Would You Rather Laugh with the Sinners than Cry with the Saints?

An Empirical Analysis of the Performance of Sin Stocks in the Swedish Market

Gustav Nilsson, 23831[a] Marcus Undén, 23883[b]

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Abstract

This thesis provides new evidence on social norms' impact on capital markets through the lens of the Swedish stock market and sheds new light on ownership structure, analyst coverage, valuation and financing decisions of vice companies – companies involved in sinful industries, including gambling, tobacco and alcohol - as well as its implication for stock returns. We show that sin stocks are neglected by institutions and have lower sell-side analyst coverage, thus sin stocks indicatively face less liquid equity markets than comparable stocks. Consistent with previous research, we find that sin stocks outperform comparable companies by generating abnormal returns of approximately 15.5% per year. Indicatively, the perception of what constitutes a sin has changed over time and should probably be widened to include fossil fuel and defense as we find that the outperformance is robust to the inclusion of these industries.

Keywords: Sin Stocks, Social Norms, SRI, ESG, Institutional Ownership
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a) 23831@student.hhs.se
b) 23883@student.hhs.se

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1. Introduction

"We learn the social norms of our society and modify our behavior accordingly."

(Jane Goodall)

A social norm is when an individual's utility is compromised by the notion of other members in the individual's community. Social norms persist in society notwithstanding substantial costs due to the high reputational costs of breaking the norm (Becker 1957; Akerlof, 1980). Social norms manifest themselves in financial markets by influencing individuals' investment preferences, as individuals increasingly incorporate social values into fund allocations (Hong & Kostovetsky, 2012) and investors progressively make investment decisions based on Socially Responsible Investing (SRI) strategies (Beal et al., 2005; Sparkes, 2017; Majoch et al., 2017). The investment approach either positively screens out best-performing companies or negatively screens out worst in class companies in terms of social responsibility (Kinder & Domini, 1997). One-third of all professionally managed assets in the US employ sustainable investing strategies, reflecting the exponential increase in demand for SRI strategies (USSIF, 2020). This asset base has grown more than 25-fold since 1995. As of end of 2020, the SRI asset base amounted to 17.1 trillion USD (USSIF, 2020). The Swedish pension system shows similar evidence regarding ESG funds' prosperity, where the number of green fund options grew from 7% to 36% of all funds between 2004 and 2017 (Anderson & Robinson, 2019). In line with SRI's advancement and its increasing impact on the financial market, sin stock research investigates the impact on returns and corporate decision making from excluding investments in vice companies as investors conform to social norms (Hong & Kacperczyk, 2009). Sin stock portfolios are increasing in interest to the public as investment managers exclude sin stocks by adapting to SRI strategies (Connaker & Madsbjerg, 2019).

While SRI has grown swiftly, and more investors retreat to green alternatives, there is inadequate evidence indicating that SRI funds generate abnormal returns to investors but rather in line with comparable funds (see, e.g., Peylo, 2014). Meanwhile, sin stocks negatively screened out by the lion's share of SRI funds seemingly generate alpha (Fabozzi et al., 2008; Hong & Kacperczyk, 2009; Salaber, 2007; Statman & Glushkov, 2008; Liston & Soydemir, 2010). Thus, conforming to Becker (1957), investors are willing to pay substantial financial costs associated with socially responsible investments by avoiding sin stocks due to litigation-, regulatory- and reputational risks. Sin investing and SRI have concurrently emerged as the two extremities of social norms' adaption

to financial markets. Contrary to SRI, sin investing hinges on the neglected stock theory (Merton, 1987), e.g. focusing on the stocks negatively screened out by SRI funds. The theory argues that the reduced investor base and thus lower coverage inflates equity returns. Another strain of research has shown that SRI investors' reluctance to hold certain assets generates a boycott premium for non-green stocks (Lou & Balvers, 2017). Moreover, evidence in recent literature suggests that investors with a preference for ESG generate utility from holding green stocks and disutility from holding brown stocks (Pastor et al., 2020) even if returns are compromised. Besides, brown stocks have higher climate betas that could be used for hedging climate risk (Engle et al., 2020). Pastor et al. (2020) provide a theoretical framework explaining how the expected returns from green assets can be lower while the expected returns from brown assets can be higher as investors dislike the substantial risk for brown assets related to a deteriorating climate.

Sin investors focus on the triumvirate of sin; tobacco, alcohol, and gambling activities, companies most often screened out of SRI funds since they promote human vice and carry substantial societal costs when over-consumed (Hong & Kacperczyk, 2009). While there has been an explosion of SRI funds globally, zero-to-none mutual funds dedicate themselves to vice industries (Richey, 2014). Only one mutual fund categorizes itself as pure sin investing, the Vice Fund, or VICEX (Richey, 2014). Interestingly this fund has outperformed its comparable index 12 out of 17 years since its inception while only managing approximately 110 million USD (Yahoo Finance, 2021). Hence, there seems to be limited demand for specialized vice funds despite sin stocks generating abnormal returns, allowing what appears to be an empirical arbitrage opportunity to sustain when in fact it could be a theoretically priced factor. That is, investors can attain a reputation risk premium over time in line with arbitrage pricing theory (Roll & Ross, 1980). Accordingly, the sin stock anomaly has been able to sustain over a long period across multiple markets (Hong & Kacperczyk, 2009). Theories developed after Hong and Kacperczyk (2009) point towards a sin stock portfolio being a factor itself and not alpha (or an anomaly) as it should be priced according to utility generation (see e.g., Pastor et al., 2020; Pedersen et al., 2019).

To the best of our knowledge, no previous literature has analyzed the sin stock anomaly in Sweden. Hence, this thesis aims to fill the research gap and facilitate practical and theoretical relevance by offering evidence on the performance of sin stocks in the Swedish stock market. The Swedish government pension funds, the AP funds, have explicit guidelines limiting the possibility of unethical investments (Sandberg et al., 2014; Du Rietz, 2016). As the AP funds rank among the largest investors globally (see Severinson & Stewart, 2012), such exclusions will have a tremendous impact on the regional financial market. Hoepner and Schopohl (2016) analyze the exclusionary screening by the AP funds and the Norwegian government pension fund due to the unethical

nature of a sector or moral violations. The authors provide evidence that the excluded companies do not generate alpha compared to the fund's benchmark index, and thus financial returns were not compromised by the funds' ethical objectives. This conclusion contradicts consensus from sin stock research; however, while the exclusion criteria are progressive, they generally do not, for instance, include all gambling stocks (Sandberg et al., 2014). Instead, the AP funds have leeway in defining what is ethical or not, which has allowed continued investments in some of the sinful industries generating abnormal returns.

We conduct several time-series regressions on the returns of 25 alcohol, tobacco, and gambling companies between 2004 and 2019 listed on the Swedish stock market, controlling for Carhart's (1997) four-factor model (in line with Hong & Kacperczyk, 2009). In addition to Carhart's specification, we control for the betting against beta (BAB) and illiquidity (ILLIQ) factors. Previous research has shown that sin stocks tend to be low beta stocks (see e.g., Blitz & Fabozzi, 2017), hence we want to control for the low beta anomaly in line with Frazzini and Pedersen (2014). Additionally, because studies have shown lower institutional ownership for sin stocks (see e.g, Hong & Kacperczyk, 2009), we hypothesize that sin stocks face less liquid equity markets and have a narrower investor base, implying that trading (share turnover) should have a higher pricing impact, posing an additional risk factor (ILLIQ) for which sin investors should be compensated for through higher expected returns. The drivers of the overperformance of sin stocks are analyzed by performing tests on institutional ownership and the number of sell-side analysts on sin stocks. Equivalently, the analysis tests the impact of a potential undervaluation and higher cost of capital by investigating the impact on the valuation and financing of sin stocks. In total, six hypotheses were formulated to address the areas above. Moreover, this thesis aims to add to the frontier of research by augmenting the Carhart (1997) four-factor model, with a betting against beta factor and Amihud's (2002) illiquidity factor to shed light on other potential explanations for the sin stock anomaly. No previous paper has considered the illiquidity factor, and only Blitz and Fabozzi (2017) have considered the BAB factor to the best of our knowledge, adding novelty to the findings.

We further nuance the institutional ownership tests by analyzing the level of ownership per subgroup of institutional investors and expand the sin stock definition to include defense and fossil fuel companies as robustness tests for examining the magnitude of stock returns and the results' sensitivity to the definition of sin stocks.

A data set of 763 listed Swedish companies between 2004 and 2019 is analyzed to investigate the sin stock anomaly in Sweden. Initially, we find results in line with previous research, showing significantly lower institutional ownership and analyst coverage of sin stocks to comparable firms.

Controlling for market, industry, and firm-specific factors, the average institutional ownership is 13.4% lower and analyst coverage 16.7% lower for sin stocks which we argue should funnel into higher expected returns. Consistent with empirical trends on growth in SRI investing and negative screenings by institutional investors (see e.g., Anderson & Robinson, 2019) in the last years, we find that these results are driven by the later period in the sample (2013-2019). This result points towards sequentially lower institutional ownership and analyst coverage of sin stocks and an increasing modification of investment behavior from conforming to societal norms. Furthermore, we find that a portfolio that is long sin stocks and short comparable firms yield a yearly abnormal return of about 16.4% when testing for a four-factor model and 15.5% when testing for a six-factor model. However, in contrast to Hong and Kacperczyk (2009), there is no evidence that sin stocks are more undervalued than comparable firms.

Nevertheless, sin stocks are significantly more likely to finance themselves by debt than equity, reflecting previous findings that outside of the US, sin stocks are not always undervalued but still rely more heavily on debt financing (McDonald & Fauver, 2012). In terms of market leverage, sin stocks hold approximately five times higher net debt to market capitalization than comparable firms. We argue that this might be attributable to limited or restricted access to equity financing for sin stocks, deferring them to debt and self-financing. Moreover, multiples might not be the most appropriate measure for undervaluation, and sin stocks might consider themselves undervalued regardless of our conclusions. Since multiples reflect future expectations, a higher multiple reflects a more positive outlook on the firm's future performance and not necessarily overvaluation. We also show that sin stocks can sustain significantly higher dividends than comparable firms. In sum, we demonstrate the impact on corporations and their decisions through social norms' impact on the Swedish stock market. Sin stocks are less owned by institutions and less covered by analysts, outperform comparable firms, take on higher indebtedness, and sustain higher payout ratios.

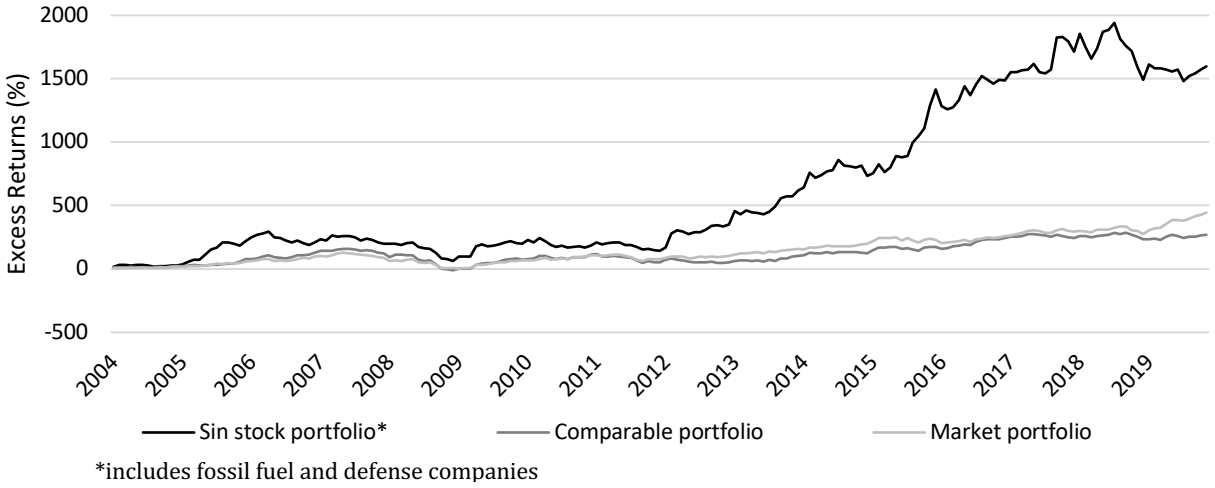
Furthermore, we expand the definition of sin stocks to include defense stocks (in line with Fabozzi et al., 2008) and subsequently add fossil fuel companies as sin stocks, which to the best of our knowledge, no previous literature has considered. The presented results show that the outperformance of sin stocks is robust to adding defense and fossil fuel companies, raising interesting questions about whether fossil fuel companies should be considered as sin stocks.

Lastly, investigating the different institutional investors shows that government pension sponsors (e.g., the pension funds) and other financial companies (e.g., PE-funds) hold significantly higher levels of sin stocks compared to other firms and take advantage of the abnormal returns in

the last years. This reflects well on previous literature on the AP-funds and confirms that they have increased flexibility in their exclusion criteria than green mutual funds.

The structure of the remainder of this thesis is as follows. Section 2 presents an overview of the existing literature on the research field. Building on the findings from previous literature, Section 3 outlines the research hypotheses of the thesis. Section 4 describes the data processing in the paper. Section 5 outlines the methodology employed to address the hypotheses, and Section 6 presents the results and robustness tests. Section 7 presents the conclusions, implications, and suggestions for future research.

Figure 1. Cumulative Portfolio Excess Returns in the Extended Sin Definition



*includes fossil fuel and defense companies

2. Literature Review

This section introduces a theoretical framework and relevant previous literature to examine the impact of social norms on the Swedish stock market by analyzing sin stocks. The first section presents a theoretical framework and an overview of the field of sin stocks to investigate social norms. After that, in section 2.2., conclusions from previous research in the field of sin stocks are presented to support the analysis.

2.1 Sin Stocks to Empirically Answer a Broader Question

While a plethora of published research on SRI has emerged in later years, the literature on sin investing has remained scarce. SRI is growing in interest worldwide, while investors are shunning further away from vice stocks through exclusion in actively and passively managed funds. Sin stocks initially offered a new take on economic behavior and market outcomes in the light of social norms. Early literature on social norms evidenced that an individual's disadvantageous behavior can prevail due to reputational risk (Akerlof, 1980; Romer, 1984). Hong and Kacperczyk (2009) instead analyzed the impact of such disadvantageous behavior on the stock market through sin stocks. Another take on social norms' impact on capital markets is reflected in Hong and Kostovetsky (2012) who show that US mutual fund managers who donate to the Democratic party are more likely to manage sustainable funds and hold fewer sin stocks relative to Republican fund managers, who can generate abnormal returns due to the neglection of these stocks as a result of an investor base's political values. Thus, an individual's stock preferences are influenced by the social context of its political peers, which might not necessarily result in disutility from investing in sin stocks and promoting human vice. By investigating the performance of sin stocks, it is possible to find financial costs associated with screening out particular stocks. Hence, while there are two alternative views on SRI investments, considering the financial costs of screening out individual companies offers a more accepted framework and definitions (see, e.g., Hong & Kacperczyk, 2009). Meanwhile, such analyses cannot answer if SRI investment can generate alpha, a drawback of the angle of approach. However, because no uniform SRI standard exists, SRI investment performance becomes more arbitrary and less conclusive.

Finding a theoretical framework for explaining the outperformance of sin stocks due to social norms' impact on investors is complicated. Pedersen et al. (2019) present a recent framework on ESG investing. They outline three investor types. Unaware investors do not consider ESG factors, aware investors incorporate the ESG factor in their investment decisions, and motivated investors focus on ESG factors in their investment decisions. The trade-off between risk, returns and ESG

can be considered through the Sharpe ratio (SR) and ESG scores. In other words, CAPM with ESG, creating a mean-variance frontier for all assets and portfolios with certain ESG ratios. The authors show that aware investors will choose the frontier's tangency point, motivated to the frontier's right (suboptimal in terms of ESG and SR trade-off), while the unaware do not consider ESG-factors. Consequently, high-ESG stocks' prices will be bid up by many motivated investors and eventually deliver lower expected returns since the motivated investors willingly trade off a higher ESG portfolio for lower returns.

This conclusion aligns well with another recent theoretical ESG model of investing, presented by Pastor et al. (2020), showing that green assets have negative alphas while brown assets have positive alphas. The framework depicts that investors derive utility from holding green stocks and disutility from holding brown stocks. Hence, investors are willing to accept a lower expected return due to the positive utility generated from the investments. The frameworks align well with Merton's (1987) neglected stock theory, stating that stocks factored out by a group of investors can produce abnormal returns. Pastor et al. (2020) show that the difference in returns increases with ESG investment preferences; a larger spread in investors' ESG preferences is associated with lower alphas for ESG motivated investors.

Exclusionary screening might additionally be related to negative externalities associated with investing in certain assets. In line with Akerlof (1980), reputational risks might be substantial enough to sustain these assets' neglection. For example, Hartzmark and Sussman (2019) looked at fund flows' impact from Morningstar ratings, where a low sustainability rating was associated with monthly withdrawals of more than USD 12 billion for the corresponding mutual fund. In a more scrutinized position, for instance, as a pension fund, investments in vice stocks might be prohibited (Blitz & Fabozzi, 2017). Henceforth, sin stock outperformance relies on the foundation that investors value sustainability, have high reputational risks, and sophisticated investors cannot invest in sin stocks by regulatory principles. Therefore, investors should attain a reputational and ESG risk premium (alpha) by not shunning away from sin stocks.

2.2 Evidence from Research on Sin Stocks

Analyzing a global set of stocks spanning 21 markets over 1970-2007, Fabozzi et al. (2008), showed that sin stocks, on average, outperformed the market by 11% and in terms of frequency, outperforming the market indices in 35 out of 37 years. Their definition of sin stocks includes alcohol, tobacco, defense, biotech, gambling, and adult entertainment industries and includes companies if above 30% of their revenue relates to vice industries. Hong and Kacperczyk (2009) sophisticated the methodology and presented evidence that sin stocks outperformed their

comparables using US stock data. The authors classified sin stocks in line with the triumvirate of sin, alcohol, tobacco, and gaming using Fama-French industry codes. The study compared a long position of an equal-weighted portfolio of sin stocks to a short position in comparable companies in similar industry categories. The position generated an alpha of approximately 3% per annum 1965-2006, controlling for the Carhart (1997) four-factor model (market excess returns, size, value, and momentum). The results were robust for data dating back to 1926. The authors evidenced that institutional investors are less likely to own sin stocks and pay a financial cost by shunning away from these stocks and in line with sin stocks being less owned by institutions also evidence analysts' sparser coverage. Lastly, given the overperformance and consequent undervaluation of sin stocks, the authors present evidence that this leads to a higher cost of equity for such firms. In line with this, sin stocks are more likely to take on debt financing instead of equity when making corporate financing decisions.

Sin stock performance in Europe was studied by Salaber (2007), looking at alcohol, tobacco, and gambling stocks in 18 European countries between 1975 and 2006. The author showed abnormal returns of sin stocks, although dependent on the traded stock region's legal environment and religion. Another study using regional data outside the US (Visaltanachoti et al., 2009) analyzed the performance of sin stocks in China and Hong Kong between 1995 and 2007. The study showed that sin stocks significantly outperformed the corresponding market index during the period, computing Jensen's alpha and Tobin's Q for the portfolio.

Another perspective on the sin stock anomaly compares the two extremities in the investment universe, sin stocks and socially beneficial stocks. Several studies have shown that SRI investors that negatively screen out the triumvirate of sin lose out on abnormal returns for excluding sin stocks (Statman & Glushkov, 2008; Liston & Soydemir, 2010). Liston and Soydemir (2010) study US stocks between 2001 and 2007 and present significant alphas using Carhart's four-factor model (1997). Meanwhile, Statman and Glushkov (2008) present evidence that any advantage from SRI positive screening is offset by the high returns of sin stocks, controlling for the CAPM framework using US data between 1992 and 2007. Lobe and Walkshäusl (2016) employed a similar methodology using global, regional, and domestic sin stock portfolios and expanded the triumvirate of sin to a sextet of sin, including defense, pornography, and nuclear power. The study contradicted previous results and did not find that sin stocks outperformed other stocks. However, as the sample is highly tilted towards nuclear stocks, constituting 46% of the portfolio, and no prior or cited studies include this industry, the results might not be comparable to other studies.

Richey (2014) offered an additional perspective by studying the performance of a portfolio of alcohol, gambling, tobacco, and defense stocks in the US during and post-financial crisis (2007-

2013). For the full period, the author evidenced a positive albeit insignificant alpha for the vice portfolio. However, the vice portfolio had a positive alpha in the bear market, controlling for the Carhart four-factor model (1997); in a bull market, results were only significant in the three and four-factor models. Richey (2017) followed up the study using the same definition of sin stocks for a data set spanning over a more extended period from 1996 to 2016. The excess returns of the sin portfolio were significant, controlling for the Carhart (1997) four-factor model. The significant results disappeared when controlling for the Fama-French (2015) five-factor model, including investment and profitability factors.

Lastly, Blitz and Fabozzi (2017) look at global data between 1963 and 2016, with a sin stock portfolio of alcohol, tobacco, gambling, and weapons companies. The authors find statistically significant alpha controlling for Carhart's four-factor model (1997). When controlling for the Fama-French (2015) five-factor model, including profitability and investment factors, the alpha's statistical significance disappears, albeit remaining positive. Blitz and Fabozzi (2017) argue that higher profit margins and more restrictive investment policies might explain the abnormal return of sin stocks which points towards other variables being able to explain the results.

To summarize the research of sin stocks, an overwhelming part has found a significant overperformance for sin stocks compared to the market and comparable companies (Fabozzi et al., 2008; Hong & Kacperczyk, 2009; Salaber, 2007; Statman & Glushkov, 2008; Liston & Soydemir, 2010). In contrast, a few studies have not been able to find significant outperformance incorporating nuclear stocks (Lobe & Walkshäusl, 2016) and controlling for additional factors (Richey, 2017; Blitz & Fabozzi, 2017).

3. Research Hypotheses

This section outlines the thesis' hypotheses and presents the definitions and data employed to test the hypotheses. Despite the plethora of studies analyzing green and socially responsible investments, a limited number of papers have focused on sin stocks (Blitz & Fabozzi, 2017). Because of the short supply of research on the topic, existing studies have focused on the US market and left other regions rather uninvestigated. To the best of our knowledge, there is no prior literature analyzing Swedish data, and a limited amount of studies incorporating recent data. Analyzing the sin stock anomaly in a Swedish context complements current research by adding another region with substantial SRI investments and influential pension funds that have negatively screened out unethical investments for a lengthy period (Sandberg et al., 2014; Du Rietz, 2016). Additionally, investigating data from January 1, 2004, to December 31, 2019, will encapsulate the growing SRI investment supply and demand in the region (Anderson & Robinson, 2019). In line with Hong & Kacperczyk (2009), the thesis analyses three overarching topics: i) the ownership of sin stocks, ii) the performance of sin stocks, and iii) the corporate financing decisions of sin stocks.

3.1 Hypotheses Regarding the Ownership and Analyst Coverage of Sin Stocks

The fundamental explanation spanning most previous literature on sin stocks states that the excess returns this group of companies generate relates to that institutional investors shun away from sin stocks (Blitz & Fabozzi, 2017). That is, in line with Merton (1987), neglected stocks can create abnormal returns. Hong and Kacperczyk (2009) hypothesized that pension funds, banks, universities, religious organizations, and similar institutional investors avoid sin stocks because of their exposure to public scrutiny and costs associated with reputational damage. Therefore, sin stocks should be systematically undervalued and produce abnormal returns. Furthermore, given that institutional investors often refrain from investing in these stocks they are less interested in equity reports on the companies, and it has been shown that analysts cover them to a lower extent (Hong & Kacperczyk, 2009).

Institutional Ownership of Sin Stocks

The first test regards the level of institutional ownership of sin stocks compared to their comparable firms. In line with Hong and Kacperczyk (2009), we hypothesize that institutions avoid sin stock and formulate the following hypothesis; **H1:** Sin stocks have lower institutional ownership, in percentage, relative to comparable firms.

Analyst Coverage of Sin Stocks

In line with lower institutional ownership and interest, Hong and Kacperczyk (2009) put forth evidence that sell-side analysts follow sin stocks to a lower extent. The reason being that many of their largest customers are not interested in financial reports and analyses of the companies. We thus hypothesize that; **H2:** Sin stocks have fewer sell-side analysts following them than comparable firms.

3.2 Hypothesis Regarding the Performance of Sin Stocks

As outlined, most of the previous literature shows that sin stocks outperform comparable firms as well as relevant market indices (e.g., Hong & Kacperczyk, 2009; Statman & Glushkov, 2008; Liston & Soydemir, 2010). The most conservative papers analyze the excess return of a portfolio going long in sin stocks and short in comparable firms to test the outperformance of sin stocks against Fama-French (1993 & 2015) factors known to impact the level of returns. In this thesis, we follow this methodology since it is the most conservative and appropriate approach. Based on this, the hypothesis is that; **H3:** An equal-weighted portfolio of sin stocks will outperform an equal-weighted portfolio of comparable stocks.

3.3 Hypotheses Regarding the Corporate Financing of Sin Stocks

Market Valuation of Sin Stocks

Hong and Kacperczyk (2009) argue that if institutions shun away from firms classified as sin stocks, they should be undervalued relative to the market. The hypothesis is that; **H4:** Sin stocks are undervalued on the stock market relative to comparable firms.

Corporate Financing Decisions of Sin Stocks

If sin stocks are undervalued it should channel into the corporate financing decisions of these companies, where an undervalued firm will go for debt financing rather than equity financing due to an increased cost of equity. We formulate the following hypothesis to test this prediction; **H5:** Sin stocks have a higher debt financing level than comparable firms.

Furthermore, given the low exposure to cyclicality derived from the addictive nature of the products, sin stocks should generate more stable cash flows across the business cycle and sustain higher dividend levels. We hypothesize that; **H6:** Sin stocks have higher payout ratios than their comparable firms.

4. Data

This section describes the thesis' scope, data, and data collection relevant to answer the six hypotheses outlined in the previous section. Section 4.1 presents the scope of the thesis. Thereafter, section 4.2 defines the sin stock category alongside the comparable portfolio of stocks, followed by section 4.3, presenting the individual stock data collection process.

4.1 Scope

Previous research has found sin stock overperformance over extended periods, mainly focusing on US data (e.g., Hong & Kacperczyk, 2009). Henceforth, this thesis' scope was formulated to investigate more recent data ranging from January 1, 2004, to December 31, 2019, while adding to the research field by looking at Swedish data. The selected period captures time before, during, and post the financial crises, encapsulating both a bull and bear market. To avoid survivorship bias in the sample, all stock data during the period is collected. That is, the data is not limited to currently listed companies. Thereby, the dataset encapsulates companies going bankrupt, delisted, or acquired. This scope is in line with previous research on the subject (see, e.g., Blitz & Fabozzi, 2017; Richey, 2017).

4.2 Constructing the Dataset

The dataset utilized in this thesis consists of 763 publicly traded companies in the Swedish stock market collected from Finbas, Capital IQ, and SNL. The databases are merged using Finbas' ID and international securities identification number (ISIN) who are manually matched with identification data from the Capital IQ and SNL databases. A total of 522 companies were excluded from the Finbas dataset due to omitted variables in the Capital IQ and SNL databases, such as missing financial data and institutional ownership data. The first step after cleaning the data is to define the sin stock and comparable portfolios. The common and most logical approach to define sin stocks is the industry classes repeatedly being excluded by SRI funds. Initially, we use the classic triumvirate of sin, e.g. alcohol, gambling, and tobacco, to define sin stocks, which are the most negatively screened out industries by SRI funds (Lou & Balvers, 2017). These three industries have commonly been considered sinful due to being thriving of human vice and causing high social costs when over-consumed (Hong & Kacperczyk, 2009). Hong and Kacperczyk (2009) use SIC codes to create their portfolios, but due to a lack of data on the Swedish market, we use GICS industry codes. Utilizing this methodology, we construct a portfolio of sin stocks,

SINPORT, and a portfolio of comparable non-sin stocks, COMP. Please refer to the appendix (A.1) for details on how we construct the portfolios.

Table 5 (Appendix) presents the distribution of sin stocks, including defense and fossil fuel stocks, over the period investigated. In total, the triumvirate of sin portfolio consists of 25 companies, or 3.3% of the total sample, highly tilted towards the gambling industry. Due to the sparse number of observations in 2004 and 2005 with 5 and 6 observations, we perform two robustness tests to broaden the data and address the tilt towards the gambling sector (in line with Hong & Kacperczyk, 2009). First, Defense companies are included in the sin stock portfolio in line with Blitz and Fabozzi (2017). Second, to incorporate more recent development from practitioners on the sin stock definition, we include fossil fuel companies in the sin stock portfolio. This thesis considers the expanded definitions of sin stocks as robustness tests due to the lower consensus whether these industries are sinful (Blitz and Fabozzi, 2017). See section 6.4 for more details regarding the robustness tests.

4.3 Collecting Individual Company Data

To investigate the hypotheses, we retrieve individual stock data. The monthly prices of individual stocks are collected from the Finbas database to calculate the returns. We define six variables to analyze the hypotheses related to returns. First, to calculate the excess return of sin stocks, the dependent variable is SINPORT, and thereafter the dependent portfolio is long SINPORT and short COMP. The Carhart (1997) four-factor model, including the betting against beta factor (Frazzini & Pedersen, 2014), BAB, and Amihud's (2002) illiquidity factor (ILLIQ), is used to control the results for well-known factors impacting companies' level of returns. The Carhart (1997) model includes the factor for the excess return of the market, MKTRF, the factor for return difference between small and large stocks, SMB, and the factor for the return difference between high and low book-to-market stocks, HML. The fourth factor, momentum, MOM, was introduced by Carhart (1997) and captures the return difference between the prior month's winners and losers. The four-factor model's monthly data is retrieved from the Swedish House of Finance, while the BAB and ILLIQ factors are constructed using the full Finbas dataset. Please refer to the appendix (A.2) for the construction of the BAB and ILLIQ factors.

We define a dependent variable for institutional ownership to compare ownership of sin stocks and their comparable firms. IO_{it} is the percentage ownership of company *i* by an institution at time *t*. The definition of institutions aligns with Capital IQ and consists of different institutions such as Family offices, Wealth funds, Trusts, Endowments, Pension Sponsors, and Financial institutions. Furthermore, $ACOV_{it}$ is the natural logarithm of the number of analysts covering firm *i* at a given

time *t* plus one. The data for institutional ownership and the analyst coverage is retrieved from Capital IQ.

In testing the remaining hypotheses, we define additional dependent variables. First, for the valuation of the company $LOGMB_{it}$ and $LOGMREV_{it}$ are employed. The dependent variables are the natural logarithm of the market capitalization to book value (MB) and market capitalization to revenue (MREV). The two deployed valuation metrics provide appropriate measures to the market valuation of a firms' equity (in line with McDonald and Fauver, 2012). For the hypotheses regarding the corporate financing decisions of the company, three dependent variables are defined. $MLEV_{it}$ is the book value of net debt divided by the market capitalization of company *i* at time *t*, and $BLEV_{it}$ divides the net debt by the book value of equity of company *i* at time *t*. The net debt is the interest-bearing liabilities, including capitalized leases and pension obligations of the company minus its cash and cash equivalents. Lastly, the payout ratio, $PAYOUT_{it}$, is the dividend paid out at time *t* divided by the price at time *t* for company *i*. We select the two most relevant metrics for indebtedness, $MLEV_{it}$ and $BLEV_{it}$, from Hong and Kacperczyk (2009) and consider the possibility that sin stocks can sustain higher dividends by incorporating $PAYOUT_{it}$. The market capitalization is retrieved from the Finbas database. All accounting figures are collected from the Capital IQ and SNL databases.

Several control variables are considered to further analyze the ownership and valuation of sin stocks. First, to distinguish between sin stocks and other stocks, a dummy variable, $SINDUM_{it}$, is created with binary properties to capture sin and non-sin stocks. To control that the difference due to firm size does not impact the results, the variable $LOGSIZE_{it}$ is defined as the natural logarithm of the market capitalization of the company. Thereafter, to control the company's quality, $LOGMB_{it}$, the natural logarithm of the firms' market capitalization to its book value is used. We also consider the industries' market sensitivities for the eleven overarching categories in the GICS, $BETA_{it}$. The beta value employs CAPM for explaining the returns over rolling 36 months of the respective industry. We also consider ROE_{it}, the return on equity, to incorporate the companies' profitability which previous literature has found to potentially explain the sin stock abnormality (e.g., Richey, 2017; Blitz & Fabozzi, 2017). The return on equity is defined as the net profit in period *t* divided by the book value of equity in period *t-1*. STD_{it} is the rolling 12-month standard deviation of the companies' stock returns.

Arguably industry effects, such as institutions being less likely to own stocks in a particular industry, might impact the results. Thus, we consider a dummy variable, $SININD_{it}$, which captures if the company is in the same overarching GICS industry (first six digits) as a sin stock. Moreover, we use the inverse of the companies' stock price, $PRINV_{it}$, to encapsulate micro-market structure

impact. The dataset is cleaned for missing or undefined variables (e.g., ROE for a company with a negative book value). In line with Hong and Kacperczyk (2009), the outlined data considers factors controlling for the market, industry, and firm characteristics. Summary statistics are presented in Table 1.

Table 1. Descriptive Statistics for Results and Analysis section

Panel A: Descriptive Statistics for Firm Characteristics Regressions

VARIABLES	Mean Sin	STD Sin	Mean Non-sin	STD Non-sin	Mean Sample	STD Sample
IO (%)	26.78	20.82	29.90	20.84	29.80	20.85
ACOV	0.699	0.966	0.960	0.963	0.952	0.964
LOGMREV	0.645	1.318	0.780	1.789	0.776	1.777
LOGMB	1.459	1.597	0.897	1.002	0.914	1.029
MLEV	1.675	6.351	0.473	3.999	0.510	4.094
BLEV	0.585	3.997	0.434	6.485	0.439	6.424
PAYOUT (%)	4.05	4.20	3.54	6.80	3.56	6.73

Panel B: Descriptive Statistics for Performance Study Regressions

VARIABLES	Mean Sin	STD Sin	Mean Comparable	STD Comparable	Mean Factors	STD Factors
Returns (%)	2.15	7.93	1.07	5.53		
MKTRF (%)					1.00	4.57
SMB (%)					0.01	4.32
HML (%)					0.58	2.65
MOM (%)					-0.68	7.33
BAB (%)					1.66	7.42
ILLIQ (%)					-0.29	6.35

Notes: (1) This table reports the summary statistics for the main results section. Panel A reports the time-series averages of cross-sectional means and standard deviation in the firm characteristics regressions. Panel B reports the summary statistics of the time-series regressions. (2) Sin denotes sin stocks. Sample denotes the total sample while Factors is intended for the augmented 6 factor model (3) Panel A: IO is the institutional ownership of a stock in % of total outstanding value, ACOV is the natural logarithm of the number of sell-side analysts covering the company plus one, LOGMREV is the natural logarithm of the market to revenue ratio, LOGMB is the natural logarithm of the market to book ratio, MLEV is the net debt divided by the market capitalization, BLEV is the net debt divided by the book value of equity, PAYOUT is the dividend divided by the stock price. Returns is the returns generated by a certain portfolio, MKTRF is the excess return of the market portfolio and the risk-free rate, SMB denotes the returns on the small minus big portfolio, HML is the return on the high minus low book to market value portfolio, MOM is a portfolio long previous month's winners and short the losers, BAB is a portfolio long low beta firms and short high beta firms, and ILLIQ is a portfolio long low liquidity firms and short high liquidity firms.

5. Empirical Methodology

In line with the ambition to investigate sin stocks' returns in a new setting by analyzing Swedish data, the three sections of the methodology align with the hypotheses. First, the empirical strategy to analyze the ownership of sin stocks and analyst coverage is presented in section 5.1. Second, the analyses of sin stock overperformance are outlined in section 5.2. Lastly, in section 5.3, the methodology to investigate the valuation of sin stocks is presented.

Performing time-series and cross-sectional regressions rely on several assumptions expected to be satisfied. We perform several tests to avoid skewness in the data and to eliminate biases in the presented model. First, to test for multicollinearity amongst the independent variables outlined in section 4.3, a variance inflation factors (VIFs) test is performed, with a threshold value of 10 (see O'Brien, 2007). Second, to test for homoscedasticity in the residuals, a Breusch-Pagan test is conducted. However, to be conservative, we employ Eicker-Huber-White (White, 1980) standard errors clustered on industry level based on the first six-digit GICS code for the cross-sectional firm characteristics regressions. Industry-clustered standard errors rely on fewer assumptions regarding their distribution and correlation over time, making the standard errors more conservative. The time-series regressions have robust standard errors. We perform Breusch-Godfrey tests for serial correlation for all time-series regressions. Lastly, since time-series and cross-sectional regressions rely on normally distributed residuals, a Kearney density estimation is used to plot the residuals against a normal distribution. No relevant adjustments are required to respective models after controlling for the biases above.

It should be noted that we use the natural logarithm of several variables to ensure the normalization of the data. Outliers are not removed in either regression to provide the most accurate estimation possible. Differences across different industries are handled by employing industry-fixed effects in all cross-sectional regressions. Dummy variables are included based on all first four-digit GICS industry codes except for one. To control for potential effects depending on the stock exchange a company is listed on, we also introduce market-fixed effects by incorporating four dummy variables to control for the five different exchanges in the sample. Moreover, as different firms' business cycles might impact the firm characteristics (Fort et al., 2013), all cross-sectional regressions include time-fixed effects. We include dummy variables for each of the years except for one year in the sample so that no single year could explain the results.

5.1 Analyzing the Ownership and Analyst Coverage of Sin Stocks

To measure the differences in ownership and analyst coverage of sin stocks, we set up cross-sectional regressions. The formulated strategy is in line with previous literature and controls for other factors that impact the institutional ownership levels (Hong & Kacperczyk, 2009). The model estimating the differences in institutional ownership and analyst coverage is denoted by the following cross-sectional regression set-up:

$$NEGLECT_{it} = A_0 + A_1 SINDUM_{it} + A_2 X_{it} + \varepsilon_{it} \quad (1)$$

Where the dependent variable is $NEGLECT_{it}$, constituting IO_{it}, the level of institutional ownership for firm *i* at time *t*, and $ACOV_{it}$, the natural logarithm of the number of sell-side analysts plus one covering stock *i* at time *t*. The $SINDUM_{it}$ variable equals one if the firm is classified as a sin stock and zero otherwise. Further, X_{it} denotes a vector of different firm characteristics we control for, and lastly, ε_{it} captures the error term. The vector consists of the previously defined control variables: PRINV, ROE, LOGMB, STD, BETA, LOGSIZE and SININD, along with control variables for time-fixed, market-fixed, and industry-fixed effects. The null hypothesis is that A_1, the coefficient of SINDUM, will equal zero, e.g., that there is no difference in the level of institutional ownership or analyst coverage for sin firms. As outlined previously, the existing literature argues several reasons that institutions are less likely to own sin stocks and subsequently lower analyst coverage (Hong & Kacperczyk, 2009; Blitz & Fabozzi, 2017). Henceforth, we expect that A_1 will be significantly below zero in the model.

5.2 Analyzing the Overperformance of Sin Stocks

To test whether sin stocks generate alpha we first test the excess returns of the sin stock portfolio against the Carhart (1997) four-factor model augmented with a betting against beta factor and illiquidity factor using time-series regressions. Thereafter, we construct a long-short portfolio as the dependent variable, going long in the sin stock portfolio and short the comparable portfolio. The time-series regression outlined to test the third hypothesis is defined in the equation below:

$$RETURNS_t = \alpha + \beta_1 MKTRF_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + \beta_5 BAB_t + \beta_6 ILLIQ_t + \varepsilon_t \quad (2)$$

$RETURNS_t$ is the return metric and dependent variable in these regressions, $SINPORT_t$ and $SINCOMP_t$. $SINCOMP_t$ is the excess return of the sin stock portfolio, SINPORT, minus the

comparable portfolio's excess returns, COMP. We regress $SINPORT_t$ and $SINCOMP_t$ against six different factors controlling for the market return under CAPM, $MKTRF_t$, the abnormal return of small firms, SMB_t, the abnormal return of value stocks over growth stocks, HML_t, the returns related to momentum, MOM_t, the returns associated with low beta stock outperforming high beta stocks, BAB_t, and return compensation for illiquidity, $ILLIQ_t$. The β represents the different loadings on the corresponding factors and ε_t the model's error term. The α is the relevant variable in this regression, and per the consensus that sin stocks generate excess returns, we expect the alpha to deviate positively from zero for both specifications.

5.3 Analyzing the Valuation and Financing of Sin Stocks

The last set of tests investigates hypotheses four, five, and six, relating to the companies' valuation and corporate financing decisions. We define several different metrics for a more comprehensive perspective on the valuation and financing differences. Cross-sectional regressions are performed for each of the metrics, as specified below:

$$CVALUATION_{it} = B_0 + B_1 SINDUM_{it} + B_2 X_{it} + \varepsilon_{it} \quad (3)$$

In the model, $CVALUATION_{it}$ is the valuation metric of the company *i* at time *t*. The valuation metrics include market to book, $LOGMB_{it}$, and market to revenue, $LOGMREV_{it}$. As argued before, we use the natural logarithm to normalize the data, applicable in this case due to the large spread of multiple valuation levels. Furthermore, X_{it} is a vector of firm characteristics defined as in model (1), with the exemption of market to book, which is the dependent variable in this regression. ε_{it} is the error term. In this model, coefficient B_1 is of relevance. We estimate B_1, the coefficient of SINDUM, to be significantly negative, in line with lower valuations of sin stocks.

To analyze the impact a potential undervaluation would have on the cost of capital, we analyze firms' corporate financing decisions in the sample. The cross-sectional regression to test the fifth and sixth hypotheses related to corporate financing is specified below:

$$FINANCING_{it} = C_0 + C_1 SINDUM_{it} + C_2 X_{it} + \varepsilon_{it} \quad (4)$$

The dependent variable $FINANCING_{it}$ comprises the following variables: $MLEV_{it}$, $BLEV_{it}$, and $PAYOUT_{it}$. The dependent variables are defined in section 4.3. As in the previously outlined models, $SINDUM_{it}$ equals one if a firm is classified as a sin stock and zero otherwise. Likewise, X_{it}

is a vector of the same firm characteristics used in regression (1). ε_{it} is the error term. We expect sin stocks to finance themselves with debt to a larger extent due to the consequently higher cost of equity. Correspondingly a significant positive C_1 dummy is projected for the $PAYOUT_{it}$ tests, indicating an ability to sustain higher dividend levels for sin stocks.

6. Results and Analysis

This section presents the empirical analyses' results, divided into the three areas the outlined hypotheses aim to investigate. Section 6.1 presents the empirical evidence related to the first and second hypotheses regarding institutional ownership and sell-side analyst coverage of sin stocks. Section 6.2 presents the empirical evidence regarding the third and fourth hypotheses, regarding the overperformance of sin stocks. After that, section 6.3 presents the empirical analysis connected to the last two hypotheses related to the valuation and corporate financing decisions of sin stocks. Section 6.4 present the robustness tests of the results. Lastly, the results are discussed and further interpreted in section 6.5.

6.1 Evidence on the Ownership and Coverage of Sin Stocks

First, the institutional ownership is analyzed for the sample, testing the first hypothesis. A sin stock's average institutional ownership is 26.8%, whereas the non-sin sample average is 29.9%. This difference in means is a 10.4% lower institutional ownership level for sin stocks. Panel A of Table 2 presents the results of the equation relating to institutional ownership (1), and various specifications are presented of the equation to control for the difference in institutional ownership. In columns 1-6, the control variables are subsequently included in the cross-sectional regression. It can be concluded from the test that the coefficient of SINDUM is significantly negative at the 5% level. The coefficient is -0.04, indicating that sin stocks are less likely to be held by institutions, in line with the outlined hypothesis. This coefficient implies that in the last regression incorporating all control variables, sin stocks have approximately 13.4% lower institutional ownership than characteristically similar stocks. The size of a company offers most of the explanatory power in the analysis and is related to a statistically significant higher institutional ownership at the 1% level, in terms of LOGSIZE, indicating that institutions prefer large corporations. The coefficient of SININD is positive; however, it is insignificant. Hence, institutional investors do not seem to shun away from investment in firms in comparable industries. In sum, the results are consistent in indicating that institutional investors are more likely to exclude sin stocks following Hong and Kacperczyk (2009). Thus, a similar story seems to apply to the Swedish stock market as in the US and global stock markets.

Second, in line with the lower institutional interest in holding sin stocks, they also present a lower sell-side analyst coverage. In our sample, sin stocks, on average, have 1.01 analysts covering them, while non-sin stocks are covered by 1.61 analysts - a difference of 37.2%. Panel B of Table 2 presents the results of the equation relating to analyst coverage (1). The tests employ the same

control variables as in the previous test and are likewise added in columns 1-6. Based on the performed tests, sin stocks have lower analyst coverage, controlling for other firm-specific factors. The SINDUM variable has a coefficient of -0.108 and is statistically significant at the 5% level controlling for independent variables. Concretizing the results in terms of the number of analysts implies that sin stocks have approximately 16.7% fewer analysts following them than a comparable non-sin stock. Thus, our findings support the second hypothesis, and in line with Hong and Kacperczyk (2009), demonstrate that sin stocks are less likely to be covered by sell-side analysts. In line with the previous regressions, larger companies are more likely to be covered by sell-side analysts. The firm size (LOGSIZE) explains a substantial portion of the variation as the R-square increases from 0.379 to 0.656 when introducing the variable, indicating that size is an important parameter for analyst coverage. The variable is significantly positive at the 1% level with a coefficient of 0.346, implying that sell-side analysts cover large firms to a more considerable extent than comparable firms. The higher coverage might be attributable to broader exposure, more capital market transactions amongst larger corporations and subsequently an increased likelihood of attracting new business, providing an economic incentive that justifies the cost of covering a company. The inverse of price (PRINV) also has significantly positive coefficients at the 1% level. Meanwhile, high-value stocks with high market-to-book levels are associated with lower coverage, statistically significant at the 10% level. Interestingly, value stocks have higher analyst coverage than growth stocks, as indicated by the negative LOGMB coefficient of -0.056 when controlling for all variables, potentially explained by the fact that many analysts cover value stocks because they are of higher interest to institutional investors as they offer more predictable development and lower downside than growth stocks.

Notably, the SINDUM coefficient is insignificant in the first two regression specifications when controlling for the inverse of price and return on equity along with time-fixed, industry-fixed, and market-fixed effects. However, as more control variables are added, the SINDUM variable becomes statistically significant. This could be explained by the fact that exogenous variables (e.g. time-fixed effects and inverse of price) capture most of the variation when not controlling for endogenous variables stemming from capital market fundamentals. The SINDUM variable becomes statistically significant after adding variables with a higher degree of connection to a company's listed equity such as market capitalization and beta.

Besides, we performed two unreported tests related to institutional ownership and analyst coverage where we split the SINDUM and SININD variables into two time periods, period one spanned 2004-2012 whereas period two spans 2013-2019. The unreported tests show that institutional ownership and analyst coverage of sin stocks are significantly negative for period two

whereas they are negative but insignificant for the first period, indicating that institutions are lowering their holdings in sin stocks. This might be related to socially responsible investing gaining more traction in later years which sell-side analysts are recognizing by lowering their coverage of sinful companies[1].

To conclude this section, the results support the first two hypotheses, and the evidence shows that Swedish stocks, during the period 2004-2019, have statistically and economically significantly lower institutional ownership and analyst coverage relative to comparable firms. Hence, we find evidence that is in line with Hong and Kacperczyk's (2009). Institutions shun away from sin stocks, and sell-side analysts follow them to a lower extent in the Swedish stock market. Furthermore, it should be noted that the methodology employed is more conservative than that of Hong and Kacperczyk (2009), as we add two dimensions by controlling for market-fixed effects alongside time-fixed effects.

[1] Results available from the authors.

Table 2. Institutional Ownership and Analyst Coverage 2004-2019

Panel A: Institutional Ownership 2004-2019

VARIABLES	IO (1)	IO (2)	IO (3)	IO (4)	IO (5)	IO (6)
SINDUM	**-0.023**	**-0.022**	**-0.045*** **	**-0.041** **	**-0.041** **	**-0.040** **
	(0.015)	(0.015)	(0.017)	(0.018)	(0.018)	(0.017)
SININD	-0.034	-0.032	-0.039	-0.036	-0.036	-0.036
	(0.050)	(0.050)	(0.045)	(0.048)	(0.048)	(0.047)
PRINV	-0.006**	-0.005**	-0.004	-0.003	-0.003	0.006
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.004)
ROE		0.005	0.006	0.005	0.005	-0.001
		(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
LOGMB			0.026***	0.027***	0.027***	-0.001
			(0.009)	(0.009)	(0.009)	(0.008)
STD				-0.161***	-0.162***	-0.027
				(0.050)	(0.051)	(0.044)
BETA					0.015	-0.003
					(0.020)	(0.020)
LOGSIZE						0.048***
						(0.004)
Constant	-0.008	-0.009	-0.033	-0.004	-0.021	-0.884***
	(0.026)	(0.026)	(0.028)	(0.031)	(0.029)	(0.083)
Observations	4,980	4,980	4,980	4,980	4,980	4,980
R-squared	0.287	0.288	0.300	0.305	0.305	0.420

Panel B: Analyst Coverage 2004-2019

VARIABLES	ACOV (1)	ACOV (2)	ACOV (3)	ACOV (4)	ACOV (5)	ACOV (6)
SINDUM	**-0.024**	**-0.021**	**-0.140*** **	**-0.118** **	**-0.118** **	**-0.108** **
	(0.056)	(0.056)	(0.052)	(0.054)	(0.054)	(0.046)
SININD	-0.016	-0.007	-0.044	-0.022	-0.023	-0.020
	(0.166)	(0.166)	(0.132)	(0.137)	(0.137)	(0.124)
PRINV	-0.039**	-0.035**	-0.027**	-0.023*	-0.022*	0.046***
	(0.015)	(0.015)	(0.013)	(0.012)	(0.012)	(0.016)
ROE		0.029**	0.036**	0.029*	0.029*	-0.017
		(0.014)	(0.017)	(0.016)	(0.016)	(0.011)
LOGMB			0.134***	0.145***	0.145***	-0.056*
			(0.031)	(0.030)	(0.030)	(0.029)
STD				-1.048***	-1.063***	-0.091
				(0.231)	(0.234)	(0.108)
BETA					0.190**	0.059
					(0.077)	(0.077)
LOGSIZE						0.346***
						(0.026)
Constant	0.086	0.083	-0.042	0.146	-0.064	-6.284***
	(0.088)	(0.089)	(0.083)	(0.089)	(0.111)	(0.478)
Observations	4,980	4,980	4,980	4,980	4,980	4,980
R-squared	0.351	0.352	0.368	0.378	0.379	0.656

Notes: (1) This table presents the results from the performed tests regarding the institutional ownership and analyst coverage of sin stocks between 2004-2019 performed on an annual basis. (2) The dependent variables are listed in the respective panel. IO is the institutional ownership of a stock in % of total outstanding value, ACOV is the natural logarithm of the number of sell-side analysts covering the company plus one. (3) PRINV is the inverse of the stock price, ROE is the net income divided by equity, LOGMB is the natural logarithm of the market to book ratio, STD is the standard deviation of the stock price, BETA is the beta of the overarching GICS industry compared to the market, LOGSIZE is the natural logarithm of the market capitalization, SININD equals one if the company is in the same overarching industry as a sin stock and 0 otherwise, SINDUM equals 1 if the company is defined as a sin stock and 0 otherwise. (4) Time-fixed, industry-fixed, and market-fixed effects are employed. (5) Eicker-Huber-White (White, 1980) standard errors in parentheses, clustered at the six-digit GICS code level. (6) *** p<0.01, ** p<0.05, * p<0.1

6.2 Evidence on the Performance of Sin Stocks

Following the neglected stock theory (Merton, 1987), the observed lower institutional ownership of sin stocks should transfer to overperformance of sin stocks relative to their comparable stocks (see, e.g., Fabozzi et al., 2008; Hong & Kacperczyk, 2009; Liston & Soydemir, 2010). As observed in Panel A of Table 3, testing for the Carhart (1997) four-factor model plus the BAB and ILLIQ factors (see equation 2), sin stocks generate statistically significant alpha. The monthly alpha is 1.4% and statistically significant at the 1% level. In other words, sin stocks generate an annual abnormal return of around 18.7% between 2004 and 2019. It is notable that the market factor, MKTRF, size factor, SMB, and momentum factor, MOM, offer high explanatory value with significantly positive beta coefficients at the 1% level, while the HML is insignificant when controlling for the beforementioned factors. Interestingly, the factoring loading of 0.16 on BAB is positively significantly at the 5% level, indicating that the betting against beta factor partially explains the excess returns as the alpha decreased from 1.71% to 1.49% when introducing the BAB variable to the Carhart four-factor model (column 5). Hence, BAB seems to be a priced factor when considering sin stocks and contributes to explaining the variation in returns by improving the R-square by two percentage points.

The largest contributor to explaining the returns seems to be the SMB beta factor since its introduction to the model increased the R-square by about seven percentage points (column 1 vs column 2). In the last regression specification, the factor loading on SMB is 0.941 which indicates that the returns of the sin portfolio behave similarly to the SMB portfolio. The SMB portfolio in itself is associated with abnormal returns of smaller companies outperforming larger ones over the long term (Fama & French, 1993). Overall, sin stocks display overperformance relative to the Carhart four-factor model when including BAB and ILLIQ.

Further, we introduce the SINCOMP portfolio regression (see equation 2) to control for the performance of sin stocks relative to its comparable group. Panel B of Table 3 displays that sin stocks generate statistically significant abnormal returns of 1.2% per month at the 5% level, corresponding to 15.5% per annum between 2004 and 2019 when controlling for all factors. The illiquidity beta factor has low explanatory power; however, the factor has a high correlation with the SMB factor, resulting in the SMB factor loading becoming statistically insignificant when incorporating the ILLIQ factor into the model. This is not surprising since the two factors capture similar effects. Smaller stocks are likely more illiquid and generate abnormal returns due to their size, characteristics, and illiquidity. The momentum factor is the only beta factor in the model with a statistically significant beta at 0.254, albeit with lower significance at the 10% level after

introducing the BAB and ILLIQ factors. The SINCOMP portfolio covaries positively with the momentum portfolio and generates a 0.254% return for every percentage point return in the MOM portfolio.

In columns 1-7, the factors are subsequently added except for BAB and ILLIQ, tested separately and together with the Carhart model. As all factors are included, the explanatory power increases, signifying the value of including all six factors known to impact the magnitude of returns. This conservative methodology, comparing sin stocks to comparable stocks, SINCOMP, regressed against the Carhart (1997) four-factor model including BAB and ILLIQ, indicates that the results are robust to factors known to impact the level of returns. Hence, the results suggest that sin stocks significantly outperform comparable stocks in Sweden during 2004-2019, thereby supporting our third hypothesis. The overall results are thus far aligned with Hong and Kacperczyk (2009), displaying lower institutional ownership and analyst coverage and subsequent overperformance of sin stocks in the Swedish stock market. The outperformance of sin stocks is robust to expanding the Carhart four-factor model (1997), including the BAB and ILLIQ factors. Although the SINCOMP significance level remains at 5% when adding BAB and ILLIQ to the Carhart four-factor model, the magnitude of alpha decreases. The results point towards that neither cyclicality (BAB) nor illiquidity explain the sin stock return anomaly.

Table 3. Sin Stock Returns 2004-2019 Tests

Panel A: SINPORT Returns 2004-2019

VARIABLES	(1) SINPORT	(2) SINPORT	(3) SINPORT	(4) SINPORT	(5) SINPORT	(6) SINPORT	(7) SINPORT
Alpha (%)	**1.68%*** **	**1.61%*** **	**1.83%*** **	**1.71%*** **	**1.49%*** **	**1.62%*** **	**1.44%*** **
	(0.57%)	(0.54%)	(0.53%)	(0.52%)	(0.51%)	(0.52%)	(0.51%)
MKTRF	0.473***	0.545***	0.653***	0.733***	0.599***	0.697***	0.584***
	(0.118)	(0.114)	(0.113)	(0.115)	(0.121)	(0.114)	(0.118)
SMB		0.490***	0.470***	0.761***	0.650***	1.129***	0.941***
		(0.165)	(0.161)	(0.170)	(0.152)	(0.271)	(0.264)
HML			-0.561***	-0.130	-0.055	-0.070	-0.017
			(0.197)	(0.238)	(0.240)	(0.240)	(0.241)
MOM				0.316***	0.290***	0.307***	0.285***
				(0.105)	(0.100)	(0.103)	(0.100)
BAB					0.176**		0.160**
					(0.0741)		(0.073)
ILLIQ						-0.286	-0.218
						(0.181)	(0.172)
Observations	191	191	191	191	191	191	191
R-squared	0.074	0.143	0.175	0.215	0.235	0.224	0.240

Panel B: SINCOMP Returns 2004-2019

VARIABLES	(1) SINCOMP	(2) SINCOMP	(3) SINCOMP	(4) SINCOMP	(5) SINCOMP	(6) SINCOMP	(7) SINCOMP
Alpha (%)	**1.23%** **	**1.20%** **	**1.37%** **	**1.27%** **	**1.21%** **	**1.27%** **	**1.21%** **
	(0.60%)	(0.60%)	(0.60%)	(0.59%)	(0.58%)	(0.59%)	(0.58%)
MKTRF	-0.141	-0.113	-0.028	0.039	-0.002	0.036	-0.002
	(0.120)	(0.121)	(0.134)	(0.139)	(0.145)	(0.141)	(0.146)
SMB		0.185	0.169	0.410**	0.376**	0.438	0.376
		(0.122)	(0.124)	(0.188)	(0.190)	(0.294)	(0.313)
HML			-0.444*	-0.087	-0.064	-0.082	-0.064
			(0.268)	(0.314)	(0.317)	(0.313)	(0.316)
MOM				0.262**	0.254**	0.261**	0.254*
				(0.127)	(0.129)	(0.127)	(0.129)
BAB					0.053		0.053
					(0.090)		(0.093)
ILLIQ						-0.022	0.000
						(0.168)	(0.178)
Observations	191	191	191	191	191	191	191
R-squared	0.006	0.015	0.033	0.059	0.060	0.059	0.060

Notes: (1) This table presents the results from the performed tests regarding the performance of sin stocks and sin stocks relative to comparable firms 2004-2019 performed on a monthly basis. (2) SINPORT is the portfolio of sin stocks while SINCOMP is a portfolio long sin stocks and short comparable firms. (3) MKTRF is the excess return of the market, SMB is a portfolio long small and short big companies, HML is a portfolio long high-quality firms and short low-quality firms, MOM is a portfolio long previous month's winners and short the losers, BAB is a portfolio long low beta firms and short high beta firms, and ILLIQ is a portfolio long low liquidity firms and short high liquidity firms. (4) Alpha is the intercept, or the constant in the regression. (5) Robust standard errors in parentheses. (6) *** p<0.01, ** p<0.05, * p<0.1

6.3 Evidence on the Valuation and Financing of Sin Stocks

The fourth hypothesis alludes that overperformance should imply undervaluation of sin stocks. The results for equation (3) are presented in Table 4. Columns 1-2 test the two outlined valuation metrics, market-to-book (LOGMB) and market-to-revenue (LOGMREV). From the performed regressions, sin stocks are indicatively overvalued in terms of MB and MREV at the 1% significance level. The SINDUM coefficient for MB is 0.761, indicating an overvaluation of 189.7% to comparable firms. Interestingly, SININD is positive for MB and MREV and statistically significant at the 1% level for the MREV regression, indicating that the comparable firms are also overvalued. As for MREV, the coefficient for SININD of 1.482 indicates that companies in the same overarching industries as the classified sin stocks are overvalued, having an MCAP/REV about seven times higher than the sample average. Another notable observation is that the ROE coefficient is negative and statistically significant at the 10% level for both dependent variables. Thus, opposite to what can be expected, higher returns on equity are associated with lower valuations. This would support a development where investors increasingly turn to growth stocks with lower profitability, meaning that profitable firms might become relatively undervalued. When controlling for the independent variables, it alludes to that sin stocks are overvalued to comparable firms, contrasting the findings of Hong and Kacperczyk (2009). While the overperformance of sin stocks seems to be connected to the level of institutional ownership, we cannot present evidence that this relates to an undervaluation. Hence, the results show that sin stocks are overvalued relative to their peers, which is the opposite of our expectations. It should, however, be noted that our methodology differs slightly from Hong and Kacperczyk (2009) as the control variables are constant across the regression. In contrast, the authors use different control variables for different regressions, potentially introducing dataset heterogeneity, and we employ time-fixed effects. This should ensure that our results are not biased in any way.

The fifth hypothesis outlines that an undervaluation of sin stocks increases the cost of equity, making firms take on higher levels of debt than comparable firms. The results from equation (4) are presented in Table 4. Columns 3-4 refer to the company's corporate financing decisions for market and book leverage (MLEV and BLEV). While no undervaluation could be evidenced in the previous section, the presented results indicate that sin stocks take on higher debt levels than comparable firms. The coefficient of SINDUM for MLEV is 2.565 and statistically significant at the 1% level, while the coefficient for BLEV is 0.086, albeit not statistically significant. Hence, sin stocks seemingly take on approximately five times higher market leverage and 19.54% higher book leverage than similar firms. Furthermore, investigating the sixth hypothesis regarding the ability to

sustain higher dividends for sin stocks, the coefficient of SINDUM is significantly positive at the 1% level (see column 5 in Table 4). The results indicate that sin stocks can sustain higher dividends than comparable firms in the magnitude of approximately 49.6% (2pcp) higher than comparable firms. LOGSIZE is also statistically significant and positive at the 1% level, implying that large corporations can sustain higher dividends per share. SININD is also positive and significant at the 10% level, indicating that the overarching industries that sin stocks belong to can sustain higher payout ratios.

In sum, the results indicate that hypothesis 4 is rejected and that sin stocks are overvalued relative to comparable firms. However, the results indicate that sin stocks are more likely to take on higher leverage indicating a higher cost of equity for sin stocks, thereby supporting hypothesis 5. Likewise, the results support our anticipation (hypothesis 6) that sin stocks should sustain higher dividend payout as the results show that sin stocks have higher payout ratios when controlling for firm characteristics. However, a higher cost of equity does not seem to be related to an undervaluation of sin stocks. Potential explanations to the findings are presented in the discussion of the results.

Table 4. Valuation and Corporate Financing Decisions Tests 2004-2019

	Valuation		Corporate Financing Decisions		
	(1)	(2)	(3)	(4)	(5)
VARIABLES	LOGMB	LOGMREV	BLEV	MLEV	PAYOUT
SINDUM	**0.761*** **	**1.674*** **	**0.086**	**2.565*** **	**0.018*** **
	(0.075)	(0.071)	(0.811)	(0.726)	(0.005)
SININD	0.226	1.482***	-0.585	0.470	0.011*
	(0.222)	(0.160)	(1.016)	(0.501)	(0.006)
PRINV	-0.020	-0.057	0.122***	0.054	-0.006
	(0.028)	(0.042)	(0.042)	(0.056)	(0.004)
ROE	-0.061*	-0.098*	0.260	-0.062	0.001
	(0.036)	(0.051)	(0.403)	(0.056)	(0.002)
STD	1.480***	3.431***	0.226	1.047	-0.074
	(0.347)	(0.534)	(1.191)	(0.687)	(0.047)
LOGMB			-0.298	-1.429	0.000
			(0.945)	(0.921)	(0.001)
BETA	-0.057	0.369***	-1.552*	0.749	0.002
	(0.085)	(0.120)	(0.908)	(0.514)	(0.008)
LOGSIZE	0.196***	0.219***	-0.048	0.179	0.006***
	(0.031)	(0.0335)	(0.184)	(0.158)	(0.001)
Constant	-2.897***	-2.917***	5.685*	-3.246	-0.112***
	(0.580)	(0.637)	(3.398)	(3.027)	(0.023)
Observations	4,980	4,980	4,980	4,980	2,658
R-squared	0.311	0.444	0.045	0.135	0.082

Notes: (1) This table presents the results from the performed tests regarding the valuation and corporate financing decisions of sin stocks 2004-2019, performed on an annual basis. (2) The dependent variables are listed in the five columns, LOGMB is the natural logarithm of the market to book ratio, LOGMREV is the natural logarithm of the market to revenue ratio, BLEV is the net debt divided by the book value of equity, MLEV is the net debt divided by the market capitalization, PAYOUT is the dividend divided by the stock price. (3) PRINV is the inverse of the stock price, ROE is the net income divided by equity, STD is the standard deviation of the stock price, BETA is the beta of the overarching GICS industry compared to the market, LOGSIZE is the natural logarithm of the market capitalization, SININD equals one if the company is in the same overarching industry as a sin stock and 0 otherwise, SINDUM equals 1 if the company is defined as a sin stock and 0 otherwise. (4) Time-fixed, industry-fixed, and market-fixed effects are employed. (5) Eicker-Huber-White (White, 1980) standard errors in parentheses, clustered at the six-digit GICS code level. (6) *** p<0.01, ** p<0.05, * p<0.1

6.4 Robustness Tests

To test the robustness of our findings and expand the thesis' contribution, additional tests are considered.

6.4.1 Our Results are not Sensitive to the Choice of Benchmark

In performing the outlined tests regarding the comparable portfolio, there might be a concern that the selected industries positively impact the results. We test the robustness of the sin stock outperformance by comparing the returns of the sin stock portfolio and the market (in line with Fabozzi et al., 2008; Blitz & Fabozzi, 2017). Thereby, we can compare the results to the comparable portfolio and illuminate any potential bias in selecting peers.

The results (see Table 6, appendix) show that the overperformance of sin stocks is even more substantial when compared to the market. Testing for a four-factor model, the overperformance is significant at the 1% level and more economically significant at 22.6% overperformance per annum (column 4). Additionally, the monthly alpha of 1.4% is statistically significant at the 1% level when considering a six-factor model (column 7). It seems as if the BAB factor explains a larger portion of the results with this dependent portfolio, being significantly positive at the 1% level with a factor loading of 0.160. The dependent portfolio is also more sensitive to the SMB portfolio's performance as the beta is 0.94 indicating a strong covariation with the SMB portfolio, meaning that the sin portfolio exhibits characteristics very similar to small firms. In contrast, the market portfolio is comparable to the big firms when controlling for six factors in the model.

6.4.2 Our Results are not Sensitive to the Composition of Owners

Hong and Kacperczyk (2009) showed that institutional investors are less likely to own sin stocks than other investors and argued that mutual funds and hedge funds are the most likely arbitrageurs in this group of investors. To provide a comprehensive analysis, we investigate the institutional investors' subgroups. Based on Capital IQ, we categorize institutional investors into five groups: Wealth funds, Family offices, Trusts, and Endowments (WFE), Government Pension Sponsors (GPS), Other Pension Sponsors (OPS), Financial institutions (FI), e.g. banks and insurance companies, and Other financial companies (OFC), for instance, private equity (PE) and hedge funds.

We identify several interesting results in this analysis (see Table 7, appendix). First, the primary drivers of institutions' significantly lower ownership levels are the OPS, FI, and WFE categories. These investors hold a substantially lower portion of their investments in sin stocks, with negative

and statistically significant coefficients at the 1% level for FI, 5% level for OPS, and 10% for WFE. The economic interpretation is noteworthy, where controlling for all factors implies average ownership of sin stocks 19.6%, 38.3%, and 14.1% below similar non-sin stocks for FI, OPS, and WFE, respectively. However, the lower ownership might be attributable to limited investment mandates, industry biases, and diverging objectives compared to other institutions. Second, OFC has a positive, statistically significant SINDUM coefficient at the 5% level of 0.002 after controlling for firm characteristics. This result implies that other financial companies (e.g. hedge funds) hold 29.6% more sin stocks than the average holdings of non-sin stocks with similar characteristics. Lastly, in contrast to the expectation, GPS holds significantly higher levels of sin stocks, with a positive SINDUM coefficient of 0.004 significant at the 1% level, corresponding to 16.2% higher ownership relative to comparable stocks. GPS and OFC thus constitute arbitrageurs within the institutional investor category. This finding paints an exciting picture, in which government pension sponsors have more leeway in defining what is sinful or not. Meanwhile, financial institutions, other pension sponsors, family offices, trusts, and endowments seem to avoid sin stocks to a more considerable extent and might have more to lose from their investor bases in terms of reputational risk. This result reflects well on Hoepner and Schopohl's (2016) findings, showing that the AP funds' negative screening does not negatively impact their returns.

6.4.3 Our Results are not Sensitive to the Definition of the Sin Stock Portfolio

Several authors have included the defense industry in the sin stock definition (e.g., Richey, 2014; Blitz & Fabozzi, 2017). Regarding the inclusion of defense stocks, there is no real virtue as to whether they are considered sinful or not. However, given the context of the data, since Sweden is a neutral country, it is arguably the case that most consider the defense industry sinful. We thus augment the sin stock portfolio with defense companies and the comparable portfolio to reflect the inclusion. The construction of the portfolios is presented in the appendix (A.1).

From the performed tests (see Table 8, appendix), the previous results remain. Sin stocks, including defense stocks, create abnormal returns controlling for a six-factor model. The inclusion strengthens the portfolio results, with an alpha significant at the 1% level. The monthly alpha is 1.3% in the last regression, including ILLIQ and BAB, indicating an overperformance of 16.3% per annum. This finding is consistent with defense companies being considered sinful in the Swedish market and thus excluded by institutional investors, generating subsequent abnormal returns. However, in contrast to the results of the regressions on the triumvirate of sin, the excess returns of the market (MKTRF) have negative factor loading of -0.262 statistically significant at the 5% level while the SMB factor-beta of 0.383 remains significant at the 10% level after including

the BAB and ILLIQ factors. The momentum factor loading is also positively significant at the 1% level when including defense companies, while it was statistically significant at the 10% level before including defense in the definition of sin. These results indicate that broadening the sin portfolio to include defense companies alters the factor loadings and exhibits larger covariation with the market rather than momentum and small minus big factors. The performed regressions offer higher explanatory power when broadening the definition of sin to include defense companies (as expected with a more diversified portfolio with lower idiosyncratic risk).

In addition to defense stocks, oil, gas, and coal stocks are arguably sinful. We thus adopt and expand the sin portfolio to include fossil fuel companies as a robustness test. This test is performed to conform to current research and practitioners in defining what constitutes a sinful industry.

In line with the previous results, sin stocks, including defense companies and fossil fuel companies, generate significant abnormal returns at the 5% level relative to comparable firms after controlling for a four-factor model (see column 4, Table 9). Interestingly, when including fossil fuel in the definition of sin, the betting against beta (BAB) factor and the illiquidity factor (ILLIQ) become statistically significant at the 10% and the 1% level, respectively, while the other factors are insignificant. Hence, the factor loadings change when further expanding the definition of sin and the overall portfolio seemingly become more illiquid with a beta of 0.402 and, to a larger extent, incorporates low beta assets that outperform high beta assets, albeit marginally as the factor loading is 0.106 for the BAB factor. Controlling for the six-factor model, the alpha remains positive, albeit lower compared to the previous definitions of sin stocks, at 0.90% per month, which is economically significant and yields approximately 11.3% abnormal returns per year[2].

One potential explanation for the lower level of returns is the lower congruence regarding whether oil, coal, and gas companies are sinful. While there is a consensus that fossil fuel energy is bad, it has often been necessary to provide households with electricity, transport goods and humans from point A to B, and keep vital societal functions in motion. Hence, it is more of a gray zone than gambling or tobacco due to the essential role in society and limited alternatives. Moreover, starting in the last years, the AP-funds have excluded fossil fuel companies, indicating higher market sentiment to fossil fuel companies' sinfulness (AP2, 2020). Relating the results to Pastor et al. (2020), the recent exclusion of fossil fuel companies might have had a pricing (and return) effect as investors might dislike the substantial climate risk these stocks carry. Thus, moving

[2] For the avoidance of doubt, a portfolio of defense and fossil fuel stocks (as defined in the appendix, A.1) has positive insignificant lower alpha than the triumvirate of sin, indicating that they outperform their comparable portfolio. Results available from the authors.

forward the expected return might be higher for fossil fuel companies due to certain investors excluding this industry. To conclude, abnormal results of sin stocks are robust, including both defense and fossil fuel companies, indicating that these companies also generate abnormal returns because of social stigma. These industries are frequently considered vice companies and negatively screened out by investors.

6.4.4 Critical Review of our Methodology

The outlined empirical methodology could be improved in multiple ways and expanded for more comprehensive conclusions. First, in collecting the data, the analysis might suffer from a selection bias. We exclude firms without available data, and hence a risk is that the excluded firms present characteristics not captured in the models. Thus, in analyzing the Swedish market, excluding individual stocks due to missing data points could imply that the results are not fully representative. However, given that all available data are employed, it is the best approximation.

Moreover, the selection of data spans an abbreviated period, from 2004 to 2019. In this period, there has been an increased focus on SRI investments in Sweden, as evidenced by Anderson and Robinson (2019) and the exclusion criteria based on ethicality in place by the AP funds (see Sandberg et al., 2014; Du Rietz, 2016). Expanding the timeframe might have enabled a more comprehensive analysis of sin stocks in the Swedish market. A last note on the data considers the number of data points. Even though all performed tests show sufficient statistical power, the first two years have a limited number of sin stocks.

Furthermore, gambling stocks constitute a large part of the data compared to research in other regions (Richey, 2017; Fabozzi et al., 2008). In addressing the issues related to the data's timing, the number of data points, and industry skewness, we performed two robustness tests to make the results more conclusive. The robustness tests broadened the definition of sin stocks to include defense (e.g., weapon manufacturers) and fossil fuel companies (e.g., oil, coal, and gas).

Another limitation to this study and previous literature on the subject is that it is impossible to formulate a perfect comparable portfolio as it does not exist. This mismatch could impact the results due to different characteristics between the comparable firms and sin stocks. The problem is approached by replicating the most credible research methodology on the topic and controlling for a four-factor model, and then adding two more factors, BAB and ILLIQ. However, notably, the selected peer group does not entirely reflect the characteristics of sin stocks, albeit a much more conservative alternative than comparing the returns to the overall market or the six-factor model. To control for a selection bias in the comparable portfolio, a robustness test is included comparing the sin stock portfolio to the market. Another potential issue in the methodology might

be an endogeneity issue. Richey (2017) and Blitz and Fabozzi (2017) present evidence that the significance of outperformance of sin stocks disappears by adding an investment and profitability factor to the model. While not possible with Swedish data since the factors are not available, this is a limitation to the thesis. Another limitation of this thesis is that we have not included future financial estimates by analysts, which might influence the valuation tests. The reason for not including estimates is that the sample would be too limited as a majority of the sample lacks future analyst estimates.

6.5 Discussion of the Results

The results from the performed tests indicate that institutions have lower ownership of sin stocks in percentage of total share capital and consequently lower analyst coverage in the Swedish market between 2004 and 2019. In previous literature, exclusionary screening by institutions of sin stocks has been outlined to explain their overperformance (Richey, 2017). Accordingly, institutional investors seem more likely to negatively screen out sin stocks in the performed tests, having 13.4% lower ownership testing for control variables. Subsequently, the evidence shows that sin stocks have 16.7% lower analyst coverage. We present evidence that results related to these tests are driven by the latter period in the sample (2013-2019), which aligns well with the empirical data on SRI investing. The exponential growth in SRI investing and negative screening internationally (USSIF) and in Sweden (Andersson & Robinson, 2019) in the last years seems to coincide with a sequentially lower ownership and analyst coverage of sin stocks. Moving forward, it can be expected that this channel of impact on the ownership will become even stronger for sin stocks. One potential consequence of a more restricted investor base could be that more companies considered to be vice chose not to go public or go private.

Hong and Kacperczyk (2009) argued that the lower ownership and analyst coverage should imply higher returns of sin stocks. Albeit not directly tested, our results show a substantial overperformance as well. We show that sin stocks outperform the market controlling for a four-factor model (Carhart, 1997) and six-factor model, including BAB and ILLIQ factors. We evidence that investors excluding sin stocks and invest in comparable companies leave approximately 15.5% yearly overperformance on the table during the investigated period between 2004 and 2019 and that sin stocks overperform the six-factor model by 18.7% per annum.

Contrasting the outlined hypothesis, we cannot show an undervaluation of sin stocks in the market to book or market to revenue. However, it should be noted that the methodology is slightly more conservative than Hong and Kacperczyk's (2009) as we employ more control variables and time-fixed and market-fixed effects. Moreover, previous literature has shown that sin stocks are

not always undervalued outside of the US and even overvalued (McDonald & Fauver, 2012). Despite the lack of proof of an undervaluation of sin stocks, they seem to have a higher cost of equity indicated by their higher indebtedness levels, particularly for market leverage, for sin stocks to comparable firms. The market leverage of a sin stock is approximately five times higher than comparable firms. Thus, in performing the initial tests, we are able to replicate the results from Hong and Kacperczyk (2009) except for the undervaluation of sin stocks. A similar story is illustrated; institutions neglect sin stocks; sin stocks have a lower analyst coverage and overperform the market and comparable firms. However, in contrast to the authors' findings, we do not find evidence that sin stocks are undervalued. Regardless of the valuation, sin stocks' corporate financing decisions align with Hong and Kacperczyk's (2009) results, as they are more likely to finance themselves by debt. We argue that the fact that sin stocks have a more restricted investor base might lead to difficulties accessing equity markets to comparable firms. Moreover, since market valuations reflect the future outlook of companies, higher multiples could reflect higher expectations of the future and not an overvaluation.

Additionally, the employed valuation metrics might not reflect the fundamental valuation of sin stocks. Sin companies might consider themselves undervalued despite the presented evidence, indicating that they would be more reluctant to finance themselves through equity issuances. To conclude, the sin stock anomaly is suggested to endure in a new setting, employing Swedish stock data 2014-2019. We present statistically significant evidence supporting five of the six outlined hypotheses to different extents (see below for a summary of the results).

Hypothesis	Explanation	Finding	Significance level
1.	Sin stocks have lower institutional ownership.	Supported	5%
2.	Sin stocks have fewer sell-side analysts covering them.	Supported	5%
3.	Sin stocks outperform comparable firms.	Supported	5%
4.	Sin stocks are undervalued to comparable firms.	Rejected	1%
5.	Sin stocks have higher leverage than comparable firms.	Supported	1%
6.	Sin stocks have higher payout ratios than comparable firms.	Supported	1%

We shed new light on the sin stock anomaly by presenting evidence that the overperformance of sin stocks is robust to the betting against beta factor and an illiquidity factor. The alpha of the sin stock portfolio remains significantly positive at the five percent level for each test. Likewise, the alpha is robust to including defense and oil, gas, and coal companies in the sin stock portfolio. The results indicate that the overperformance of sin stocks is robust and significantly positive at the

5% level, including defense and fossil fuel stocks. However, the size of the outperformance decreased somewhat, albeit remaining economically significant. We argue that the reasons for these latter findings are twofold. First, there is a consensus that defense is sinful in Sweden over a long period, making this group of companies accurate to include in the sin stock definition. Second, fossil fuel companies are more ambiguous regarding whether they are sinful and have just recently been excluded by the Swedish AP funds indicating an increasing consensus, reflected in the presented empirical evidence.

In accordance with the new theoretical frameworks on ESG investing and the impact on returns (Pastor et al., 2020; Pedersen et al., 2019), sin stocks should be able to sustain higher returns when a large portion of the market are motivated in terms of ESG factors. Hence, the sin stock anomaly should perhaps be considered a factor rather than an anomaly. That is, investors that take on higher climate risk by investing in sin stocks can earn a boycott-premium as motivated investors attain disutility by such investments. Given the increasing amount of funds employing negative screening in the Swedish market (Anderson & Robinson, 2019) that implies that sin stocks are avoided, the results should not be surprising; it implies that more investors factor in ESG in their investment decisions. Thus, while Hong and Kacperczyk (2009) alongside other authors have been able to evidence the sin stock anomaly over time and across markets, they did not have the theoretical frameworks to comprehensively explain the results (and instead relied on the neglected stock theory by Merton, 1987). We instead argue that the larger spread in investors' ESG preferences in Sweden is associated with a higher alpha for sin stocks. Thus, the sin stock portfolio (or negatively screened out industries and companies) should be considered a factor, where investors are being compensated for exposure to additional risks, relating to higher climate betas, lower liquidity, litigation and reputation alongside a boycott premium, rather than an anomaly.

7. Concluding Remarks

This thesis investigates the impact of social norms on the Swedish stock market by exploring the sin stock anomaly, analyzing the Swedish market between 2004 and 2019. To analyze the anomaly, the thesis considers three key areas, ownership and coverage, overperformance, valuation and corporate financing decisions of sin stocks (in line with Hong & Kacperczyk, 2009).

The presented results show that companies involved in vice, e.g. alcohol, tobacco, and gambling, are shunned away by institutional investors and have lower analyst coverage. We present statistically significant evidence related to the overperformance of sin stocks against comparable stocks, with an alpha of approximately 15.5% per year. However, we cannot distinguish a significantly lower valuation of sin stocks relating to the valuation hypotheses. Regardless, sin stocks' corporate financing decisions differ from comparable companies as they use significantly more debt financing and pay higher dividends relative to their share price. In particular, market leverage is around five times higher than comparable firms, and the payout ratio is 49.6% higher than comparable firms. We argue that there are two potential explanations for the contrasting findings regarding valuation and debt financing decisions. Firstly, the valuation metrics might be nonreflecting the company's actual value, and the companies might consider themselves undervalued irrespective of multiple valuations. Secondly, sin stocks might face less liquid equity markets and, as shown, a more limited investor base, diverting them to debt financing. Lower access to the equity market would make the company's valuation useless in deciding how to finance themselves as norm constrained institutional investors would not participate in new issues. Moreover, the high dividend payouts of sin stocks could potentially be due to investor preferences and to cater to certain investor clienteles. We can present statistically and economically significant results for five of the six outlined hypotheses. To conclude, in line with the previous literature on sin stocks, we present evidence that the exponential growth in socially responsible investments has implications for at least sin stocks.

This thesis adds to the frontier of sin stock research by providing new evidence of the robustness of the sin stock anomaly in the Swedish stock market. We present evidence that the overperformance of sin stocks is robust to the betting against beta factor (Frazzini & Pedersen, 2014) as well as an illiquidity factor (Amihud, 2002). Both factors offer limited explanatory power concerning overperformance, while the overperformance of sin remains statistically and economically significant. Given our findings regarding returns and institutional ownership in the Swedish market, we connect to recent theoretical frameworks on ESG investing (Pastor et al., 2020; Pedersen et al., 2019) and argue that the triumvirate of sin stock portfolio could be regarded

as a factor rather than an unexplainable anomaly. Investors are seemingly willing to trade of sin stocks' abnormal returns due to the associated negative utility, allowing an empirical anomaly to persist in the market. Furthermore, in line with previous literature, the overperformance of sin stocks remains economically and statistically significant when expanded to include defense stocks to the triumvirate of sin. Additionally, we add to the current research by presenting evidence that augmenting the definition of sin stocks to include fossil fuel companies in addition to defense stocks results in retention of significantly positive alpha, albeit at lower levels than for the triumvirate of sin definition. Yet, the statistical significance of the positive alpha increases by including defense and fossil fuel companies in the sin stock portfolio and both industries outperform their comparable firms in a six-factor model, albeit statistically insignificant.

Furthermore, we raise questions regarding the definition of sin stocks. Should the research follow the stream in practice that is excluding fossil fuel companies? We provide evidence that this sector can be included in the definition and generate equivalent results in terms of at least outperformance. Besides, negative screening of fossil fuel companies will probably continue and become even more prominent with more regulation concerning the classification of sustainable activities, marketing of funds and disclosure of fund holdings (e.g., the EU taxonomy) as well as goals relating to zero-carbon emission.

More recent findings on sin stock investing (e.g., Richey, 2017; Blitz & Fabozzi, 2017) provides evidence explaining that the sin stock anomaly can persist due to the more conservative investments and higher profitability of sin stocks. This result was shown by controlling for the Fama-French five-factor model, including factors for profitability and investments. Due to the unavailability of these factors in Swedish data, they could not be considered. As a suggestion for future research, it would add value to the debate to see whether these factors better explain the performance in a Swedish market context. Moreover, considering our findings, it would be valuable to investigate fossil fuel companies' performance in the US to test for a similar result.

To wrap up and paraphrase Jane Goodall's quote commencing this thesis; investors conform to constantly evolving social norms and modify their behavior accordingly as societal trends are increasingly being channeled into investment decisions. SRI investing should thus impact the opportunities of companies based on investors' perception of their ESG performance which channels into financing and investment decisions and have an actual impact and real consequences for firms, for instance by indicatively referring sin stocks to a larger degree of debt financing.

8. References

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Appendix

A.1 Constructing the Portfolios

This section presents how the different portfolios in the thesis are composed. The data for GICS codes is collected from Capital IQ and offers narrower definitions of industries than the SIC, allowing a more precise selection. We use the following GICS industry codes to distinguish the triumvirate of sin from the data; alcohol constituting Distillers and Vintners (30201020) and Brewers (30201010); gambling constituting Casino and Gaming (25301010); and tobacco constituting Tobacco (30203010). After that, we specify a portfolio of comparable companies to the sin stock portfolio. Hong and Kacperczyk (2009) use Food, Soda, Fun, and Meals & Hotels as comparable industries. The comparable portfolio to sin stocks is aligned with Hong and Kacperczyk's (2009) definition by using the following GICS codes; Soft Drinks (30201030); Packaged Food & Meats (30202030); Agricultural products (30202010); Hotels, Resorts & Cruise Lines (25301020); Leisure Facilities (25301030); and Restaurants (25301040). We screen the companies to conclude that a company mainly operates within its industry classification, resulting in no exclusions. Two equal-weighted portfolios are created for the corresponding industry classifications, termed SINPORT for the sin portfolio and COMP for the comparable portfolio. A standard critique in formulating such strategies is that they are not viable in practice. Thus, the portfolio rebalances monthly to achieve an equal-weighted portfolio that is practically implementable. It should be noted that financial innovation has enabled investors to buy fractional shares, which implies that it has become practically easier to achieve an equally weighted portfolio without large capital requirements. However, it is not theoretically equally weighted, which would require continuous rebalancing.

In the third robustness test (see section 6.4.3) we include defense and fossil fuel companies in the sin stock portfolio and add firms to the comparable portfolio to reflect the changes. Therefore, the sin portfolio, SIN_{DEF}, is expanded to include Defense (GICS code 20101010). The comparable portfolio, $COMP_{DEF}$, needs to reflect this change. Hence, we add Security and alarm solutions (GICS code 20201080) and Construction machinery and heavy trucks (GICS code 20106010) to the comparable portfolio as peers to the defense stocks. The final definition of sin stocks includes tobacco, alcohol, gambling, defense, and fossil fuel companies, defined as SIN_{DEF+FF}. To adjust the sin portfolio, we include Oil, Gas, and Consumable Fuels (GICS codes 10102020, 10102050, 10102010, and 10101010). Meanwhile, Utilities, GICS code 5510, is correspondingly added to the comparable portfolio, $COMP_{DEF+FF}$.

A.2 Constructing the BAB and ILLIQ Factors

Research has shown that the betting against beta (BAB) factor can explain abnormal returns relative to their riskiness, in terms of market correlation, of low-beta assets compared to high beta assets (Frazzini & Pedersen, 2014). This anomaly is driven by the fact that leverage-constrained investors must invest in higher beta assets to increase their returns, pushing up these assets' prices and implying that neglected low beta assets can generate alpha. This argument should be particularly relevant for sin stocks since the addictive features of the offered products result in low cyclicality and thus translates into lower betas. The average beta for sin stocks in the sample is 0.73, below the sample mean of 0.87. The BAB factor is constructed by ranking the stocks based on their previous month's beta (ex-ante) and constructing two portfolios, one that is long low-beta stocks and one that is short high-beta stocks. We apply rolling three-year betas and utilize daily returns (in line with Frazzini & Pedersen, 2014). Unlike the factor's originators (Frazzini & Pedersen, 2014), we do not employ a rank-weighted methodology for the portfolio. Instead, we construct an equal-weighted BAB factor. These two strategies have been shown to have a 99.6% correlation with equal-weighted having a higher Sharpe ratio, inducing comparable results (Novy-Marx & Velikov, 2018). The top 30% of all stocks in the Finbas dataset ranked by beta are equally weighted and put into a portfolio. Correspondingly the bottom 30% of the sample are put into another portfolio. The portfolios are then deleveraged and leveraged so that both portfolios have a beta of 1, making the BAB portfolio market neutral (following Frazzini & Pedersen, 2014). We define the factor as going long the leveraged low beta portfolio and short the deleveraged high beta portfolio, BAB. The betting against beta factor, BAB_{it}, is calculated per period through the following equation:

$$BAB_{it} = \frac{r_{L,t+1} - r_f}{\beta_{L,t}} - \frac{r_{H,t+1} - r_f}{\beta_{H,t}} \quad (5)$$

Where L refers to the low beta stocks and H to the high beta stocks, r_{t+1} refers to the portfolios' return, and r_f is the risk-free rate. β is the beta of the portfolio.

Another factor that knowingly impacts returns is Amihud's (2002) illiquidity factor. In contrast to Amihud (2002), we create the factor on a monthly basis using daily returns and do not winsorize the dataset. The author shows an illiquidity premium to more illiquid stocks that long-term investors can earn excess returns from. We calculate and specify the illiquidity as follows per company:

$$ILLIQ_{it} = \frac{1}{N}\Sigma_{t=1}^{T}\frac{|r_t|}{\$V_t} \quad (6)$$

Where *T* is the number of days, $|r_t|$ is the absolute return on day *t*, and $\$V_t$ is the dollar volume on day *t*. After that, the previous month's stocks are sorted based on the illiquidity factor divided into three liquidity groups, low, medium, and high. The low liquidity stocks exhibit the top 30% of Amihud's ratio observations, while the high liquidity stocks are the bottom 30% of observations. The remaining 40% constitutes the medium group. We construct the ILLIQ variable used in the performance regressions by taking the difference between the low and high liquidity portfolios' equally weighted returns for each period.

A.3 Tables not Included in the Main Section

Table 5. Distribution of the Portfolio of Sin Stocks Including Extended Definition 2004-2019

Year	**Total**	Tobacco	Alcohol	Gaming	Defense	Fossil Fuel
2004	**12**	1	1	2	3	5
2005	**14**	1	1	2	4	6
2006	**18**	1	1	5	4	7
2007	**21**	1	1	6	5	8
2008	**21**	1	1	6	5	8
2009	**22**	1	1	7	5	8
2010	**23**	1	1	7	5	9
2011	**23**	1	1	6	5	10
2012	**27**	1	2	8	6	10
2013	**28**	1	2	9	6	10
2014	**31**	1	2	11	6	11
2015	**32**	1	2	12	6	11
2016	**35**	1	2	13	7	12
2017	**40**	1	3	16	8	12
2018	**42**	1	3	19	7	12
2019	**41**	1	3	20	6	11
Total	**47**	**1**	**3**	**21**	**8**	**14**

Note: This table presents the distribution of sin stocks analyzed, including defense and fossil fuel companies, divided by industry. Total number of stocks include all unique companies included in the sample.

Table 6. Sin Stock Returns 2004-2019 Compared to the Market

VARIABLES	(1) SINMARKET	(2) SINMARKET	(3) SINMARKET	(4) SINMARKET	(5) SINMARKET	(6) SINMARKET	(7) SINMARKET
Alpha (%)	**1.68%*** **	**1.61%*** **	**1.83%*** **	**1.71%*** **	**1.49%*** **	**1.62%*** **	**1.44%*** **
	(0.57%)	(0.54%)	(0.53%)	(0.52%)	(0.51%)	(0.52%)	(0.51%)
MKTRF	-0.527***	-0.455***	-0.347***	-0.267**	-0.401***	-0.303***	-0.416***
	(0.118)	(0.114)	(0.113)	(0.115)	(0.121)	(0.114)	(0.118)
SMB		0.490***	0.470***	0.761***	0.650***	1.129***	0.941***
		(0.165)	(0.161)	(0.170)	(0.152)	(0.271)	(0.264)
HML			-0.561***	-0.130	-0.055	-0.070	-0.017
			(0.197)	(0.238)	(0.240)	(0.240)	(0.241)
MOM				0.316***	0.290***	0.307***	0.285***
				(0.105)	(0.100)	(0.103)	(0.100)
BAB					0.176***		0.160**
					(0.074)		(0.073)
ILLIQ						-0.286	-0.218
						(0.181)	(0.172)
Observations	191	191	191	191	191	191	191
R-squared	0.090	0.159	0.189	0.229	0.249	0.238	0.254

Notes: (1) This table presents the results from the performed tests regarding the performance of sin stocks, defined as gambling, alcohol, tobacco, and defense companies compared to the market returns 2004-2019 performed on a monthly basis. (2) SINMARKET is a portfolio long sin stocks and short the market portfolio. (3) MKTRF is the excess return of the market, SMB is a portfolio long small and short big companies, HML is a portfolio long high-quality firms and short low-quality firms, MOM is a portfolio long previous month's winners and short the losers, BAB is a portfolio long low beta firms and short high beta firms, and ILLIQ is a portfolio long low liquidity firms and short high liquidity firms. (4) Alpha is the intercept, or the constant in the regression. (5) Robust standard errors in parentheses. (6) *** p<0.01, ** p<0.05, * p<0.1

Table 7. Institutional Ownership 2004-2019 per Subgroup

VARIABLES	(1) IO_GPS	(2) IO_OPS	(3) IO_FI	(4) IO_WFE	(5) IO_OFC
SINDUM	**0.004*** **	**-0.002*** **	**-0.050*** **	**-0.001***	**0.002** **
	(0.001)	(0.001)	(0.016)	(0.001)	(0.001)
SININD	-0.002	0.003*	-0.036	-0.002	0.000
	(0.002)	(0.002)	(0.048)	(0.001)	(0.001)
PRINV	0.001***	0.001***	0.005	-0.000	-0.000
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)
ROE	-0.000	-0.001	0.000	-0.000	-0.000
	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)
LOGMB	-0.001*	-0.001	0.003	-0.001	0.000
	(0.001)	(0.001)	(0.007)	(0.001)	(0.000)
STD	0.005	-0.001	-0.024	-0.007	-0.002
	(0.004)	(0.005)	(0.039)	(0.006)	(0.003)
BETA	0.006**	0.002	-0.011	0.001	-0.001
	(0.003)	(0.002)	(0.019)	(0.002)	(0.002)
LOGSIZE	0.007***	0.003***	0.037***	0.001	-0.000
	(0.000)	(0.001)	(0.004)	(0.002)	(0.000)
Constant	-0.153***	-0.069***	-0.675***	-0.018	0.014
	(0.009)	(0.014)	(0.071)	(0.028)	(0.009)
Observations	4,980	4,980	4,980	4,980	4,980
R-squared	0.367	0.178	0.377	0.076	0.078

Notes: (1) This table presents the results from the performed tests regarding the ownership of sin stocks, by different institutions between 2004-2019 performed on an annual basis. (2) The dependent variables are seen in each column, IO_GPS is government pension sponsors, IO_OPS is other pension sponsors, IO_FI is financial institutions, IO_WFE is family offices, trusts, and endowments, IO_OFC is other financial companies. (3) PRINV is the inverse of the stock price, ROE is the net income divided by equity, LOGMB is the natural logarithm of the market to book ratio, STD is the standard deviation of the stock price, BETA is the beta of the overarching GICS industry compared to the market, LOGSIZE is the natural logarithm of the market capitalization, SININD equals one if the company is in the same overarching industry as a sin stock and 0 otherwise, SINDUM equals 1 if the company is defined as a sin stock and 0 otherwise. (4) Time-fixed, industry-fixed, and market-fixed effects are employed. (5) Eicker-Huber-White (White, 1980) standard errors in parentheses, clustered at the six-digit GICS code level. (6) *** p<0.01, ** p<0.05, * p<0.1

Table 8. Sin Stock Returns 2004-2019 Including Defense Stocks

VARIABLES	(1) SINCOMP	(2) SINCOMP	(3) SINCOMP	(4) SINCOMP	(5) SINCOMP	(6) SINCOMP	(7) SINCOMP
Alpha (%)	**1.26%*** **	**1.20%*** **	**1.38%*** **	**1.28%*** **	**1.24%*** **	**1.32%*** **	**1.27%*** **
	(0.43%)	(0.41%)	(0.41%)	(0.40%)	(0.40%)	(0.40%)	(0.40%)
MKTRF	-0.456***	-0.400***	-0.309***	-0.244**	-0.272***	-0.228**	-0.262**
	(0.103)	(0.101)	(0.096)	(0.094)	(0.103)	(0.098)	(0.106)
SMB		0.382***	0.365***	0.602***	0.578***	0.439*	0.383*
		(0.121)	(0.127)	(0.139)	(0.138)	(0.023)	(0.224)
HML			-0.469***	-0.118	-0.102	-0.145	-0.128
			(0.166)	(0.176)	(0.177)	(0.176)	(0.177)
MOM				0.258***	0.252***	0.262***	0.255***
				(0.072)	(0.073)	(0.072)	(0.073)
BAB					0.037		0.048
					(0.057)		(0.057)
ILLIQ						0.126	0.146
						(0.132)	(0.127)
Observations	191	191	191	191	191	191	191
R-squared	0.109	0.176	0.211	0.253	0.254	0.256	0.258

Notes: (1) This table presents the results from the performed tests regarding the performance of sin stocks, defined as gambling, alcohol, tobacco, and defense companies compared to comparable firms 2004-2019 performed on a monthly basis. (2) SINCOMP is a portfolio long sin stocks and short comparable firms. (3) MKTRF is the excess return of the market, SMB is a portfolio long small and short big companies, HML is a portfolio long high-quality firms and short low-quality firms, MOM is a portfolio long previous month's winners and short the losers, BAB is a portfolio long low beta firms and short high beta firms, and ILLIQ is a portfolio long low liquidity firms and short high liquidity firms. (4) Alpha is the intercept, or the constant in the regression. (5) Robust standard errors in parentheses. (6) *** p<0.01, ** p<0.05, * p<0.1

Table 9. Sin Stock Returns 2004-2019 Including Defense and Fossil Fuel Stocks

VARIABLES	(1) SINCOMP	(2) SINCOMP	(3) SINCOMP	(4) SINCOMP	(5) SINCOMP	(6) SINCOMP	(7) SINCOMP
Alpha (%)	**1.04%****	**0.97%****	**0.96%****	**0.90%****	**0.81%****	**1.01%*****	**0.90%****
	(0.42%)	(0.39%)	(0.39%)	(0.38%)	(0.39%)	(0.38%)	(0.39%)
MKTRF	-0.138	-0.069	-0.072	-0.031	-0.089	0.014	-0.061
	(0.117)	(0.120)	(0.108)	(0.108)	(0.106)	(0.110)	(0.108)
SMB		0.469***	0.470***	0.618***	0.571***	0.159	0.034
		(0.100)	(0.103)	(0.156)	(0.168)	(0.237)	(0.261)
HML			0.0173	0.238	0.271	0.164	0.200
			(0.256)	(0.322)	(0.324)	(0.334)	(0.335)
MOM				0.162	0.151	0.174*	0.159
				(0.105)	(0.108)	(0.105)	(0.106)
BAB					0.076		0.106*
					(0.054)		(0.059)
ILLIQ						0.357**	0.402***
						(0.146)	(0.135)
Observations	191	191	191	191	191	191	191
R-squared	0.010	0.116	0.116	0.134	0.140	0.159	0.170

Notes: (1) This table presents the results from the performed tests regarding the performance of sin stocks, defined as gambling, alcohol, tobacco, defense, and fossil fuel companies compared to comparable firms 2004-2019 performed on a monthly basis. (2) SINCOMP is a portfolio long sin stocks and short comparable firms. (3) MKTRF is the excess return of the market, SMB is a portfolio long small and short big companies, HML is a portfolio long high-quality firms and short low-quality firms, MOM is a portfolio long previous month's winners and short the losers, BAB is a portfolio long low beta firms and short high beta firms, and ILLIQ is a portfolio long low liquidity firms and short high liquidity firms. (4) Alpha is the intercept, or the constant in the regression. (5) Robust standard errors in parentheses. (6) *** p<0.01, ** p<0.05, * p<0.1