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SIN STOCK ANOMALY DURING THE YEARS OF 2002-2021

Bachelor's Thesis
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Abstract of bachelor's thesis

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Abstract

In this paper, I investigate the monthly sin stock anomaly from years 2002-2021 on an annual basis by building value weighted, equal weighted, and equal-industry weighted portfolios consisting of U.S. sin stocks from the alcohol, tobacco, weapons (defence), and the gambling industries. The portfolios are compared to the U.S. market returns to investigate how the sin stock anomaly changes annually. In addition to understand the drivers behind sin stock portfolio returns, I investigate the alcohol, tobacco, weapons, and gambling industries' returns by building value and equal weighted portfolios for each industry and comparing them to the U.S. market returns on an annual basis. I find that sin stock portfolios do not generate significant monthly abnormal returns consistently, which cannot confirm the existence of the sin stock anomaly. Inspecting the sin stock industries individually, I find that the weapons stocks and small capitalization alcohol stocks have been important drivers of returns behind the sin stock portfolios during 2002-2021.

Keywords Sin stock, abnormal returns, anomaly, excess return

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1. Introduction

Sin stocks are stocks of companies which work in areas that are considered sinful, immoral, or socially questionable. The stocks of companies which are defined as "sin stocks" are dependent on the culture, country, political views, individual's sentiment, religion, and the current period. (Cheung and Lam 2015, Fauver and McDonald IV 2014, Hong and Kostovetsky 2012, Liston 2016, Salaber 2007) Most commonly alcohol, tobacco, gambling, sex, and weapons (defense) industry stocks are viewed as "sin stocks". Most studies include and examine alcohol, tobacco, and gambling stocks as sin stocks, since sex industry is difficult to distinguish from other industries, and companies that work in it are rare in the stock market. Also, weapons industry is sometimes left out, since in some countries and cultures weapons might not be seen as immoral, for example arguably in the U.S. (Blitz and Fabozzi 2017) Some studies in addition view nuclear energy and biotech as sinful industries, while in some countries they are viewed as important industries of the future. (Statman and Glushkov 2008, Fabozzi et al. 2008) In the future, the definition of sin stock might change to include sugar and fat industries, since they are increasingly viewed as vices. (Blitz and Fabozzi 2017) The U.S. based Vice fund is the largest fund that invests specifically in sin stocks. The Vice fund primarily invests in companies that generate most of their revenue from alcohol, tobacco, gambling, and weapons. (Investopedia) And for that reason I am including weapons stocks in my study, in addition to alcohol, tobacco and gambling stocks, as sin stocks.

With the rise of the popularity of Socially Responsible Investing (SRI) and Environmental, Social and Governance (ESG) -investing, sin stocks have been left with little attention. SRI and ESG -investing do not necessarily stay clear of sin stocks, since sin stocks can be rated highly, for example, in ESG rating. (Cayón and Gutierrez 2021) However, many socially responsible investors want to stay away from the bad reputation risk and the stigma sin stocks have. Previous studies have shown that sin stocks generate significant positive abnormal returns when compared to the market and comparable industries. (Hong and Kacperczyk 2006, Fabozzi et al. 2008) Sin stocks are also believed to be stable with their revenues and "recession proof" due to the addictive nature of their products. (Salaber 2009) With this is mind, some investors might be more inclined to invest in sin stocks in hopes of higher and more stable returns. A popular theory explaining the abnormal returns of sin stocks theorizes that the shunning of sinful industries has caused them to be undervalued compared

to others. (Hong and Kacperczyk 2006) Sin companies might enjoy monopolistic returns, as their industries have high barriers of entry which restricts competition. (Fabozzi et al. 2008) As of the discovery of the sin stock anomaly, it has received attention from researchers trying to explain the anomaly. Various researchers have tried explaining the anomaly with religious, cultural, sentimental, and political views, while some have produced evidence that with modern factors in a stock pricing model the sin stock anomaly seems to be explained. (Blitz and Fabozzi 2017, Cheung and Lam 2015, Hong and Kostovetsky 2012, Liston 2016, Salaber 2007)

In this paper, I examine sin stocks returns against excess market returns and investigate how the sin stock anomaly varies on an annual basis for the last twenty years starting from 2002. I consider stocks of companies that deal with alcohol, tobacco, weapons, and gambling as sin stocks in my study. The stocks considered in this study are from the U.S., listed in Nasdaq, Amex, or the New York Stock Exchange. U.S. excess market returns, risk-free returns, and SMB and HML -factors are available from the Kenneth French data library. (Kenneth R. French – Data library) I build value, equal, and equal industry -weighted portfolios from the sin stock sample, and I use the Fama-French Three-Factor Model (Fama and French 1993) for the regression. I also construct individual portfolios for each of the industries in this study to investigate their effect on the overall portfolio. The main research questions are, (1) if the sin stock portfolios generate abnormal returns, (2) do they generate abnormal returns every year, (3) and do these abnormal returns vary. In addition, (4) I observe if sin stocks generate significant results during years of crisis, (5) if sin stock portfolios beat the market on average and risk-adjusted returns, (6) and which specific industries drive the sin stock portfolio returns.

Results in this study show that sin stock portfolios do not produce statistically significant abnormal returns consistently during 2002-2021. The results cannot confirm the existence of the sin stock anomaly. Abnormal returns observed every year are inconsistent with relatively high variation. Low and significant market betas for sin stocks confirm the defensive nature of sin stocks, although gambling stocks are found to have high market betas. There are no significant outperformances of the market generated by the sin stock portfolios during times of crisis. Not all sin stock portfolios constructed in this study outperform the market on average and on risk-adjusted returns. From observing the individual industries considered in the sin stock portfolios, weapons stocks and small capitalization alcohol stocks have been important drivers of the sin stock portfolios returns during 2002-2021.

This paper contributes to the existing literature by investigating if the sin stock anomaly can be observed every year. As of writing this thesis, I am not aware of previous studies that have investigated the returns of sin stocks on annual basis, trying to understand if the sin stock anomaly has been stronger in some years than others, and if the sin stock anomaly varies yearly. Previous studies have largely focused on long-term abnormal returns of sin stocks. Looking into the short-term yearly abnormal returns is interesting, because sin stocks are often thought of as stable and "recession proof". (Salaber 2009) If this should be the case, the results should show that sin stocks abnormal returns are stable over time, even over the financial crisis and the COVID-19 pandemic. Additionally, sin stock anomaly is a recent finding. It is possible that the anomaly has decreased or disappeared after its finding, due to investors trying to benefit from it.

The rest of the paper is divided into five sections. In the first section, I will take a look into the existing literature. In the second section, I will present my hypotheses. In the third section, I will describe the data sample and methodology, and after that I will present the results of this study. Finally, in the fifth section, I will conclude this study.

2. Literature review

Past research has been contradictory over the cause of the abnormal results of sin stocks. Researchers have provided evidence on the existence of the positive abnormal results of sin stocks, and some researchers have then tried to explain the results with culture, religion, investor sentiment, country, political views et cetera. Direct comparison between the results can be difficult, since not all studies consider the same set of sin industries. While it is uncertain if the abnormal results of the sin stock portfolios observed in these studies can be associated directly with the "sinfulness" of these stocks, or as known as the sin stock anomaly, it is commonly accepted that the sin stocks create positive abnormal results.

Hong and Kacperczyk (2006) examined sin stocks in the U.S. using stock data from 1962-2003. They argue in their research that there is a clear societal norm against funding operations that promote human vice. They continue that the rise of socially responsible investing (SRI) as a mutual fund asset class in which managers screen their investments to rule out sinful stocks is anecdotal evidence which supports their argument. They predict that institutional investors have less ownership in sin stocks

than in their comparable stocks. Consistent with the prediction, they find out that sin stocks have less institutional ownership, and in addition receive less analyst coverage, than their comparable stocks. Since institutional investors neglect sin stocks, they predict based on the work of Merton (1987) that sin stocks should be cheaper than other stocks, and hence they should outperform comparables. Furthermore, they predict that the prices of sin stocks should have higher expected returns than comparables, because their prices are depressed in relation to their fundamental values. They find out that sin stocks outperform their comparables by 39 basis points per month when using Fama-French factors and the momentum factor in their regression. Hong and Kacperczyk then conclude that social norms have significant effects on stock markets.

Fabozzi, Ma and Oliphant (2008) find similar results with Hong and Kacperczyk (2006) in their study. Fabozzi, Ma and Oliphant (2008) use a sample from 21 different countries from 1970 to 2007. They find out that in their sample average sin stock produced an average annual return of 19.02%, while the average annual stock market return was 7.87%. They argue that the returns could be explained by not conforming to social standards, as it costs firms to uphold such standards. They also find evidence which is consistent with the argument that sin stocks are initially underpriced due to their negative reputation. They also argue that sin companies enjoy monopolistic returns based on their results, and the fact that the sin industry companies are hard to start, closely monitored, and severely disciplined by the social opinion. Evidence supporting this claim that sin companies are disciplined more than others by the social opinion can be found from Leventis, Hasan and Dedoulis (2013) paper, where they find that audit companies charge significantly higher fees for services to companies which do not comply with social norms.

Blitz and Fabozzi (2017) find evidence in their study that there is no sin stock anomaly. In their research, they use global data up until the end of 2016, and apply in addition to the classic Fama-French factors and the momentum factor controls for three new factors: profitability and investment (Fama and French, 2015), and betting against beta factor (Frazzini and Pedersen 2014). Consistent with the previous studies of Hong and Kacperczyk (2006) and Fabozzi, Ma and Oliphant (2008), they find that controlling for the classic factors of size, value and momentum, sin stocks create highly significant alphas and seem to confirm the existence of the sin stock anomaly. However, adding the new factors of profitability, investment, and betting against beta to their regression, they find out that the alpha produced by the sin stocks becomes statistically indistinguishable from zero and that all three of the new factors are significant and seem to fully explain the abnormal results of sin stocks. Based on these results, they argue that the sin stock anomaly is resolved. In their words: “There is

nothing mysterious about the performance of sin stocks: it is exactly what one would expect based on their exposure to factors that are included in current asset pricing models." They continue by adding that their results do not imply that excluding sin stocks has no effect on financial performance, since as long as sin stocks are exposed to factors that are rewarded with positive premiums, like the new Fama-French factors, their raw expected return remains higher than of the market, meaning that exclusion of sin stocks would have negative impact on raw expected portfolio return.

Salaber (2009) examined U.S. sin stocks over the period of 1926-2005 in her study. She found out that when accounting for changing economic conditions the evidence that past research had shown of abnormal returns of sin stocks to comparables (Hong and Kacperczyk 2006) is not valid. Her results show that sin stocks create abnormal returns relative to the market, but the abnormal returns disappear, when comparing sin stocks to industry-comparable stocks. She finds that the abnormal return relative to the market is earned during recessions and that sin stocks do not generate abnormal returns during market expansions. She presents that time-varying risk premiums could explain the out-performance of sin stocks in the long run relative to the market, since their abnormal returns disappear when using when using risk premiums as information variables. In addition, she argues that the characteristics of sin stocks can be obtained from other defensive stocks, since she finds out that sin stocks do not behave differently from their comparable stocks.

Other studies of sin stocks have presented evidence of culture (Cheung and Lam 2015), investor sentiment (Liston 2016), countries (Fauver and McDonald IV 2014), ethical preferences (Collonello et al. 2019), political views (Hong and Kostovetsky 2012), religion (Salaber 2007) and legal characteristics (Salaber 2007) affecting sin stock returns. Durand et al. (2013) have also found that sin stocks have a connection with their opposite stocks, stocks of virtuous companies, which they call "saints". They find that where sin stocks provide positive or negative returns, the saints do the opposite. However, this division between saints and sinners is not clear. Stocks with both characteristics of saints and sinners have been studied by Lam et al. (2015). In their study they examined stocks of socially ambiguous "grey" firms and found out that portfolio of "grey" stocks earns abnormal returns. Moreover, Alessandrini and Jondeau (2019) investigate ESG investing. In their research they describe how socially responsible investing (SRI) has changed from shunning sin stocks to cover environmental, social, and governance (ESG) criteria, in which, sin stocks might be rated highly instead of completely being excluded. What has been sinful in the past, might not be seen as sinful today.

3. Hypotheses

Based on the previous studies having abnormal positive returns using U.S. sin stock data, I expect to find positive abnormal returns for the value weighted, equal weighted, and the equal industry weighted sin stock portfolios over the market returns. This is examined by doing time series regressions in which I use the classical Fama-French 3-factor model, as used in previous studies. (Fama and French 1993) The portfolios and market returns are net of risk-free rates.

I expect to find that sin stock portfolios generate positive monthly abnormal returns every year. Sin stocks being defensive, stable due to their addictive nature of products and "recession proof", as described in previously cited literature, I expect that these abnormal returns generated by the portfolios do not vary a lot, and I expect that especially during the financial crisis of 2007-2008, and the recent COVID-19 pandemic, sin stocks have performed well when compared to the market. These are examined by adding dummy variables for every year to the previous Fama-French 3-factor model. As a result, I get monthly abnormal returns the sin stock portfolios generated every year. Variation of the abnormal returns is analyzed using standard deviation. In short, I expect to find positive abnormal returns for every year with little variation.

In addition, I examine individual industry portfolios to understand which specific industries drive the results of the sin stock portfolios. I observe the cumulative returns of the sin stock portfolios, industry portfolios, and the market. I expect that the sin stock portfolios beat the market during 2002-2021 with average, and risk-adjusted returns. From the industry portfolios I expect to find over-, and underperformances as compared to the market.

4. Data and methodology

4.1 Selection and preparation of the data

Like previous studies and the U.S. based Vice fund, I chose to include alcohol, tobacco, weapons, and gambling industries in my study. Following Hong and Kacperczyk's (2006) method of sin stock identification, I begin with the Fama and French (1997) classification of stocks into 48 industries. In the classification, industry group 4 represents beer and alcohol, group 5 represents smoking/tobacco,

and group 26 represents guns, weapons, and defense. Therefore, stocks with the Standard Industrial Classification (SIC) code of 2080-2085 are identified as alcohol stocks, 2100-2199 are tobacco stocks, and 3760-3769, 3795, and 3480-3489 are weapons stocks. (Kenneth R. French – Data Library) The Fama-French classification does not separate gambling stocks into its own group. Again, similarly to Hong and Kacperczyk (2006), I use North American Industry Classification System (NAICS) classification to identify gambling stocks. NAICS codes of 7132, 71312, 713210, 71329, 713290, 72112, and 721120 represent stocks with any form of gambling activity. (NAICS Association)

Next, I download monthly information from every stock listed in Nasdaq, Amex, or NYSE from 2002-2021 from CRSP from WRDS. The data I download includes unique security identification number for every stock (PERMNO), date, share code, exchange code, SIC code, ticker, company name, NAICS code, share volume, numbers of shares outstanding, price, shares observation end date, date of next available information, delisting price, delisting return, and cumulative factors to adjust prices and shares. Since I only want to include stocks in my data, I only include stocks with share codes of 10 and 11 in my data, which represent 'Ordinary Common Shares'. (CRSP Data Descriptions Guide) Because CRSP data is not automatically adjusted for share issues and delisting prices, I also download factors to adjust share prices, shares outstanding and delisting prices. Next, I filter the downloaded data just to include information of stocks with the SIC, NAICS, and share codes mentioned earlier. To make sure that the stocks left are listed in NYSE, Amex, and Nasdaq, I check that their exchange codes are 1, 2, or 3, which represent the exchanges. Finally, I adjust the share prices, shares outstanding and include delisting prices using the downloaded factors. The distribution of shares in the data is presented in Table 1.

Excess market returns, risk-free returns, high-minus-low, and small-minus-big -factors are available from the Kenneth R. French data library.

Table 1. Yearly distribution of shares by their industry

Year	Alcohol	Tobacco	Weapons	Gambling	Total
2002	19	5	9	24	38
2003	17	5	9	24	38
2004	17	5	10	25	40
2005	14	5	10	23	38
2006	14	5	11	27	43

2007	13	7	10	26	43
2008	13	9	10	22	41
2009	11	8	10	21	39
2010	12	7	10	18	35
2011	13	7	9	17	33
2012	13	6	7	18	31
2013	12	6	6	18	30
2014	13	8	5	16	29
2015	13	8	5	9*	22
2016	13	7	5	9	21
2017	13	6	9	9	24
2018	13	5	9	9	23
2019	12	5	9	9	23
2020	11	5	8	2*	15
2021	10	4	9	1	14

* During 2014-2015 and 2019-2020 a relatively high number of gambling companies were either delisted, defaulted, merged, or changed their industry. Either way, NAICS codes do not identify these companies as gambling companies anymore.

4.2 Building the portfolios

4.2.1 Value weighted portfolios

Value weighted portfolios are built for the whole sin stock portfolio, as well as for every industry. In total there are five value weighted portfolios: value weighted sin stock portfolio, value weighted alcohol stock portfolio, value weighted tobacco stock portfolio, value weighted weapons stock portfolio, and value weighted gambling stock portfolio.

Value weighted portfolios are built by weighing the stocks in the portfolio by their percentage share of the sum of the companies' values considered in the portfolio. Companies and industries with higher total value (market capitalization) have a higher weight in the portfolio than those with a lower value. The portfolios are rebalanced monthly. Trading costs and taxes are not taken into account when rebalancing the portfolios.

4.2.2 Equal weighted portfolios

Equal weighted portfolios are built for sin stocks and the individual industries. As per the value weighted portfolios, there are five equal weighted portfolios: for sin stocks, alcohol stocks, tobacco stocks, weapons stocks, and gambling stocks.

Equal weighted portfolios are built by having equal weight for every stock in the portfolio, which is calculated as 1/n, where n is the number of stocks in the portfolio. Equally weighing the stocks gives smaller market capitalization stocks and industries with a higher number of companies higher weight in the portfolio. The portfolios are rebalanced monthly. Trading costs and taxes are not taken into account when rebalancing the portfolios.

4.2.3 Equal Industry weighted portfolio

In the equal industry weighted portfolio, every industry is weighted equally. Every industry's weight is one quarter of the total since there are four industries in this study, and this is then equally divided for every stock in the industry. Equal industry weight portfolio consists of all the sin stocks in this study. Equally weighing the industries makes sure that industries higher in value do not have higher weight in the portfolio. The portfolio is rebalanced monthly. Trading costs and taxes are not taken into account when rebalancing the portfolio.

4.3 Methodology

4.3.1 Fama and French Three factor model

As used in previous studies, I use the Fama and French Three factor model initially to confirm if the sin stock portfolios in this study produce positive abnormal returns. The individual industry portfolios are additionally observed to understand the drivers behind the sin stock portfolio returns. (Fama and French 1993)

$$Pr_{it} - Rf_t = \alpha_i + \beta_1(Mr_t - Rf_t) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_t$$

Where:

Pr_{it} = portfolio i return at time t

Rf_t = risk-free return at time t

α_i = the abnormal return of portfolio i

$\beta_1, \beta_2, \beta_3$ = factor coefficients

Mr_t = market return at time t

SMB_t = small minus big factor at time t

HML_t = high minus low factor at time t

ε_t = error term

4.3.2 Fama and French Three factor model with dummy variables for every year

In addition to the Fama and French Three factor model, I include dummy variables for every year, except for the last year (year 2021) since that would lead to multicollinearity. Leaving the last year out of the regression means that the constant, α, is equal to the value of the last year's (year 2021) abnormal return.

$$Pr_{it} - Rf_t = \alpha_i + \beta_1(Mr_t - Rf_t) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 Y2002DUM + \cdots + \beta_{22} Y2020DUM + \varepsilon_t$$

Where:

Pr_{it} = portfolio i return at time t

Rf_t = risk-free return at time t

α_i = the abnormal return of year 2021

$\beta_1, \dots, \beta_{22}$ = factor coefficients

Mr_t = market return at time t

SMB_t = small minus big factor at time t

HML_t = high minus low factor at time t

$Y2002DUM, \dots, Y2020DUM$ = dummy variables for years 2002 to 2020

ε_t = error term

4.3.3 Robustness tests

To test the robustness of the results, I test for autocorrelation and heteroscedasticity. Autocorrelation means that the level of the error term in the regression is predictable by the past error terms, and heteroscedasticity means that the variance in the error terms is predictable by the explanatory variables in the regression. Both are in violation of the Independent and identically distributed random variables (i.i.d.) assumption, that the error terms are independent of each other and identically distributed. Autocorrelation is also in violation of the assumption that the error terms are uncorrelated. If autocorrelation and/or heteroscedasticity exists in the regressions, hypothesis testing using regular standard errors is invalid. Autocorrelation test is done using the Breusch-Godfrey test, and heteroscedasticity is tested with the Breusch-Pagan test. (Breusch 1978, Godfrey 1978, Breusch and Pagan 1979) As a result, the regressions produce results with robust t-statistics.

4.3.4 Standard deviation and the coefficient of variation

Standard deviation is used to measure the amount of variation in the abnormal returns of different sin stock portfolios. Standard deviation is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N}}$$

Where:

s = standard deviation

N = sample size

x_i = observation value i

$\bar{x}$ = mean of the observations in the sample

The denominator is N instead of N – 1, because I observe variation in a particular set of data.

5. Results

5.1 Sin stock portfolio returns

5.1.1 Fama and French Three factor model

Value weighted sin stock portfolio generated a monthly 3-factor alpha of 0.1%, equal weighted portfolio generated a monthly 3-factor alpha of 0.35%, and the equal industry weighted portfolio generated a monthly 3-factor alpha of 0.36%. However, only the alpha generated by the equal industry weighted portfolio was statistically significant, at the 10% level. The other alphas generated were not statistically significant. R-squared values indicate how high percentage of the variability in the target variables are explained by the regression model. Table 2. presents alphas, robust t-statistics, factors for the market beta (MKT), small-minus-big (SMB), and high-minus-low (HML), and the R-squared for the regressions.

Table 2. Sin portfolios Fama and French 3-factor model

	SIN-VA	**SIN-EQ**	**SIN-EI**
ALPHA	0.0010	0.0035	0.0036*
	(0.50)	(1.62)	(1.69)
MKT	0.82***	0.89***	0.89***
	(13.38)	(13.82)	(15.57)
SMB	-0.24**	0.70***	0.62***
	(-2.54)	(6.16)	(5.86)

HML	0.17**	0.24**	0.25**
	(2.02)	(2.21)	(2.65)
R-squared	0.59	0.66	0.68

Significances: * 10%, ** 5%, *** 1%. SIN-VA = value weighted, SIN-EQ = equal weighted, SIN-EI = equal industry weighted.

As only the equal industry weighted portfolio alpha is statistically significant, it cannot confirm the hypothesis of finding abnormal results for sin stocks, as the results of previous studies have shown. The market betas for every portfolio are under the value of 1, and significant at the 1% level, implying that sin stocks are less sensitive compared to the overall stock market, and confirming the defensive nature of sin stocks. The SMB, and HML -factors are all significant, either at the 5% or the 1% level. The negative SMB factor for value weighted portfolio implies that the portfolio behaves like large company stocks, which is in line with value weighting. Positive coefficients for SMB for equal and equal industry portfolios imply small company like behavior, which is as well in line with equal weighting. Positive HML factors are in line with previous literature, often describing sin companies having higher book-to-market ratios than others, due to investors shunning them (Hong and Kacperczyk 2006).

5.1.2 Fama and French Three factor model with dummy variables for every year

Table 3. presents the findings for the sin stock portfolio regressions with dummy variables for each year. Since the last year (year 2021) was left out from the regression, the value of alpha, α, equals the value of the last years' coefficient. In these results the 'base' result is the value for α. Meaning that the coefficients of years 2002 to 2020 are compared to the value of α. For example, the coefficient of Y2004 in SIN-EI is interpreted as $(-0.0147) + 0.0433 = 0.0286$. The statistical significances of the year coefficients are also compared against the value of α, instead of 0. The market betas for every portfolio are statistically significant, and under the value of 1, suggesting that sin stock portfolios are less volatile than the market portfolio, confirming the defensive nature of sin stocks. SMB and HML -factors are also in line with the findings from the first regressions.

Table 3. Sin portfolios Fama and French 3-factor model with dummy variables

	SIN-VA	**SIN-EQ**	**SIN-EI**
ALPHA (Y2021)	-0.0118	-0.0101	-0.0147
	(-1.13)	(-1.05)	(-1.42)
MKT	0.84***	0.84***	0.85***
	(10.57)	(15.70)	(16.85)
SMB	-0.25**	0.68***	0.59***

	(-2.57)	(6.05)	(6.08)
HML	0.14	0.28***	0.28***
	(1.42)	(2.62)	(3.04)
Y2002	0.0317	0.0187	0.0194
	(1.37)	(1.03)	(1.03)
Y2003	0.0083	0.0243**	0.0350***
	(0.65)	(2.40)	(2.90)
Y2004	0.0191*	0.0391***	0.0433***
	(1.70)	(2.77)	(3.02)
Y2005	0.0075	0.0048	0.0070
	(0.65)	(0.41)	(0.59)
Y2006	0.0247*	0.0188	0.234**
	(1.97)	(1.60)	(2.18)
Y2007	0.0171	0.0070	0.0105
	(1.23)	(0.63)	(0.88)
Y2008	0.0111	-0.0168	0.0012
	(0.81)	(-1.54)	(0.10)
Y2009	0.0121	0.0324	0.0319
	(1.011)	(1.25)	(1.54)
Y2010	0.0244*	0.0179	0.0227*
	(1.90)	(1.56)	(1.76)
Y2011	0.0258**	0.0104	0.0200*
	(2.33)	(0.94)	(1.77)
Y2012	0.0058	0.0169	0.0217*
	(0.47)	(1.40)	(1.73)
Y2013	0.0120	0.0272**	0.0301**
	(1.00)	(2.39)	(2.27)
Y2014	0.0074	0.0056	0.0075
	(0.64)	(0.47)	(0.64)
Y2015	0.0214*	0.0216*	0.0261**
	(1.72)	(1.71)	(2.10)
Y2016	0.0111	-0.0007	0.0042
	(0.84)	(-0.06)	(0.31)
Y2017	0.0138	0.0240*	0.0269**
	(0.97)	(1.84)	(2.13)
Y2018	-0.0121	0.0045	0.0099
	(-1.05)	(0.45)	(0.92)
Y2019	0.0127	0.0116	0.0175
	(0.93)	(1.07)	(1.41)
Y2020	-0.0009	0.0139	0.0136
	(-0.08)	(1.29)	(1.14)
R-squared	0.64	0.70	0.71

Significances: * 10%, ** 5%, *** 1%. SIN-VA = value weighted, SIN-EQ = equal weighted, SIN-EI = equal industry weighted.

Interpretations of the coefficients, average values, and standard deviations are presented in Table 4. From the table, it can be observed that sin stock portfolios do not generate positive monthly abnormal returns every year.

Table 4. Interpreted values

	SIN-VA		SIN-EQ		SIN-EI	
Y2002	0,0199		0,0086		0,0047	
Y2003	-0,0035		0,0142	**	0,0203	***
Y2004	0,0073	*	0,029	***	0,0286	***
Y2005	-0,0043		-0,0053		-0,0077	
Y2006	0,0129	*	0,0087		0,0087	**
Y2007	0,0053		-0,0031		-0,0042	
Y2008	-0,0007		-0,0269		-0,0135	
Y2009	0,0003		0,0223		0,0172	
Y2010	0,0126	*	0,0078		0,008	*
Y2011	0,014	**	0,0003		0,0053	*
Y2012	-0,006		0,0068		0,007	*
Y2013	0,0002		0,0171	**	0,0154	**
Y2014	-0,0044		-0,0045		-0,0072	
Y2015	0,0096	*	0,0115	*	0,0114	**
Y2016	-0,0007		-0,0108		-0,0105	
Y2017	0,002		0,0139	*	0,0122	**
Y2018	-0,0239		-0,0056		-0,0048	
Y2019	0,0009		0,0015		0,0028	
Y2020	-0,0127		0,0038		-0,0011	
Y2021	-0,0118		-0,0101		-0,0147	
Average	0,0009		0,0040		0,0039	
Standard deviation	0,0101		0,0125		0,0115	

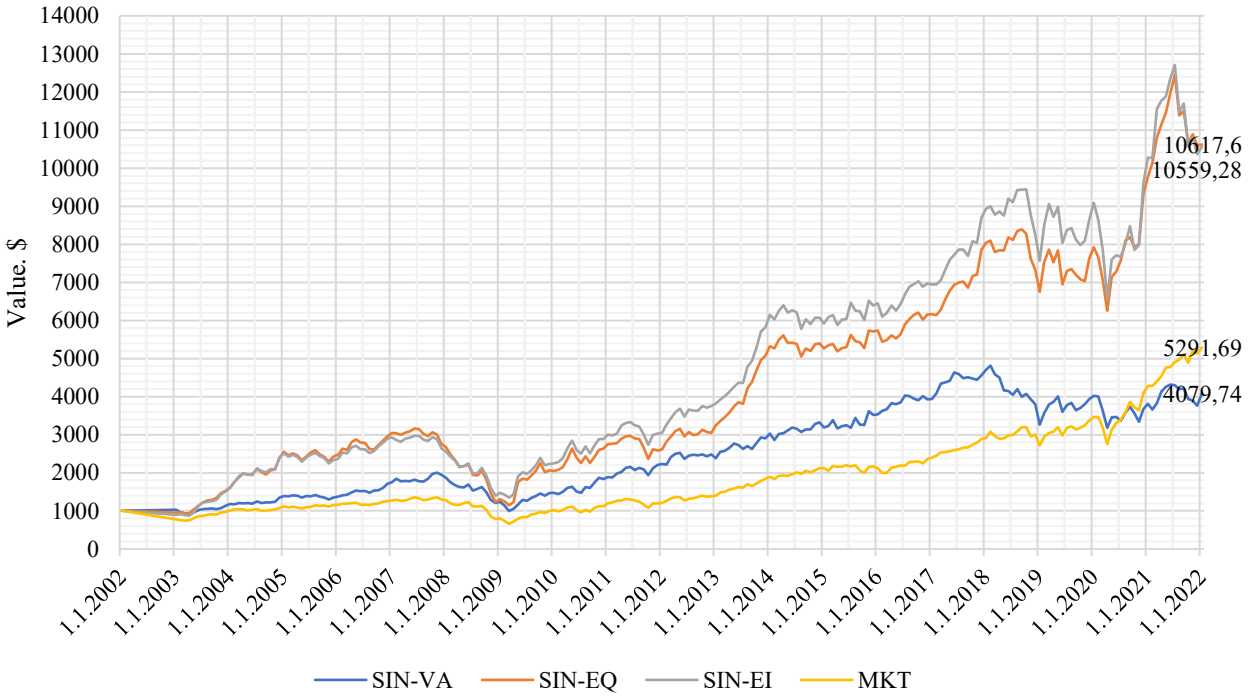
Significances: * 10%, ** 5%, *** 1%. SIN-VA = value weighted, SIN-EQ = equal weighted, SIN-EI = equal industry weighted.

On average, every portfolio generated positive monthly abnormal returns, although most of the returns in the sample are statistically insignificant. The hypothesis of finding positive abnormal returns for every year does not hold. Equal weighted portfolio performed the best, generating 0.40% monthly abnormal returns on average, while equal industry weighted portfolio generated 0.39%, and value weighted portfolio generated 0.09%. The standard deviations of the abnormal returns are relatively high when compared to their means, over 1% in every portfolio. This goes against the hypothesis of finding abnormal returns with little variation. In addition, there are no significant outperformances of the market during the financial crisis of 2007-2008, and the recent COVID-19 pandemic in 2020-2021, which goes against the expectations.

5.1.3 Cumulative returns of the sin stock portfolios and the market

Figure 1. presents the returns of the sin stock portfolios and the market during 2002-2021.

Figure 1.The cumulative returns of the sin stock portfolios and the market



SIN-VA = value weighted, SIN-EQ = equal weighted, SIN-EI = equal industry weighted., MKT = market.

As per the figure shows, equal and equal industry weighted sin stock portfolios beat the market during 2002-2021 while the value weighted portfolio lost to the market. With a starting value of $1000 in January 2002, the value weighted portfolio increased to $4079.74 in January 2022, with an average monthly return of 0.69% and a geometric mean of 0.59%. During the same period, equal weighted portfolio increased to $10617.60 with an average monthly return of 1.16% and a geometric mean of 0.99%, equal industry weighted portfolio increased to $10559.28, with an average monthly return of 1.15% and a geometric mean of 0.99%, and the market increased to $5291.69, with an average monthly return of 0.79% and a geometric mean of 0.70%. The annualized Sharpe ratios (Sharpe 1994) for the portfolios are the following: 0.52 for the value weighted, 0.67 for the equal weighted, 0.69 for the equal industry weighted, and 0.63 for the market, meaning that even with risk-adjusted returns, the equal and equal industry weighted portfolios beat the market. The hypothesis of every sin stock portfolio beating the market does not hold.

5.2 Sin industry portfolio returns

In order to understand the drivers behind the sin stock portfolios' returns, in this section the individual industry portfolios are observed.

5.2.1 Fama and French Three factor model

Table 5. presents the industry portfolios. Only the value weighted weapon portfolio generated statistically significant positive abnormal returns out of the value weighted industries, generating a monthly 0.58% abnormal return. Out of the equal weighted portfolios, both alcohol and weapon equal weighted portfolios generated positive abnormal returns, being 0.51% and 0.81% respectively. Every portfolio has a significant market beta coefficient. Being the outliers, both gambling stock portfolios have a market beta of over 1, implying that the gambling industry is more volatile than the market overall. Other industry portfolios have a market beta which is less than 1, implying that these industries are defensive and less reactive to market changes. The SMB factors are typical for the value weighted portfolios, being indicative of behaving like stocks of large companies, although the SMB factor for alcohol value weighted is insignificant, and the SMB factor for gambling value portfolio is high, implying that even with value weighting, gambling stocks behave like stocks of small companies. Positive values for HML factors are in line with the previous findings, and typical for sin stocks. These results show that the weapons industry, and small capitalization alcohol companies might be an important driver driving the sin stock portfolio returns. What is notable, however, is that many of the values of R-squared are small, meaning that the regression models do not explain their variations very well.

Table 5. Industry portfolios Fama and French 3-factor model

	A-VA	**T-VA**	**W-VA**	**G-VA**	**A-EQ**	**T-EQ**	**W-EQ**	**G-EQ**
ALPHA	0.0036	0.0017	0.0058*	-0.0043	0.0051*	0.0017	0.0081*	-0.0007
	(1.27)	(0.53)	(1.92)	(-0.78)	(1.84)	(0.37)	(1.85)	(-0.19)
MKT	0.67***	0.77***	0.67***	1.67***	0.82***	0.67***	0.77***	1.29***
	(8.57)	(9.27)	(5.14)	(9.08)	(10.91)	(6.03)	(7.64)	(10.16)
SMB	-0.19	-0.62***	-0.10	0.81**	0.22**	0.33	0.93***	1.01***
	(-1.61)	(-3.71)	(-0.53)	(2.58)	(1.98)	(1.36)	(5.53)	(4.18)
HML	0.11	0.24**	0.23*	0.71***	0.21*	0.32**	-0.17	0.65***

	(1.02)	(2.44)	(1.79)	(2.84)	(1.74)	(2.28)	(-1.00)	(3.41)
R-squared	0.35	0.32	0.27	0.49	0.47	0.19	0.32	0.55

Significances: * 10%, ** 5%, *** 1%. A-VA = alcohol value weighted, A-EQ = alcohol equal weighted, T-VA = tobacco value weighted, T-EQ = tobacco equal weighted, W-VA = weapons value weighted, W-EQ = weapons equal weighted, G-VA = gambling value weighted, G-EQ = gambling equal weighted

5.2.2 Fama and French Three factor model with dummy variables for every year

Table 6. presents the findings for the industry portfolio regressions with dummy variables for each year. As per in the sin stock portfolio regressions, α, takes the value of the year 2021 coefficient. The coefficient values for the year variables are to be interpreted similarly as in the sin stock portfolio regression results.

Table 6. Industry portfolios Fama and French 3-factor model with dummy variables

	A-VA	T-VA	W-VA	G-VA	A-EQ	T-EQ	W-EQ	G-EQ
ALPHA								
(Y2021)	-0.0161	-0.0066	-0.0128	-0.0563***	-0.0078	-0.0024	-0.0010	-0.0476***
	(-0.97)	(-0.49)	(-1.24)	(-3.78)	(-0.49)	(-0.34)	(-0.05)	(-3.38)
MKT	0.74***	0.79***	0.69***	1.61***	0.72***	0.70***	0.75***	1.24***
	(9.82)	(9.61)	(4.30)	(6.94)	(11.14)	(6.68)	(8.08)	(8.95)
SMB	-0.24**	-0.66***	-0.0470	0.79***	0.23**	0.29	0.84***	1.01***
	(-2.19)	(-3.75)	(-0.24)	(2.93)	(2.19)	(1.27)	(4.42)	(4.81)
HML	0.13	0.21*	0.2031	0.81**	0.27**	0.29*	-0.18	0.74***
	(1.11)	(1.74)	(1.21)	(2.52)	(2.58)	(1.94)	(-1.08)	(4.27)
Y2002	0.0358	0.0159	0.0431	0.0872***	0.0120	-0.0156*	0.0130	0.0684***
	(1.55)	(0.69)	(1.34)	(3.40)	(0.69)	(-1.87)	(0.30)	(3.06)
Y2003	0.0120	0.0257	-0.0067	0.0287**	0.0073	0.0261	0.0594**	0.0473***
	(0.71)	(1.01)	(-0.39)	(2.12)	(0.41)	(1.38)	(2.55)	(3.31)
Y2004	0.0109	0.0156	0.0166	0.0725***	0.0227	0.0328***	0.0405	0.0771***
	(0.62)	(0.79)	(0.98)	(4.94)	(1.31)	(2.93)	(1.49)	(3.92)
Y2005	0.0007	0.0121	0.0134	0.0458**	0.0157	-0.0076	-0.0227	0.0423**
	(0.04)	(0.81)	(0.97)	(2.49)	(0.98)	(-0.65)	(-1.10)	(2.25)
Y2006	0.0171	0.0128	0.0289**	0.0705***	0.0243	0.0154	0.0039	0.0497***
	(0.92)	(0.86)	(2.18)	(4.16)	(1.44)	(1.29)	(0.20)	(3.07)
Y2007	0.0171	0.0006	0.0253*	0.0795***	0.0044	-0.0066	-0.0060	0.0502***
	(0.94)	(0.04)	(1.86)	(2.91)	(0.24)	(-0.36)	(-0.18)	(3.31)
Y2008	0.0599**	0.0119	0.0172	-0.0036	-0.0252	0.0306*	-0.0006	0.0000001
	(2.30)	(0.67)	(1.16)	(-0.15)	(-1.52)	(1.79)	(-0.02)	(0.00)
Y2009	0.0021	0.0111	0.0019	0.0974**	0.0422**	-0.0021	0.0187	0.0689
	(0.09)	(0.75)	(0.11)	(2.42)	(2.05)	(-0.17)	(0.73)	(1.56)
Y2010	0.0295	0.0193	0.0068	0.0924***	0.0289	0.0265	-0.0143	0.0499***
	(1.47)	(1.11)	(0.51)	(4.28)	(1.39)	(1.42)	(-0.52)	(3.25)
Y2011	0.0110	0.0271*	0.0309**	0.0591**	-0.0103	0.0318	0.0154	0.0432**
	(0.52)	(1.77)	(2.41)	(2.17)	(-0.62)	(1.61)	(0.68)	(2.21)
Y2012	0.0216	-0.0001	0.0253	0.0409**	0.0101	-0.0023	0.0304	0.0484**
	(1.15)	(-0.01)	(1.45)	(2.11)	(0.62)	(-0.12)	(1.56)	(2.22)
Y2013	0.0293	-0.0007	0.0422***	0.0565***	0.0457**	-0.0141	0.0420	0.0470***
	(1.57)	(-0.05)	(2.70)	(3.43)	(2.22)	(-1.31)	(1.22)	(3.40)
Y2014	0.0296	0.0043	0.0263*	0.0224	0.0232	-0.0181	-0.0039	0.0287*
	(1.62)	(0.29)	(1.86)	(1.20)	(1.24)	(-1.22)	(-0.20)	(1.78)
Y2015	0.0367**	0.0205	0.0250*	0.0404**	0.0198	-0.0020	0.0177	0.0690***
	(1.99)	(1.40)	(1.65)	(2.07)	(1.20)	(-0.06)	(0.68)	(3.52)
Y2016	0.0086	0.0082	0.0142	0.0416	-0.0019	-0.0152	0.0029	0.0311*
	(0.46)	(0.52)	(1.13)	(1.47)	(-0.10)	(-0.81)	(0.10)	(1.92)
Y2017	0.0256	0.0030	0.0225**	0.0690***	0.0275	0.0228**	-0.0187	0.0760***
	(1.41)	(0.15)	(2.01)	(3.37)	(1.34)	(2.02)	(-0.96)	(4.87)
Y2018	-0.0028	-0.0220	0.0008	0.0445	-0.0086	-0.0061	0.0074	0.0467***
	(-0.15)	(-1.11)	(0.05)	(1.47)	(-0.52)	(-0.36)	(0.37)	(2.89)
Y2019	0.0167	0.0010	0.0281*	0.0618***	0.0130	0.0067	-0.0109	0.0613***
	(0.89)	(0.04)	(1.94)	(4.13)	(0.70)	(0.21)	(-0.55)	(4.16)
Y2020	0.0245	-0.0028	0.0041	0.0460	0.0225	-0.0241	0.0141	0.0421*
	(1.26)	(-0.19)	(0.25)	(1.46)	(1.28)	(-1.17)	(0.50)	(1.72)
R-squared	0.43	0.35	0.33	0.53	0.56	0.24	0.39	0.59

Significances: * 10%, ** 5%, *** 1%. A-VA = alcohol value weighted, A-EQ = alcohol equal weighted, T-VA = tobacco value weighted, T-EQ = tobacco equal weighted, W-VA = weapons value weighted, W-EQ = weapons equal weighted, G-VA = gambling value weighted, G-EQ = gambling equal weighted

As per in the model with no dummy variables, the market betas remain similar; every portfolio has significant betas which are under the value of 1, expect the gambling portfolios. The SMB and HML factors remain similar as well with no notable differences. R-squared values see moderate increases when compared to the model without dummy variables.

Table 7. Interpreted values for the industry portfolios

	A-VA	**T-VA**	**W-VA**	**G-VA**	**A-EQ**	**T-EQ**	**W-EQ**	**G-EQ**
Y2002	0,0197	0,0093	0,0303	0,0309 ***	0,0042	-0,018 *	0,012	0,0208 ***
Y2003	-0,0041	0,0191	-0,0195	-0,0276 **	-0,0005	0,0237	0,0584 **	-0,0003 ***
Y2004	-0,0052	0,009	0,0038	0,0162 ***	0,0149	0,0304 ***	0,0395	0,0295 ***
Y2005	-0,0154	0,0055	0,0006	-0,0105 **	0,0079	-0,01	-0,0237	-0,0053 **
Y2006	0,001	0,0062	0,0161 **	0,0142 ***	0,0165	0,013	0,0029	0,0021 ***
Y2007	0,001	-0,006	0,0125 *	0,0232 ***	-0,0034	-0,009	-0,007	0,0026 ***
Y2008	0,0438 **	0,0053	0,0044	-0,0599	-0,033	0,0282 *	-0,0016	-0,0476
Y2009	-0,014	0,0045	-0,0109	0,0411 **	0,0344 **	-0,0045	0,0177	0,0213
Y2010	0,0134	0,0127	-0,006	0,0361 ***	0,0211	0,0241	-0,0153	0,0023 ***
Y2011	-0,0051	0,0205 *	0,0181 **	0,0028 **	-0,0181	0,0294	0,0144	-0,0044 **
Y2012	0,0055	-0,0067	0,0125	-0,0154 **	0,0023	-0,0047	0,0294	0,0008 **
Y2013	0,0132	-0,0073	0,0294 ***	0,0002 ***	0,0379 **	-0,0165	0,041	-0,0006 ***
Y2014	0,0135	-0,0023	0,0135 *	-0,0339	0,0154	-0,0205	-0,0049	-0,0189 *
Y2015	0,0206 **	0,0139	0,0122 *	-0,0159 **	0,012	-0,0044	0,0167	0,0214 ***
Y2016	-0,0075	0,0016	0,0014	-0,0147	-0,0097	-0,0176	0,0019	-0,0165 *
Y2017	0,0095	-0,0036	0,0097 **	0,0127 ***	0,0197	0,0204 **	-0,0197	0,0284 ***
Y2018	-0,0189	-0,0286	-0,012	-0,0118	-0,0164	-0,0085	0,0064	-0,0009 ***
Y2019	0,0006	-0,0056	0,0153 *	0,0055 ***	0,0052	0,0043	-0,0119	0,0137 ***
Y2020	0,0084	-0,0094	-0,0087	-0,0103	0,0147	-0,0265	0,0131	-0,0055 *
Y2021	-0,0161	-0,0066	-0,0128	-0,0563 ***	-0,0078	-0,0024	-0,001	-0,0476 ***
Average	0,0032	0,0016	0,0055	-0,0037	0,0059	0,0015	0,0084	-0,0002
Standard deviation	0,0149	0,0112	0,0136	0,0270	0,0171	0,0182	0,0208	0,0206

Significances: * 10%, ** 5%, *** 1%. A-VA = alcohol value weighted, A-EQ = alcohol equal weighted, T-VA = tobacco value weighted, T-EQ = tobacco equal weighted, W-VA = weapons value weighted, W-EQ = weapons equal weighted, G-VA = gambling value weighted, G-EQ = gambling equal weighted

Table 7. shows the interpretation of the year coefficients presented in Table 6., averages of these values, and standard deviations. The highest average performance is found from the equal weapons portfolio, with an average of 0.84% monthly abnormal returns. The second and the third highest

average returns belong to the equal alcohol, and the value weapons portfolios, respectively with 0.59% and 0.55% average abnormal monthly returns. This is similar to the model without dummy variables, where these three portfolios generated statistically significant monthly abnormal returns. This further implies weapons stocks and small capitalization alcohol stocks being an important part of the overall sin stock portfolio returns. It is also notable that both of the gambling portfolios generate negative monthly abnormal returns on average. Standard deviations of the portfolios are relatively high, which is typical for portfolios with small number of stocks (Table 1.).

5.2.3 Cumulative industry portfolio returns and the market

Figures 2. and 3. presents the cumulative returns of the industry portfolios and the market.

Figure 2. The cumulative returns of the value weighted industry portfolios and the market

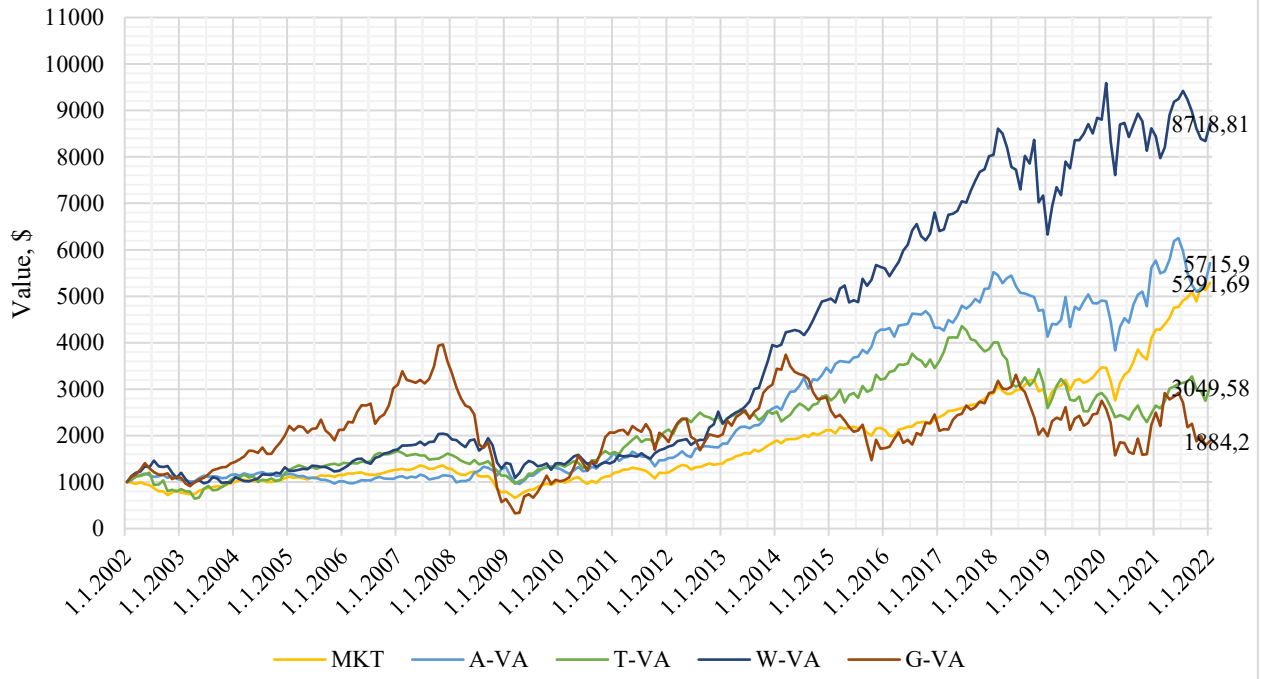


Figure 2. shows that from the value weighted portfolios, weapons and alcohol portfolios outperformed the market, while tobacco and gambling underperformed. With a starting value of $1000, the weapons portfolio reached $8718.81 by the beginning of 2022, with an average monthly return of 1.08%, geometric mean of 0.91%, and an annualized Sharpe ratio of 0.64. The respective values for alcohol value portfolio are $5715.9, 0.85%, 0.73%, and 0.60. For the market, the values are $5291.69, 0.79%, 0.70%, and 0.63. For the tobacco portfolio $3049.58, 0.65%, 0.47%, and 0.38. Finally, for the

gambling portfolio $1884.20, 0.99%, 0.26%, and 0.27. On a risk adjusted basis (Sharpe ratio), only the weapons portfolio beat the market portfolio.

Figure 3. The cumulative returns of the equal weighted industry portfolios and the market

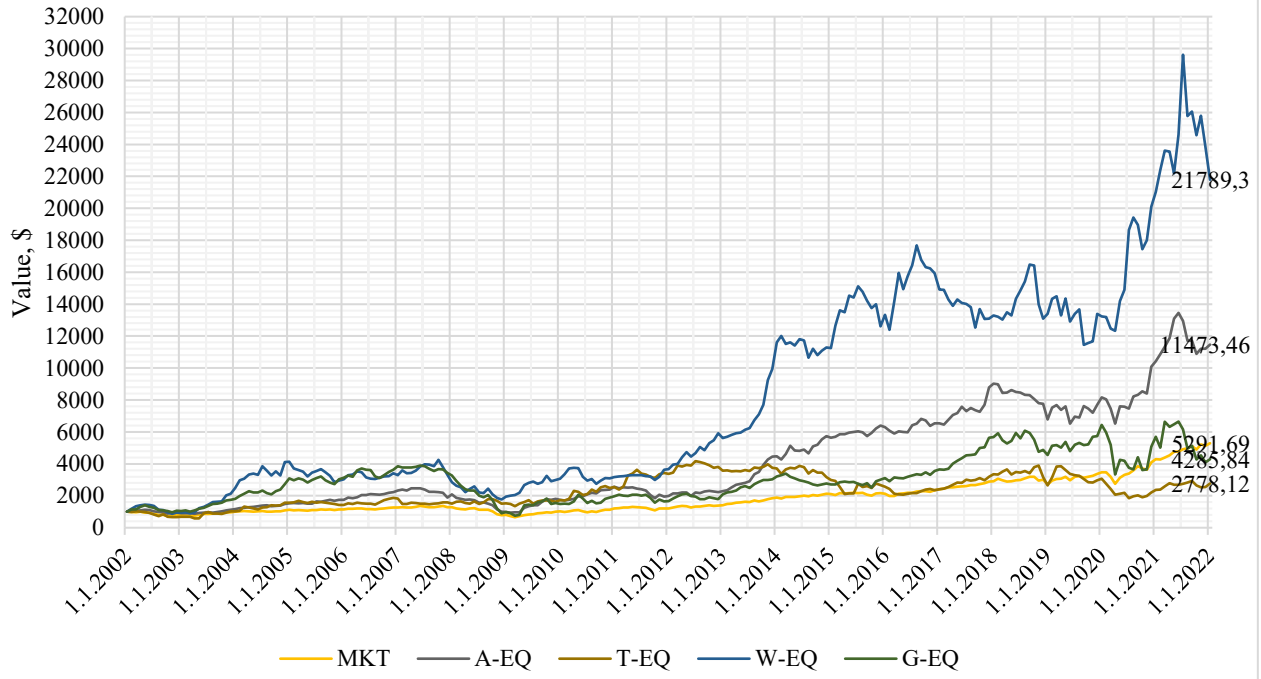


Figure 3. shows equal weapons and alcohol portfolios beating the market, with equal tobacco and gambling underperforming. The weapons portfolio reached a value of $21789.30 by 2022, alcohol $11473.46, the market $5291.69, gambling $4285.84, and tobacco $2778.12. Average monthly returns were 1.60% for weapons, 1.18% for alcohol, 0.79% for the market, 1.09% for gambling and 0.74% for tobacco. Geometric means were 1.29% for weapons, 1.02% for alcohol, 0.70% for the market, 0.61% for gambling, and 0.43% for tobacco. Annualized Sharpe ratios were 0.70 for weapons, 0.72 for alcohol, 0.63 for the market, 0.38 for gambling and 0.31 for tobacco, meaning that on a risk-adjusted basis, equal alcohol and weapons portfolios beat the market with alcohol portfolio being the best. These cumulative return observations are in line with what was found in the regressions: weapons industry portfolios and the equal alcohol portfolio beats the market in the regressions, and, with average and risk-adjusted returns. This confirms our previous observation of weapons stocks, and small capitalization alcohol stocks being an important driver of returns in the sin stock portfolios. The hypothesis of finding over- and underperformances as compared to the market holds. Weapons portfolios, and the equal alcohol portfolio outperforms the market, while the others underperform.

6. Conclusion

This paper has examined the sin stock anomaly in U.S. during the years of 2002-2021. As the main result in this paper, sin stock portfolios do not generate statistically significant monthly abnormal returns consistently. The monthly abnormal returns sin stocks produce have relatively high variation. Thus, the results cannot confirm the existence of the sin stock anomaly. However, two out of the three sin stock portfolios outperformed the market on average and on risk-adjusted returns. These results cannot be directly credited to the "sinfulness" of these portfolios. The results from the individual industry examination show that these performances are likely to be driven by weapons stocks, and small capitalization alcohol stocks.

In other results, the paper confirms the defensive nature of sin stocks by showing a significant low market beta for the sin stock portfolios, and for most of the industries. However, the paper does not find any significant outperformances of the market during times of crisis and therefore cannot confirm that sin stocks are "recession proof".

Using NAICS codes to identify gambling industry stocks is one limitation of this study. The amount of gambling companies included in this study decreased by a relatively high number during 2014 to 2015, and during 2019 to 2020, from a peak amount of 27 in 2006 to only 1 in 2021. Using a different method of gambling stock identification could have a high impact on the results of this study. Furthermore, using daily stock data instead of monthly stock data could produce different results observed from the regressions.

This study has a few points to consider in future research. First, the finding that small capitalization alcohol stocks generate abnormal returns and outperforms the market with average and risk-adjusted returns needs further examination. Second, weapons stocks outperforming the market and generating abnormal returns needs further investigation and explanation. And third, the finding that sin stocks do not generate statistically significant abnormal returns during 2002-2021, but have in previous studies samples, needs further investigation when and why the sin stock anomaly seems to have disappeared.

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