocorrelation
VW Weapon & Defence Comparable Portfolio	2.00	0.47	no	No Autocorrelation

The Durbin-Watson statistic ranges from 0 to 4, with values between 1.5 and 2.5 indicating no significant autocorrelation concerns. All DW values in Table B.4 fall within this acceptable range, and the high p-values confirm we cannot reject the null hypothesis of no autocorrelation. These results indicate no evidence of autocorrelation in our regression residuals, supporting the reliability of our estimates.

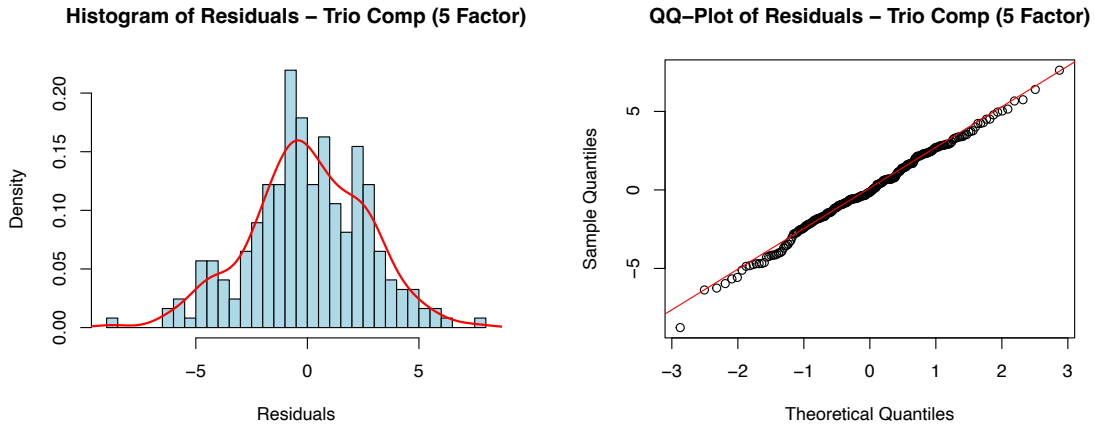
B.4 Testing for normality

We assess the normality assumption by visually inspecting histograms with density lines and Q-Q plots for the residuals of the value-weighted regression under the five-factor model specification. Figures B.1 to B.4 show that the residuals for all portfolios are reasonably centered around zero and exhibit symmetric, bell-shaped distributions with limited skewness. In addition, the Q-Q plots indicate that the residuals align closely with the diagonal line, suggesting normality in the central ranges. While minor deviations are observed in the tails, the residuals overall meet the normality assumption, supporting the reliability of the regression models.



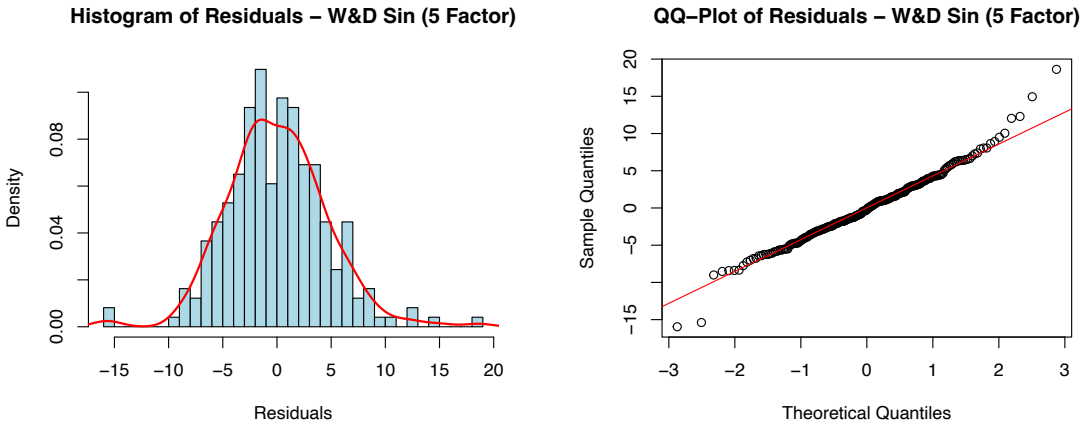
(a) Histogram of residuals **(b)** Q-Q plot of residuals

Figure B.1: Residual diagnostics for the VW Sin Trio Portfolio (5-factor model).



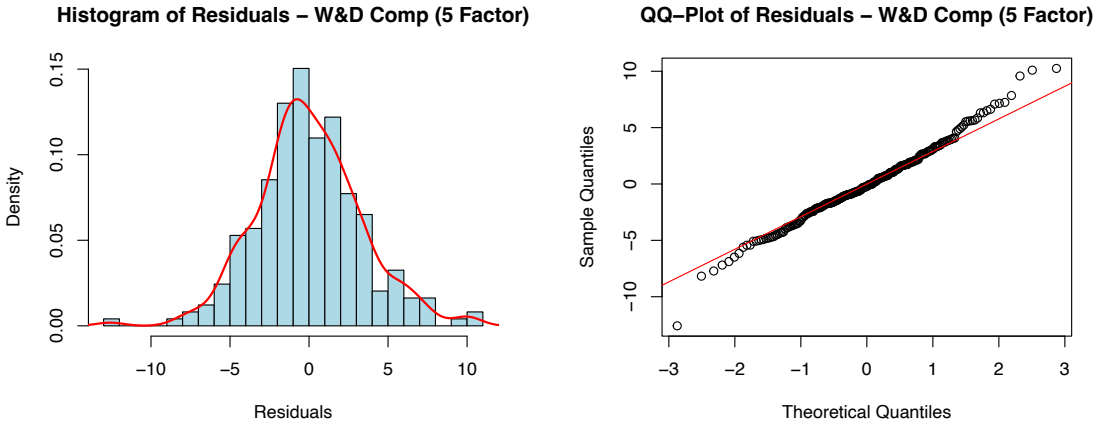
(a) Histogram of residuals **(b)** Q-Q plot of residuals

Figure B.2: Residual diagnostics for the VW Trio Comparable Portfolio (5-factor model).



(a) Histogram of residuals **(b)** Q-Q plot of residuals

Figure B.3: Residual diagnostics for the VW Weapon & Defence Portfolio (5-factor model).



(a) Histogram of residuals **(b)** Q-Q plot of residuals

Figure B.4: Residual diagnostics for the VW Weapon & Defence Comparable Portfolio (5-factor model).

B.5 Testing for stationarity

Table B.5 presents the outcomes of the Augmented Dickey-Fuller test conducted to assess stationarity. The test is conducted for the value-weighted sin and comparable portfolios, as well as the risk factors used in our regressions. "DF" denotes the test statistic, with the null hypothesis stating that the data is non-stationary. We want the data to be stationary for valid regression results. A low p-value (< 0.05) indicates that the null hypothesis can be rejected.

Table B.5: Augmented Dickey-Fuller test for unit root

Dependent Variable	**DF-Statistic**	**P-value**	**Rejection?**	**Conclusion**
VW Sin Trio Portfolio	-5.38	0.01	yes	Stationary
VW Trio Comparable Portfolio	-5.42	0.01	yes	Stationary
VW Weapon & Defence Portfolio	-5.94	0.01	yes	Stationary
VW Weapon & Defence Comparable Portfolio	-5.93	0.01	yes	Stationary
Risk Factors	**DF-Statistic**	**P-value**	**Rejection?**	**Conclusion**
Mkt-Rf	-5.97	0.01	yes	Stationary
SMB	-5.26	0.01	yes	Stationary
HML	-5.69	0.01	yes	Stationary
RMW	-6.22	0.01	yes	Stationary
CMA	-6.31	0.01	yes	Stationary
WML	-6.26	0.01	yes	Stationary

C Descriptive analysis (EW portfolios)

C.1 Total period

Table C.1: Total period overview for equally-weighted portfolios

Portfolio	Mean Return (%)	Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)	Annualised Return (%)
Sin Trio	1.15	4.31	0.83	-22.04	14.89	1222.12	13.48
Trio Comparable	0.84	3.89	0.64	-17.75	19.08	554.05	9.64
Weapon & Defence	1.22	5.39	0.71	-26.72	22.25	1292.92	13.77
Weapon & Defence Comparable	1.25	5.96	0.66	-23.85	23.48	1282.42	13.73

Notes: Mean return represents the arithmetic monthly average. Standard deviation shows monthly values. The Sharpe Ratio is annualised. Returns are equally-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest monthly returns observed during the respective period.

C.2 Sub-periods

Table C.2: Period-divided overview for equally-weighted portfolios

Panel	Portfolio	Mean Return (%)	Std. Dev (%)	Sharpe Ratio	Min Return (%)	Max Return (%)	Total Period Return (%)	Annualised Return (%)
Panel A: 2004-2007								
	Sin Trio	2.09	3.52	1.78	-7.20	9.95	162.14	27.91
	Trio Comparable	1.68	2.61	1.86	-6.24	7.25	119.06	22.18
	Weapon & Defence	2.10	3.81	1.66	-7.81	8.51	162.50	27.95
	Weapon & Defence Comparable	3.05	4.59	2.09	-11.54	9.91	302.75	42.74
Panel B: 2008-2011								
	Sin Trio	0.40	6.16	0.20	-22.04	14.89	10.05	2.48
	Trio Comparable	-0.38	5.34	-0.27	-16.95	12.65	-22.10	-6.18
	Weapon & Defence	0.13	6.45	0.05	-18.18	18.34	-3.67	-0.95
	Weapon & Defence Comparable	-0.08	8.17	-0.05	-23.85	23.48	-18.24	-5.01
Panel C: 2012-2015								
	Sin Trio	2.08	3.01	2.39	-2.73	12.07	163.04	28.02
	Trio Comparable	1.63	2.60	2.18	-5.61	6.01	114.42	21.51
	Weapon & Defence	1.89	3.79	1.73	-5.35	10.91	138.33	24.84
	Weapon & Defence Comparable	1.83	3.94	1.61	-8.33	11.05	130.86	23.82
Panel D: 2016-2019								
	Sin Trio	0.59	2.94	0.57	-6.03	6.59	29.78	6.89
	Trio Comparable	0.88	2.23	1.21	-4.78	5.68	50.59	11.02
	Weapon & Defence	1.11	4.03	0.86	-10.83	9.49	63.19	13.33
	Weapon & Defence Comparable	0.85	4.72	0.55	-10.50	12.51	42.63	9.49
Panel E: 2020-2024								
	Sin Trio	0.66	4.77	0.35	-13.23	11.97	34.24	6.90
	Trio Comparable	0.44	5.03	0.19	-17.75	19.08	18.69	3.96
	Weapon & Defence	0.93	7.41	0.35	-26.72	22.25	41.64	8.21
	Weapon & Defence Comparable	0.69	6.88	0.26	-19.39	19.46	27.50	5.66

Notes: Mean return represents the arithmetic monthly average. Standard deviation shows monthly values. The Sharpe Ratio is annualised. Returns are equally-weighted and adjusted for dividends. Min/Max Return refers to the highest and lowest monthly returns observed during the respective period.

D Regression results for Trio Comparable Portfolio

D.1 Total period

Table D.1: Regression results for the Trio Comparable Portfolio (Robust SEs)

	Model Specification: Value-Weighted				*Model Specification: Equally-Weighted*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	0.4891***	0.4883***	0.3544*	0.4095**	0.3982**	0.3535**	0.2635*	0.3632**
	(0.1774)	(0.1746)	(0.1848)	(0.1899)	(0.1596)	(0.1385)	(0.1557)	(0.1665)
Mkt-Rf	0.3848***	0.4286***	0.4657***	0.4579***	0.5723***	0.5131***	0.5016***	0.4875***
	(0.0336)	(0.0384)	(0.0437)	(0.0430)	(0.0484)	(0.0334)	(0.0364)	(0.0363)
SMB		−0.1198	−0.0577	−0.0499		0.6233***	0.6285***	0.6425***
		(0.0945)	(0.0974)	(0.0968)		(0.0852)	(0.0865)	(0.0859)
HML		−0.2289***	−0.1854	−0.2385*		0.2223***	0.3862***	0.2900**
		(0.0636)	(0.1169)	(0.1271)		(0.0741)	(0.1143)	(0.1145)
RMW			0.3392**	0.3342*			0.2843*	0.2752*
			(0.1729)	(0.1729)			(0.1590)	(0.1594)
CMA			0.2949	0.3415*			−0.0881	−0.0036
			(0.1924)	(0.1976)			(0.1398)	(0.1484)
WML				−0.0638				−0.1157**
				(0.0645)				(0.0526)
Observations	246	246	246	246	246	246	246	246
R^2	0.3587	0.3894	0.4058	0.4086	0.6036	0.7016	0.7072	0.7143
Adjusted R^2	0.3561	0.3818	0.3934	0.3938	0.6020	0.6979	0.7011	0.7072

Notes: The table presents time-series regression results for the Trio Comparable Portfolio for the full period from January 2004 to June 2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly excess return, $r_{comp,t} - r_{f,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Significant alphas are observed across all model specifications and weighting approaches, although the level of significance decreases as more factors are included. In the VW approach, the alpha remains significant at the 10% level in the five-factor model, indicating a monthly excess return of 0.4883%. In contrast, the EW approach generally shows lower

significance and factor loadings compared to VW approach. This differs from the sinful counterpart, which achieves stronger significance and factor loadings when stocks are equally weighted. The market factor consistently exhibits strong significance at the 1% level across all weighting methods and factor specifications, highlighting the portfolio's substantial market exposure.

D.2 Sub-periods

Table D.2: Regression results for the Trio Comparable Portfolio across different sub-periods (Robust SEs)

	Model Specification: Value-Weighted					*Model Specification: Equally-Weighted*				
	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)
Constant (a)	0.3075	0.0734	1.0392***	0.6426*	0.0808	0.3985	−0.1486	1.2798***	0.4037**	−0.0626
	(0.6146)	(0.5511)	(0.3484)	(0.3411)	(0.3587)	(0.3942)	(0.4448)	(0.2807)	(0.1620)	(0.3594)
Mkt-Rf	0.2791*	0.3793***	0.4205***	0.4648***	0.5932***	0.2826***	0.4367***	0.4923***	0.4954***	0.5821***
	(0.1467)	(0.0824)	(0.0880)	(0.1632)	(0.0675)	(0.0875)	(0.0562)	(0.0697)	(0.0561)	(0.0780)
SMB	−0.2087	0.0773	−0.4284***	−0.4775**	0.1450	0.4010**	0.8681***	0.1888	0.4243***	0.7248***
	(0.2968)	(0.1793)	(0.1484)	(0.2307)	(0.2401)	(0.1724)	(0.1885)	(0.1561)	(0.1485)	(0.2102)
HML	0.9072	0.2035	−0.7728***	−0.7377	−0.4534**	1.0652***	0.5279***	−0.4681**	0.0483	0.4226*
	(0.6170)	(0.2248)	(0.2446)	(0.4987)	(0.2065)	(0.3735)	(0.1940)	(0.2227)	(0.2250)	(0.2188)
RMW	−0.3159	0.7412**	−0.3933	−0.2798	0.4313	−0.4282	0.3245	−0.6083**	0.1526	0.5297*
	(0.5311)	(0.3747)	(0.3759)	(0.5328)	(0.3103)	(0.3816)	(0.3301)	(0.2660)	(0.2404)	(0.2965)
CMA	0.3039	−0.0326	0.3569	0.0348	1.1659***	−0.1147	−0.4400**	0.2498	0.0167	0.3006
	(0.4831)	(0.2473)	(0.3110)	(0.5369)	(0.4397)	(0.2541)	(0.2060)	(0.2449)	(0.2346)	(0.3710)
Observations	48	48	48	48	54	48	48	48	48	54
R^2	0.1934	0.5088	0.5048	0.4336	0.6217	0.6037	0.8215	0.5940	0.7494	0.7721
Adjusted R^2	0.0973	0.4503	0.4458	0.3662	0.5823	0.5565	0.8002	0.5457	0.7196	0.7483

Notes: The table presents time-series regression results for the Trio Comparable Portfolio across five distinct time periods: 2004-2007, 2008-2011, 2012-2015, 2016-2019, and 2020-2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly excess return, $r_{comp,t} - r_{f,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Similar to its sinful counterpart, the 2012–2015 period stands out positively, with a monthly alpha of 1.0392% significant at the 1% level. Alphas remain significant under both weighting methods from 2012 to 2019, indicating a concentration of returns during this interval. Notably, the comparable portfolio shows significant alphas during the 2016–2019 period across both weighting methods, contrasting with the lack of significance observed in its unethical counterpart. In terms of market exposure, the portfolio consistently

demonstrates significant positive loadings across all periods, confirming that the market factor accounts for a portion of the returns regardless of economic conditions.

E Robustness test: Duo Difference Portfolio

Table E.1: Regression results for the equally-weighted Duo Difference Portfolio (Robust SEs)

	Dependent variable: Sin Duo - Comp Duo			
	CAPM	3 Factor	5 Factor	5+MOM
	(1)	(2)	(3)	(4)
Constant (α)	0.0290	0.0397	0.0096	0.0466
	(0.1374)	(0.1371)	(0.1415)	(0.1584)
Mkt-Rf	0.0692**	0.0789**	0.0378	0.0326
	(0.0331)	(0.0339)	(0.0306)	(0.0325)
SMB		−0.1359*	−0.1716**	−0.1664**
		(0.0805)	(0.0748)	(0.0752)
HML		−0.0300	0.1623	0.1267
		(0.0626)	(0.1232)	(0.1026)
RMW			0.1524	0.1490
			(0.1456)	(0.1434)
CMA			−0.3221*	−0.2909*
			(0.1777)	(0.1563)
WML				−0.0428
				(0.0790)
Observations	246	246	246	246
R^2	0.0281	0.0412	0.0718	0.0749
Adjusted R^2	0.0241	0.0293	0.0524	0.0517

Notes: The table presents time-series regression results for the Duo Difference Portfolio for the full period from January 2004 - June 2024. This regression excludes gambling and gambling comparable stocks. The dependent variable for the portfolio is the monthly sin portfolio return net of the comparable portfolio return,$r_{sin,t} - r_{comp,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Table E.1 shows that the Duo Difference Portfolio does not generate significant alphas under the equal-weighted approach across any model specifications. This robustness test demonstrates that the gambling portfolio was the primary driver of our previous significant results in the Trio Difference Portfolio.

F Regression results for Weapon & Defence Comparable Portfolio

F.1 Total period

Table F.1: Regression results for the Weapon & Defence Comparable Portfolio (Robust SEs)

	Model Specification: Value-Weighted				*Model Specification: Equally-Weighted*			
	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)	CAPM (1)	3 Factor (2)	5 Factor (3)	5+MOM (4)
Constant (a)	0.8511***	0.8183***	0.8033***	0.7807***	0.5969***	0.5181***	0.4222**	0.5010**
	(0.2251)	(0.2204)	(0.2173)	(0.2318)	(0.2076)	(0.1776)	(0.1876)	(0.2000)
Mkt-Rf	0.9604***	0.9669***	0.8811***	0.8843***	0.9446***	0.9022***	0.8448***	0.8337***
	(0.0540)	(0.0544)	(0.0534)	(0.0513)	(0.0489)	(0.0408)	(0.0476)	(0.0480)
SMB		0.3115**	0.2282*	0.2250		0.9198***	0.8800***	0.8911***
		(0.1317)	(0.1365)	(0.1371)		(0.1082)	(0.1085)	(0.1093)
HML		−0.0969	0.2399*	0.2617		0.0693	0.4104***	0.3344***
		(0.0780)	(0.1421)	(0.1745)		(0.0689)	(0.1288)	(0.1217)
RMW			0.1766	0.1786			0.3723**	0.3651**
			(0.2016)	(0.2030)			(0.1791)	(0.1769)
CMA			−0.6732***	−0.6924***			−0.4481**	−0.3814**
			(0.2462)	(0.2633)			(0.1879)	(0.1765)
WML				0.0262				−0.0914
				(0.0828)				(0.0723)
Observations	246	246	246	246	246	246	246	246
R^2	0.6798	0.6896	0.7044	0.7045	0.6996	0.7748	0.7854	0.7873
Adjusted R^2	0.6785	0.6858	0.6982	0.6971	0.6983	0.7720	0.7809	0.7819

Notes: The table presents time-series regression results for the Weapon & Defence Comparable Portfolio for the full period from January 2004 to June 2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly excess return, $r_{comp,t} - r_{f,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

The VW portfolio demonstrates exceptionally strong alphas, significant at the highest level across all factor specifications. In the Fama-French five-factor model, the alpha is 0.8033%, indicating a substantial monthly abnormal return. In comparison, the EW approach yields lower alphas, suggesting that the value-weighted portfolio achieves far better abnormal returns, adjusted for risk factors. This outcome aligns with expectations, as the shift to the EW approach reduces the holding period return by 1148 percentage points, as shown in the descriptive statistics in Tables C.1 and 6.6. The market factor is significant at the 1% level across all model specifications and weighting methods, with a substantial loading. This presents an intriguing perspective, as the comparable portfolio not only delivers statistically significant abnormal returns but also exhibits substantial market exposure, which plays a major role in driving its overall performance.

F.2 Sub-periods

Table F.2: Regression results for the Weapon & Defence Comparable Portfolio across different sub-periods (Robust SEs)

	Model Specification: Value-Weighted					*Model Specification: Equally-Weighted*				
	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)	2004-2007 (1)	2008-2011 (2)	2012-2015 (3)	2016-2019 (4)	2020-2024 (5)
Constant (a)	1.1205**	0.7698	0.6630	0.5107	0.7238*	0.5305	0.5737	0.9395**	−0.0524	−0.0436
	(0.5463)	(0.6386)	(0.4597)	(0.3605)	(0.4002)	(0.4712)	(0.5546)	(0.3789)	(0.3587)	(0.4056)
Mkt-Rf	0.7379***	0.8576***	0.7420***	1.1069***	0.9314***	0.7093***	0.6778***	0.8290***	1.1197***	0.9530***
	(0.2253)	(0.1300)	(0.1049)	(0.1131)	(0.0721)	(0.1529)	(0.0944)	(0.1102)	(0.1287)	(0.0790)
SMB	0.6928*	0.1564	−0.0597	0.4950**	−0.2593	1.1003***	1.0505***	0.4556**	0.8269***	0.4440*
	(0.3545)	(0.2912)	(0.2615)	(0.2213)	(0.2522)	(0.2621)	(0.2321)	(0.2322)	(0.2504)	(0.2332)
HML	1.3576*	0.0214	−0.1011	0.0092	0.2483	1.5068***	0.7027**	−0.2475	−0.2111	0.3137*
	(0.7529)	(0.4173)	(0.3428)	(0.4285)	(0.2241)	(0.5347)	(0.2922)	(0.2611)	(0.4390)	(0.1855)
RMW	0.3348	−0.3746	−0.4819	0.3752	0.2998	0.6905	0.0794	−0.0940	0.1531	0.0599
	(0.6442)	(0.5634)	(0.5328)	(0.4793)	(0.3336)	(0.4388)	(0.4093)	(0.4683)	(0.4368)	(0.3354)
CMA	−0.6750	−0.7416**	−1.4062***	−0.0060	−0.5804	−0.2841	−0.8485***	−0.5617	0.3460	−0.3799
	(0.6560)	(0.3581)	(0.4886)	(0.4327)	(0.4372)	(0.3421)	(0.3234)	(0.3972)	(0.3797)	(0.3451)
Observations	48	48	48	48	54	48	48	48	48	54
R^2	0.4864	0.7752	0.5911	0.7517	0.8264	0.7010	0.8697	0.6136	0.7748	0.8671
Adjusted R^2	0.4253	0.7484	0.5424	0.7222	0.8083	0.6654	0.8542	0.5676	0.7480	0.8533

Notes: The table presents time-series regression results for the Weapon & Defence Comparable Portfolio across five distinct time periods: 2004-2007, 2008-2011, 2012-2015, 2016-2019, and 2020-2024. Separate results are reported for the Value-Weighted and Equally-Weighted portfolios. The dependent variable for both portfolios is the monthly excess return, $r_{comp,t} - r_{f,t}$. The constant (α) represents the monthly abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, and CMA is the Conservative-minus-Aggressive investment factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

The time-divided regressions for the comparable portfolio, seen in Table F.2, reveal a concentration of abnormal returns in the earliest and most recent periods. During the first time period, the portfolio achieves an alpha of 1.1205%, significant at the 5% level, reflecting strong monthly abnormal returns. Notably, the 2020–2024 period also shows a significant alpha at the 10% level, suggesting a resilient portfolio performance during the volatile COVID-19 crisis. This finding is particularly intriguing, as the sinful counterpart failed to produce significant alpha during this period. Additionally, the comparable portfolio's market exposure maintains consistently high loadings and significance, reaffirming the exposure observed over the total period.

G Regression results for the Russia-Ukraine war period

Table G.1: Regression results for value-weighted Weapon & Defence Difference Portfolio during the Russia-Ukraine war period (Robust SEs)

	Dependent variable: W&D Sin - W&D Comparable			
	CAPM	3 Factor	5 Factor	5+MOM
	(1)	(2)	(3)	(4)
Constant (a)	0.0660	0.0390	0.0424	0.0437
	(0.0439)	(0.0449)	(0.0439)	(0.0417)
Mkt-Rf	−0.2862***	−0.3197***	−0.2206***	−0.0706
	(0.0446)	(0.0435)	(0.0523)	(0.0537)
SMB		−0.6461***	−0.5079***	−0.1428
		(0.1686)	(0.1790)	(0.1865)
HML		0.2180*	−0.2147	−0.4455***
		(0.1129)	(0.1457)	(0.1431)
RMW			−0.4654**	−0.5678***
			(0.1986)	(0.1887)
CMA			0.7166***	0.7144***
			(0.2058)	(0.1938)
WML				0.5200***
				(0.0801)
Observations	617	617	617	617
R^2	0.0864	0.1374	0.1735	0.2431
Adjusted R^2	0.0850	0.1332	0.1667	0.2357

Notes: The table presents time-series regression results for the Weapon & Defence Difference Portfolio during the war period from February 2022 to June 2024. The dependent variable is the daily sin portfolio return net of the comparable portfolio return, $r_{sin,t} - r_{comp,t}$. The constant (α) represents the daily abnormal return in percentage. Mkt-Rf is the market factor, SMB is the Small-minus-Big size factor, HML is the High-minus-Low value factor, RMW is the Robust-minus-Weak profitability factor, CMA is the Conservative-minus-Aggressive investment factor, and WML is the Winners-minus-Losers momentum factor. Significance levels are denoted as $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Table G.1 reveals that the Difference Portfolio exhibits no significant alphas across any factor model specifications during the Russia-Ukraine war period. The analysis indicates a positive and significant loading on the momentum factor, suggesting that the Weapon & Defence Portfolio demonstrates heightened sentiment exposure during the war period

relative to its comparable portfolio.

H Overview of sample companies

Table H.1: Sin Trio Portfolio overview and exclusions

Company	Exclusions	Country of Exchange	Industry
Ambra SA	1	Poland	Alcohol
Anheuser-Busch Inbev SA	5	Belgium	Alcohol
Anora Group Oyj	2	Finland	Alcohol
Artisanal Spirits Company PLC		United Kingdom	Alcohol
Berentzen Gruppe AG	1	Germany	Alcohol
C&C Group PLC	1	United Kingdom	Alcohol
Carlsberg A/S	5	Denmark	Alcohol
Compagnia Dei Caraibi SpA	1	Italy	Alcohol
Davide Campari Milano NV	1	Italy	Alcohol
Diageo PLC	5	United Kingdom	Alcohol
Fevertree Drinks PLC		United Kingdom	Alcohol
Harboes Bryggeri A/S	1	Denmark	Alcohol
Heineken Holding NV	5	Netherlands	Alcohol
Heineken NV	5	Netherlands	Alcohol
Italian Wine Brands S.P.A.	1	Italy	Alcohol
Kopparbergs Bryggeri AB	1	Sweden	Alcohol
Lanson BCC SA		France	Alcohol
Laurent Perrier SA	1	France	Alcohol
Marie Brizard Wine and Spirits SA	1	France	Alcohol
Masi Agricola SpA	1	Italy	Alcohol
Naked Wines PLC		United Kingdom	Alcohol
Olvi Oyj		Finland	Alcohol
Pernod Ricard SA	5	France	Alcohol
Prilepska Pivarnica AD Prilep		Macedonia	Alcohol
Purcari Wineries PCL	1	Romania	Alcohol
Remy Cointreau SA		France	Alcohol
Royal Unibrew A/S	2	Denmark	Alcohol
Schloss Wachem AG	1	Germany	Alcohol
Virgin Wines UK PLC		United Kingdom	Alcohol
Viva Wine Group AB		Sweden	Alcohol
Vranken Pommery Monopole SA		France	Alcohol
Accroud AB		Sweden	Gambling
Angler Gaming PLC	3	Sweden	Gambling
B90 Holdings PLC	1	United Kingdom	Gambling
bet at home com AG	4	Germany	Gambling
Betsson AB	6	Sweden	Gambling
Entain PLC	9	United Kingdom	Gambling
Evoke PLC		United Kingdom	Gambling
Evolution AB (publ)	11	Sweden	Gambling
Gaming Innovation Group Inc	5	Norway	Gambling
Greek Organisation of Football Prognostics SA	3	Greece	Gambling
Groupe Partouche SA	1	France	Gambling
Intralot Integrated Lottery Systems and Services SA	4	Greece	Gambling
Kambi Group PLC	4	Sweden	Gambling
Kindred Group PLC	8	Sweden	Gambling
La Francaise des Jeux SA	7	France	Gambling
Lottomatica Group SpA	3	Italy	Gambling
Pferdewetten de AG	1	Germany	Gambling
Playtech PLC	5	United Kingdom	Gambling
Rank Group PLC	4	United Kingdom	Gambling
Societe Anonyme des Bains de Mer et du Cercle des Etrangers a Monaco SA		France	Gambling
ZEAL Network SE	2	Germany	Gambling
British American Tobacco plc	61	United Kingdom	Tobacco
Bulgartabac Holding AD	35	Bulgaria	Tobacco
Cantourage Group SE	0	Germany	Tobacco
Haypp Group AB (publ)	1	Sweden	Tobacco
Imperial Brands PLC	60	United Kingdom	Tobacco
Karelia Tobacco Company Inc	40	Greece	Tobacco
Philip Morris CR as	61	Czech Republic	Tobacco
Scandinavian Tobacco Group A/S	53	Denmark	Tobacco

Table H.2: Trio Comparable Portfolio overview

Company Name	Country	Comparable Industry
Spadel SA	Belgium	Alcohol
Kofola CeskoSlovensko as	Czech Republic	Alcohol
Krynica Vitamin SA	Poland	Alcohol
Coca Cola HBC AG	United Kingdom	Alcohol
A G Barr PLC	United Kingdom	Alcohol
Britvic PLC	United Kingdom	Alcohol
Nichols PLC	United Kingdom	Alcohol
Nestle SA	Switzerland	Alcohol
Kinepolis Group NV	Belgium	Gambling
Arena Hospitality Group dd	Croatia	Gambling
Liburnia Riviera Hoteli dd	Croatia	Gambling
Maistra dd	Croatia	Gambling
Plava Laguna dd	Croatia	Gambling
Valamar Riviera dd	Croatia	Gambling
Aalborg Boldspilklub A/S	Denmark	Gambling
Parken Sport & Entertainment A/S	Denmark	Gambling
Broendbyrenes IF Fodbold A/S	Denmark	Gambling
Agf A/S	Denmark	Gambling
Tallink Grupp AS	Estonia	Gambling
Accor SA	France	Gambling
Les Hotels Baverez SA	France	Gambling
Eagle Football Group SA	France	Gambling
Compagnie des Alpes SA	France	Gambling
Pierre et Vacances SA	France	Gambling
Borussia Dortmund GmbH & Co KGaA	Germany	Gambling
TUI AG	Germany	Gambling
Lampsa Hellenic Hotels SA	Greece	Gambling
Dalata Hotel Group PLC	Ireland	Gambling
I Grandi Viaggi SpA	Italy	Gambling
Juventus FC SpA	Italy	Gambling
SS Lazio SpA	Italy	Gambling
AFC Ajax NV	Netherlands	Gambling
Rainbow Tours SA	Poland	Gambling
Grand Hotel Bucharest SA	Romania	Gambling
Tatry Mountain Resorts as	Slovak Republic	Gambling
Minor Hotels Europe & Americas SA	Spain	Gambling
Scandic Hotels Group AB	Sweden	Gambling
SkiStar AB	Sweden	Gambling
Ultima Capital SA	Switzerland	Gambling
Jungfraubahn Holding AG	Switzerland	Gambling
Orascom Development Holding AG	Switzerland	Gambling
Everyman Media Group PLC	United Kingdom	Gambling
On The Beach Group PLC	United Kingdom	Gambling
XP Factory Plc	United Kingdom	Gambling
Hollywood Bowl Group PLC	United Kingdom	Gambling
Carnival PLC	United Kingdom	Gambling
PPHE Hotel Group Ltd	United Kingdom	Gambling
InterContinental Hotels Group PLC	United Kingdom	Gambling
Whitbread PLC	United Kingdom	Gambling
Greenyard NV	Belgium	Tobacco
Atlantic Grupa dd	Croatia	Tobacco
Cakovecki Mlinovi dd	Croatia	Tobacco
Podravka dd	Croatia	Tobacco
Fodelia Oyj	Finland	Tobacco
Danone SA	France	Tobacco
Kerry Group PLC	Ireland	Tobacco
Newlat Food SpA	Italy	Tobacco
Valsoia SpA	Italy	Tobacco
Chefielo AB (publ)	Sweden	Tobacco
Bakkavor Group Plc	United Kingdom	Tobacco
Premier Foods PLC	United Kingdom	Tobacco
Agrana Beteiligungs AG	Austria	Tobacco
Lotus Bakeries NV	Belgium	Tobacco
Miko NV	Belgium	Tobacco
Kras dd	Croatia	Tobacco
Savencia SA	France	Tobacco
Bonduelle SA	France	Tobacco
Veganz Group AG	Germany	Tobacco
FRoSTA AG	Germany	Tobacco
Suedzucker AG	Germany	Tobacco
Kri Kri Milk Industry SA	Greece	Tobacco
Glanbia PLC	Ireland	Tobacco
Centrale del Latte d'Italia SpA	Italy	Tobacco
Italmobiliare SpA	Italy	Tobacco
Pieno Zvaigzdes AB	Lithuania	Tobacco
Rokiskio Suris AB	Lithuania	Tobacco
Vilkyskiu Pienine AB	Lithuania	Tobacco
Zemaitijos Pienas AB	Lithuania	Tobacco
JDE Peets NV	Netherlands	Tobacco
Orkla ASA	Norway	Tobacco
Wawel SA	Poland	Tobacco
Ebro Foods SA	Spain	Tobacco
Midsona AB	Sweden	Tobacco
Cloetta AB	Sweden	Tobacco
Barry Callebaut AG	Switzerland	Tobacco
Chocoladefabriken Lindt & Spruengli AG	Switzerland	Tobacco
Emmi AG	Switzerland	Tobacco
Aryzta AG	Switzerland	Tobacco
Cake Box Holdings PLC	United Kingdom	Tobacco

Table H.3: Weapon & Defence Comparable Portfolio overview

Company Name	Country
Palfinger AG	Austria
Rosenbauer International AG	Austria
Koncar dd	Croatia
Koncar Distributivni i Specijalni Transformatori dd	Croatia
Harju Elekter Group AS	Estonia
Valmet Oyj	Finland
Rohit Oyj	Finland
Norrhydro Group Oyj	Finland
Cargotec Corp	Finland
Glaston Oyj Abp	Finland
Konecranes Abp	Finland
Metso Oyj	Finland
Ponsse Oyj	Finland
Raute Oyj	Finland
Mcphy Energy SA	France
DBT SA	France
Enogia SA	France
Alstom SA	France
Manitou BF SA	France
Exail Technologies	France
Haulotte Group SA	France
Kion Group AG	Germany
Stabilus SE	Germany
Aumann AG	Germany
Knorr Bremse AG	Germany
Traton SE	Germany
Daimler Truck Holding AG	Germany
2G Energy AG	Germany
DEUTZ AG	Germany
Krones AG	Germany
Nordex SE	Germany
KSB SE & Co KGaA	Germany
Wacker Neuson SE	Germany
Jungheinrich AG	Germany
Pfeiffer Vacuum Technology AG	Germany
Koenig & Bauer AG	Germany
technotrans SE	Germany
Marel hf	Iceland
Tesmec SpA	Italy
Vimi Fasteners SpA	Italy
Omer SpA	Italy
Iveco Group NV	Italy
Erredue SpA	Italy
Eurogroup Laminations SpA	Italy
Biesse SpA	Italy
Emak SpA	Italy
Sogefi SpA	Italy
Interpump Group SpA	Italy
Alfen NV	Netherlands
NX Filtration NV	Netherlands
Ebusco Holding NV	Netherlands
Exor NV	Netherlands
Hav Group ASA	Norway
Tekna Holding ASA	Norway
Tomra Systems ASA	Norway
Newag SA	Poland
Wielton SA	Poland
Talgo SA	Spain
Arteche Lantegi Elkartea SA	Spain
Construcciones y Auxiliar de Ferrocarriles SA	Spain
Nicolas Correa SA	Spain
Cell Impact AB (publ)	Sweden
Oxe Marine AB	Sweden
Climeon AB (publ)	Sweden
Epiroc AB	Sweden
Ferroamp AB (publ)	Sweden
Beijer Alma AB	Sweden
Impact Coatings AB (publ)	Sweden
Trelleborg AB	Sweden
Volvo AB	Sweden
SFS Group AG	Switzerland
VAT Group AG	Switzerland
Klingelnberg AG	Switzerland
Stadler Rail AG	Switzerland
Belimo Holding AG	Switzerland
Burckhardt Compression Holding AG	Switzerland
Bucher Industries AG	Switzerland
Bystronic AG	Switzerland
StarragTornos Group AG	Switzerland
Abb Ltd	Switzerland
Haydale Graphene Industries PLC	United Kingdom
Avingtrans PLC	United Kingdom
Essentra PLC	United Kingdom
Somero Enterprises Inc	United Kingdom
Rotork PLC	United Kingdom
Tanfield Group PLC	United Kingdom
MS International PLC	United Kingdom