
IS SOCIALLY RESPONSIBLE INVESTMENT WORTH IT?

The (In)efficiency of SRI Mutual Funds

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Abstract

Socially responsible investment (SRI) concerns the incorporation of environmental, social, and corporate governance issues (ESG) into investment decision-making. This investment class has grown enormously, and so has the interest of academics in this field. Most of the vast empirical literature concerns the financial performance of SR investments, with the evidence being mixed. Nonetheless, the significant literature demonstrating the financial outperformance of SRI funds is intriguing since, theoretically, a portfolio with investment restrictions, *ceteris paribus*, should not have a better performance than an unrestricted portfolio. Therefore, we resorted to the Modern Portfolio Theory of Markowitz (1952) and Tobin's Separation Theorem (Tobin, 1958), and collected a sample of 259 SRI mutual funds and a sample of 159 sin stocks, to test if investment exclusively in SRI mutual funds, which reject "sin stocks", is efficient. For the samples considered, socially responsible investment was not efficient almost every time and for any SRI fund. In most situations, holding even a small portion of SRI mutual funds was detrimental, with results suggesting short selling SRI funds to invest more than 100 percent in sin stocks. The main implication is that, by choosing SRI, investors are hindering their financial performance. Thus, investors looking for the most efficient investment portfolio should consider investing beyond the realm of socially responsible investments.

Resumo

O *investimento socialmente responsável* (SRI) distingue-se por incorporar o ambiente, a sociedade e o governo da empresa nas decisões de investimento. Esta classe de investimento tem tido um crescimento enorme, gerando um grande interesse nos académicos. A maior parte da vasta literatura empírica preocupa-se com o desempenho financeiro desses investimentos, com os resultados a serem inconclusivos. Não obstante, a literatura que evidencia um desempenho superior por parte de fundos SRI é intrigante, já que, teoricamente, um portfólio com restrições de investimento, *ceteris paribus*, não deve ter um desempenho melhor que um portfólio sem restrições. Portanto, recorreremos à Teoria Moderna do Portfólio de Markowitz (1952) e ao Teorema da Separação de Tobin (1958), e recolhemos uma amostra de 259 fundos de investimento SRI e uma amostra de 159 “ações pecadoras”, para testar se o investimento exclusivamente em fundos SRI, que rejeitam “ações pecadoras”, é eficiente. Para as amostras consideradas, o investimento socialmente responsável não foi eficiente em praticamente todas as situações e para qualquer fundo SRI. Na maioria das situações, deter mesmo uma pequena parte de fundos SRI mostrou-se prejudicial, com os resultados a sugerirem tomar posições curtas nos fundos SRI para investir mais de 100 por cento em ações pecadoras. A conclusão principal é que, ao escolher SRI, os investidores estão a prejudicar o seu desempenho financeiro e, portanto, os investidores que pretendam eficiência máxima devem considerar investir além dos investimentos socialmente responsáveis.

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1. Introduction

Socially responsible investment (SRI) appeared in the 1960s, as a niche for humanitarians who wanted to do good through investments (Utz & Wimmer, 2014). Since then, it has matured into a significant investment category, with the increasing environmental and social concerns, reaching \$35.3 trillion in assets under management globally in 2020, accounting for 35.9% of total assets under management, which represents a 55% increase since 2016 (Global Sustainable Investment Alliance [GSIA], 2021). The growing importance of socially conscious investments has also been observed in mutual funds. Bialkowski and Starks (2016) analyzed both SRI and conventional mutual funds, for a sample covering 1999 through 2011, in the US, observing that, on average, SRI mutual funds have attracted more flows than conventional funds. Moreover, SRI mutual funds had positive net flows for the period, excluding only two quarters. There is vast empirical literature on the financial performance of SRI funds, providing mixed evidence (Utz & Wimmer, 2014). Some studies report the financial outperformance of SRI funds (Derwall et al., 2005; Edmans, 2011). Others report evidence of underperformance (Brammer et al., 2006; Mănescu, 2011). Furthermore, some studies find no significant differences between the performances of SRI and conventional investments (Schröder, 2007; Statman & Glushkov, 2008).

The starting point of this research is the considerable empirical literature showing that SRI mutual funds have a better performance than the rest. But, theoretically, it does not hold. Effectively, *ceteris paribus*, a portfolio with investment restrictions should not perform better than an unrestricted portfolio (Renneboog et al., 2008).

Assuming that the performance of SRI funds, which reject the so-called “sin stocks”, is superior to conventional (unrestricted) funds, then adding sin stocks to SRI funds should not increase their performance. Therefore, we will resort to the Modern Portfolio Theory of Markowitz (1952) and Tobin’s Separation Theorem (Tobin, 1958) to find out if the efficiency of SRI portfolios increases by adding sin stocks, that is, to see if SRI funds would see their risk-adjusted returns, measured by the Sharpe ratio (Sharpe, 1966), increase by adding these sin stocks. The aim of this study is to answer the following question: is the investment exclusively in the SRI mutual funds efficient? Or, equivalently: does the efficiency of a SRI portfolio increase by adding sin stocks?

To accomplish that, both a sample of SRI funds and a sample of sin companies ineligible by SRI funds were collected. Then, a portfolio was created with those ineligible companies, the “Black Sheep” portfolio. At last, we estimated an optimal portfolio, in the light of the work of Tobin (1958), for each pair (Black Sheep; SRI fund_i, $j = 1, \dots, n$). The weights of the Black Sheep portfolio and each SRI fund on such portfolios were then analyzed.

If the weight of the Black Sheep portfolio in the efficient portfolio is null or negative, then the restriction does not imply a loss of efficiency. However, if the weight of the Black Sheep portfolio in the efficient portfolio is positive, then, choosing SRI has a cost, harming financial performance.

We complemented this research by computing three investment performance measures (Sharpe ratio, Treynor ratio, and Jensen’s alpha) to compare the performance of the Black Sheep and SRI portfolios.

This research differs from the existing empirical studies, which tend to focus on comparing the financial performance of SRI funds *vis-à-vis* “conventional” mutual funds (Utz & Wimmer, 2014; Gil-Bazo et al., 2010) or against a market benchmark (Weber et al., 2010; Lean et al., 2015). In this research, more than comparing returns, the purpose was to find out if there was any combination between SRI mutual funds and sin stocks that can lead to a greater risk-adjusted return than the one that may be obtained by only investing in SRI mutual funds.

For the samples considered, adding sin stocks improved the efficiency of SRI funds almost every time and for any SRI fund. We concluded that socially responsible investment is not efficient, representing a financial cost and that investors looking for the maximum financial performance should invest their money elsewhere.

This dissertation is organized as follows. In the following section, we go over the most relevant literature concerning socially responsible investment and the more relevant theories on portfolio management. Then, in chapter 3, we describe the data and the methodology employed. In chapter 4, the results are presented. Finally, in chapter 5, we draw our study’s main conclusions, implications, extensions, and limitations.

2. Literature Review

2.1 Socially Responsible Investment

Socially responsible investment (SRI), also called ethical or sustainable investment, concerns the incorporation of environmental, social, and corporate governance issues (ESG) into investment decision-making. Unlike conventional investments, SRI incorporates a series of investment criteria to select (positive screens) or exclude (negative screens) assets derived from environmental, social, corporate governance, or ethical standards. As such, responsible investors usually shun investing in “sin stocks” (alcohol, gambling, tobacco, weapons, etc.) while preferring companies that adopt quality policies regarding environmental sustainability, community relations, and labor conditions. Frequently, SRI investors get involved in shareholder activism and engage with local communities to stimulate firms to gear towards these goals. (Capelle-Blancard & Monjon, 2012; Renneboog et al., 2008).

Despite ethical investing having ancient foundations, namely in Christian, Islamic and Jewish religions, that address that money should be used ethically, for instance, when conceding loans, excessive interest rates were forbidden, the first modern SRI mutual fund was created in 1971 in the US, the Pax World Fund. The fund, conceived for investors that contested the Vietnam War, and militarism in general, excluded investments in weapon contractors. Since the 1960s, social movements, including anti-war and anti-racism campaigns, brought to the spotlight the social impact of investments, which led to the origination of the aforementioned fund but also a movement of generalized pressure applied by US and Europe SRI investors, in the 1980s, concerning the institutionalized racial segregation system of apartheid in South Africa, that wanted companies with operations in South Africa to divest such businesses as well as for mutual funds to not include firms doing business in South Africa in their portfolios. Furthermore, environmental disasters such as the Chernobyl nuclear plant in 1986 also made investors aware of the negative impact that industrial development can have on the environment. Recently, corporate scandals have made corporate responsibility and governance a critical matter for SRI investors, with transparency, governance and sustainability appearing as fundamental SRI screens (Renneboog et al., 2008).

It should be noted that even though “ethical” and “socially responsible” are often used interchangeably, the use of the term “ethics” has decreased, with only half of SRI articles including that word in the 2000s, compared to eighty percent in 1990s, state Capelle-Blancard

and Monjon (2012). These authors note that the most convincing justification for the decreasing usage of the word “ethics” appears to be that both practitioners and researchers are not interested in putting much importance on the moral issues that are typically linked with the word “ethics”, which are normally assigned a negative meaning. An illustration of such a trend is that in 1999 the Ethical Investment Association was created, which was renamed Responsible Investment Association Australasia, in 2007. Moreover, another trend should be mentioned, the shift from “socially” to “sustainable”. Two clear examples are the name change of the UK Social Investment Forum (UKSIF) into UK Sustainable Investment and Finance and the US Social Investment Forum (USSIF), which became the Forum for Sustainable and Responsible Investment. Nonetheless, socially responsible investing will be the preferred term in this research.

Socially responsible investment has grown into a matured investment industry, with increasing environmental and social concerns, having a vast number of assets under management (see discussion in Introduction). Renneboog et al. (2008) state that part of this growth is justified by the alterations in regulation related to the disclosure of ethical, social and environmental information by listed companies and pension funds. It started in the UK in 2000, and other countries have followed, passing regulation requiring pension funds to disclose SRI-related information. Furthermore, France was the first country obliging listed companies to report on social, ethical and environmental standards, in 2001.

In the United States, the region in which there are more SRI assets under management, representing 48% of global SRI assets in 2020 (GSIA, 2021), the SRI assets managed by money managers rose 43 percent from 2018 to 2020, reaching \$16.6 trillion, growing substantially from the \$569 billion in 2010. Moreover, mutual funds are responsible for 19% of socially responsible investments (US SIF Foundation [USSIF], 2020).

2.2 SRI Investment Screens

The investment screens used in SRI have been evolving. Typically, SRI mutual funds employ a combination of multiple types of screens. The USSIF (2020) reported that just 5% of money managers applied only one ESG criterion, a decreasing percentage, with the majority of managers (58%) considering from two to four criteria. The remaining 37% of money managers applied at least five ESG criteria.

Traditionally, SRI screens can be generally classified into two groups: negative and positive. The oldest and most simple SRI strategy is negative screening. Such screens have to do with the exclusion of specific companies or sectors from SRI portfolios based on specific social, ethical and environmental criteria. A typical example of a negative screen is taking a large pool of assets such as the S&P 500 and then excluding companies from the alcohol, defense, gambling and tobacco sectors and/or firms with weak performance concerning environmental protection and labor relations. Further negative screens can include abortion, animal testing, irresponsible foreign operations, poor workplace conditions, pornography and violation of human rights. After the negative screening is applied, the portfolio is built through financial and quantitative techniques (Renneboog et al., 2008). Many of these examples fall into product-related criteria, such as investment restrictions on firearms or tobacco industries. The USSIF (2020) reported that the exclusion of specific sectors from SRI investments was employed for \$4.94 trillion of assets, 30% of SRI, in 2020. Moreover, restricting tobacco investment was the most popular specific product-related criterion, affecting \$2.1 trillion in SRI investments, followed by military and weapons, considered in SRI investments worth \$1.2 trillion. Furthermore, 69% of money managers admitted employing a negative/exclusionary strategy, the second highest value.

Positive screening is the selection of stocks that comply with superior ESG standards. Generally, positive screens emphasize on corporate governance, the environment, labor relations, the stimulation of cultural diversity and the sustainability of investments. Often, it functions as a selection of companies with good performance in renewable energy and community engagement. Frequently, positive screening is combined with the “best in class” strategy, in which companies are ranked within each sector, based on ESG performance, and then only firms performing better than their peers are selected (Renneboog et al., 2008). A positive/best-in-class approach was applied by 60% of money managers (USSIF, 2020). Negative and positive screens are usually mentioned as the first and second-generation of SRI screens.

The third generation of screens is an integrated approach to choosing companies based on ESG criteria, containing both negative and positive screens. This strategy may be called “sustainability” or “triple bottom line.” A practical example of the employment of this approach is the MSCI KLD 400 Social Index. This index covers firms with excellent ESG scores, while rejecting companies that harm the environment or society. The methodology

for selecting the index's constituents is split in two phases. First, companies in the nuclear power, tobacco, alcohol, gambling, military weapons, civilian firearms, genetically modified organisms and adult entertainment industries are excluded (negative screening). Second, to be eligible, firms must have an MSCI ESG Controversies score larger than two and a MSCI ESG rating above "BB" (positive screening) (MSCI, 2022).

The fourth generation combines the third generation, sustainable investing, with shareholder activism. In this approach, portfolio managers try to influence companies' behaviors through direct conversations with the management or by using the voting right at general meetings (Renneboog et al., 2008). Shareholders in public companies have the right to vote on topics presented by either the management or other shareholders at the firm's annual general meeting. Moreover, shareholders can exert additional influence by filling proposals on ESG-related topics, which may be voted by investors, bringing awareness to the management and the board of directors. In fact, from 2018 through the middle of 2020, money managers and institutional investors who managed \$1.98 trillion in assets had filled shareholder resolutions on ESG matters (USSIF, 2020). Investors can also communicate with the managers of portfolio firms. Often, socially responsible investors join investor networks to gain scale in spreading their messages. An example is the Carbon Disclosure Project (CDP), which had more than 500 institutional investors, managing assets worth \$106 trillion, joining them by 2020, taking part in an initiative which demanded global companies to report on greenhouse gas emissions and to evaluate the impact of climate change and other environmental issues (USSIF, 2020).

More than 90% of the socially responsible assets held by money managers in the US, in 2020, were screened, taking into account criteria from all ESG categories (environment, social, and governance). However, concerning specific criteria, climate change/carbon (environmental), was by far the leading factor, being considered in a quarter of sustainable investments, \$4.18 trillion (USSIF, 2020).

2.3 The Academic Relevance of SRI

In recent decades, the growing importance of socially conscious investments has led to several studies in this area. When considering the proportion of investment articles that concern SRI, the relative number has doubled from the 1990s to the 2000s (Capelle-Blancard & Monjon, 2012). Nevertheless, most studies focused on the financial performance of socially responsible investments, with those articles being the most cited. Little attention has been paid to SRI subjects not related to financial performance. Therefore, research on moral values, ethics or altruism is scarce and has declined, which is surprising considering that the point of SRI is that it exceeds the financial features. One compelling finding is that the SRI literature seems to be under-theorized, namely on topics such as investors' motivations to engage in SRI, the connection between regulation and SRI and non-financial performance, with most of the attention being aimed at the financial performance of SRI funds.

On the non-financial performance side of SRI research, there are some studies regarding the ethical performance of SRI funds, that is, checking if the funds labeled as SRI are really SRI, having better ethical standards than conventional funds. For instance, Utz and Wimmer (2014) do not find much evidence of SRI funds having a higher ethical rating than conventional funds, concluding that the SRI label has become more of a marketing tool, used to lure in investments, taking advantage of a trendy investment category, rather than a genuine way of accomplishing ethical preferences through investments. This result contrasts with the work of Kempf and Osthoff (2008). They found that SRI funds had a significantly higher ethical ranking than conventional funds, in all ethical criteria analyzed, indicating that SRI funds are not conventional funds with an SRI label.

2.4 Financial Performance of SR Investments

Do SRI investors make their decisions taking into account solely the risk-return attributes or are they willing to accept suboptimal financial performance to satisfy their personal goals concerning social responsibility? SRI applies multiple screening approaches to select stocks complying with specific environmental, governance, ethical and social criteria, restricting the investment opportunities available to non-SRI investors. Therefore, SRI may impose a constraint on the diversification possibilities, shifting the efficient frontier towards worse risk-return combinations than conventional portfolios. If markets value the investment

opportunities correctly, SRI underperformance is expected as SRI funds may underinvest in financially appealing investments that do not comply with ethical standards and overinvest in projects that are not financially interesting but promote sustainability policies. Therefore, if markets are efficient, the argument for SRI underperforming conventional investments is quite strong (Renneboog et al., 2008).

However, Renneboog et al. (2008) mention that if markets are inefficient in the short run, mispricing ESG information, an argument can be built for SRI outperformance. First, the authors say that remarkable environmental and social performance signals quality managers, and thus SRI screening can lead to better stock selection. Second, social and environmental screening diminishes the probability of suffering high costs amidst environmental disasters and social crises. Third, such hypothesis states that such value-relevant information would not be available to investors if not for SRI screening, which may help SRI fund managers select securities and generate better risk-adjusted returns than non-SRI funds. Finally, note that if the efficient market hypothesis holds, conventional portfolio managers could easily mimic such strategies, eliminating the advantage of SRI managers.

Furthermore, a case can be made for investors not caring only about financial attributes when engaging in socially responsible investments. First, there is evidence that SRI funds, which have financial and social goals, have gathered more investment than conventional funds. Bialkowski and Starks (2016) that analyzed the money flows of US SRI and conventional mutual funds between 1999 and 2011, observed that SRI mutual funds attracted more flows than conventional funds, on average. Moreover, Bollen (2007), besides studying the money flows of US SRI funds, also considers the past returns of such funds. He finds out that the volatility of flows is lower for SRI funds than for conventional funds, which suggests that social investors' assets are "stickier". Moreover, money flows of socially responsible funds are less sensitive to lagged negative returns than conventional funds but significantly more sensitive to lagged positive returns. The author concludes that socially conscious investors seem to obtain utility from non-financial, socially responsible factors, especially when SRI funds generate positive returns. Renneboog et al. (2006) studied the money flows of SRI funds across 17 countries. They report that SRI investors care more about past positive returns than negative ones unless there is persistent underperformance. The relation between money flows and past performance depends on the forms and intensities of the SRI screening activities. This latter finding, by demonstrating that SRI investors care about SRI

screening, is, once again, consistent with the proposition that SRI investors consider non-financial attributes when investing.

A vast number of studies were conducted on the financial performance of SRI, comparing it with the performance of conventional investments, and conclusions diverged. First, there some studies find no significant differences in performance (Schröder, 2007; Statman & Glushkov, 2008), second, studies are showing that socially responsible investments have better financial performance (Derwall et al., 2005; Edmans, 2011), and third, some studies conclude that conventional investments perform better (Brammer et al., 2006; Mănescu, 2011). In the short run, this divergence may be explained in light of the work conducted by Derwall et al. (2011), which present two hypotheses: the shunned-stock hypothesis and the errors-in-expectation hypothesis. The shunned-stock hypothesis states that substantial demand for SR investment and/or shortage demand for “irresponsible” assets, due to SR investors avoiding buying them, depresses the price of “irresponsible” assets, which will make them experience larger returns than SR investments (conventional outperformance). On the other hand, the errors-in-expectation hypothesis predicts that SR investments can generate higher returns because the market systematically underestimates the financial importance of corporate social responsibility (CSR) due to the subjectivity of CSR and outdated accounting standards, for instance (SRI outperformance). Both effects can only coexist in the short run, with the authors expecting that sooner or later, investors comprehend the effect of CSR on firms’ future cash flows and that, thus, the higher returns of SR investments due to the errors-in-expectation hypothesis disappear in the long run.

On their thorough literature review, Renneboog et al. (2008) conclude that there is little evidence that SRI funds significantly over or underperform non-SRI funds. This conclusion is corroborated by Revelli and Viviani (2015), who conducted an extensive analysis of studies testing the relationship between SRI and financial performance, demonstrating that the inclusion of corporate social responsibility concerns in stock market portfolios is neither a strength nor a weakness *vis-a-vis* conventional investments.

As Renneboog et al. (2008) noted, comparing the average performance of SRI funds with conventional funds may not necessarily present valuable information to an investor who can selectively invest in a subset of mutual funds. That is, unless you are somehow restricted to either investing in a pool of SRI funds or a pool of non-SRI funds, you can design your optimal portfolio with the investment opportunities available, for which the information on

whether the generality of SRI funds perform better or worse, on average, than the generality of non-SRI funds may not be of much help. The present research also aims to tackle this issue from a portfolio management perspective, trying to conclude on whether SRI funds should include sin stocks when aiming at investment efficiency, i.e., maximizing risk-adjusted return, and, potentially, how large should be the weight of such stocks. Equivalently, the goal is to determine if SRI fund managers are maximizing the risk-adjusted return of their investors by doing SRI screening, in this case, excluding sin stocks.

2.5 The (In)efficiency of SRI Funds

As stated before, the starting point of this research is the considerable empirical literature showing that SRI mutual funds have a better performance than the rest. Bear in mind that SRI funds apply multiple screening approaches to select stocks complying with specific environmental, governance, ethical and social criteria, which restricts the investment opportunities available to non-SRI investors. Theoretically, the proposition does not hold. *Ceteris paribus*, a portfolio with investment restrictions should perform better than an unrestricted portfolio. Note that SRI screening can impose a constraint on the diversification possibilities, shifting the efficient frontier towards worse risk-return combinations than conventional portfolios (Renneboog et al., 2008).

But, if SRI funds, which reject the so-called sin stocks, have a superior performance than that of conventional funds, which can freely invest in such stocks, then adding sin stocks to such funds should not increase the efficiency of such portfolios. The aim is to answer the following question: is the investment exclusively in the SRI mutual funds efficient? Or, equivalently: does the efficiency of an SRI portfolio increase by adding sin stocks?

Taking into account the knowledge on this topic, it is expected that investment exclusively in SRI mutual funds is not efficient, with the efficiency of an SRI portfolio increasing when adding sin stocks. In addition to the literature review presented, the following studies corroborate this expectation.

First, Geczy et al. (2005), who studied the cost of imposing the SRI constraint on investors seeking the highest Sharpe ratio, by comparing the optimal portfolio built from SRI funds and the optimal portfolio built from non-SRI funds, demonstrated that enforcing SRI restrictions can provoke significant financial costs on mean-variance optimizing investors,

which is consistent with the idea that SRI funds are suboptimal. Furthermore, the costs were even higher when the authors only considered SRI funds that screened out sin stocks.

Second, Renneboog et al. (2008) suggest that SRI portfolio managers, by having this multi-task job of accomplishing both social and financial goals, may see their incentives to aim at economic efficiency, that is, maximizing risk-adjusted returns decrease, increasing agency costs.

Therefore, when considering the findings that SRI constraints imply a financial cost, translating the SRI portfolio into a suboptimal portfolio, when compared to a conventional one (Geczy et al., 2005) and that SRI portfolio managers may have weaker incentives to pursue economic efficiency *vis-à-vis* conventional fund managers (Renneboog et al., 2008), in conjunction with the theoretical premise that an SRI, and thus, restricted portfolio should not perform better than a conventional, and thus, unrestricted portfolio (Renneboog et al., 2008), and that SRI investors seem to consider other factors beyond financial performance when investing (Bialkowski & Starks, 2016; Bollen, 2007; Renneboog et al., 2006), it is expected that adding sin stocks to SRI funds ought to increase efficiency.

2.6 Theory of Portfolio Management

To perform the testing that this research intends, it is necessary to introduce the leading theories on Portfolio Management.

2.6.1 Markowitz's Modern Portfolio Theory and Tobin's Separation Theorem

Investment and portfolio management have building blocks from what is known as Modern Portfolio Theory (MPT), which was developed based on the work of Markowitz (1952). This author rejected the traditional rule in portfolio selection that stated that the investor should maximize the discounted expected value of future returns, introducing a rule in which investors would bear in mind the expected return but also the variance of return, as a measure of risk, considering the former as attractive and the latter as unattractive.

Let Y be a random variable that can take on a finite number of values $y_1, y_2, \dots, y_N$ and the probability that $Y = y_1$ is p_1 . The expected value of Y is

$$E = p_1 y_1 + p_2 y_2 + \cdots + p_N y_N$$

Equation (2.1)¹

And then, the variance, which Markowitz introduced in the context of portfolio selection to measure risk, of Y is

$$V = p_1 (y_1 - E)^2 + p_2 (y_2 - E)^2 + \cdots + p_n (y_n - E)^2$$

Equation (2.2)¹

Note that variance V , often represented as σ^2 , is defined as the average squared deviation of Y from its expected value E . Similarly, one can use the standard deviation measure which is $\sigma = \sqrt{V}$.

Now let's consider multiple variables $R_1, R_2, \dots, R_N$ with R being a weighted sum, or, in the investment world, a portfolio composed of multiple securities, each with a specific weight on the total portfolio composition. In this case, the expected value of the weighted sum (portfolio) is the weighted sum of the expected values of the variables (securities).

$$E(R) = \alpha_1 E(R)_1 + \alpha_2 E(R)_2 + \cdots + \alpha_N E(R)_N$$

Equation (2.3)¹

Then comes the variance of a weighted sum, which is trickier to compute. For this we need to introduce an important concept, covariance, which is the expected value of the product of the deviation of R_1 from its expected value and the deviation of R_2 from its expected value.

$$\sigma_{1,2} = E \{ [R_1 - E(R)_1] [R_2 - E(R)_2] \}$$

Equation (2.4)¹

Equivalently, one can express covariance through the correlation coefficient, which ranges from -1 to +1, with the covariance between R_1 and R_2 equal to their correlation coefficient multiplied by the standard deviation of R_1 and the standard deviation of R_2 .

$$\sigma_{1,2} = \rho_{1,2} \sigma_1 \sigma_2$$

Equation (2.5)¹

¹ From Markowitz (1952)

Now we can present the formula for the variance of a portfolio, which is to say, the variance of the weighted sum of random variables. Note that the variance depends on the covariance between the securities that compose that same portfolio. Considering α_i to be the weight of security i on the portfolio, with $\sum \alpha_i = 1$, then V is

$$V = \sum_{i=1}^N \sum_{j=1}^N \sigma_{i,j} \alpha_i \alpha_j$$

Equation (2.6)¹

As we can conclude, in the framework introduced by Markowitz (1952), where investors should follow the “expected return-variance of return” rule, there is diversification and the “right kind” of diversification. This means that diversification is not only about investing in multiple assets, following the old “do not put all your eggs in one basket” proverb, but investing in securities that have small covariances among themselves. For instance, a portfolio with thirty stocks of banks would not be as well diversified as a portfolio of the same size that contained stocks of banks, mining, automotive and healthcare companies, as it is more common for companies in the same sector to perform poorly at the same time than for companies that engage in diverse activities. Simply put, the securities in the first portfolio had higher covariance among themselves than the securities of the second portfolio. That is, reducing variance is about putting eggs in multiple *and* different baskets. A very interesting implication of the diversification concept, as introduced by Markowitz (1952), is that if an investor diversifies his investment between two portfolios with equal variance, then the variance of the combined portfolio will generally be lower than the variance of either initial portfolio. It will never be larger. In fact, there is just one case in which the variance remains the same: when the portfolios are perfectly correlated, which means that the correlation coefficient between them is maximum, equaling 1. Note that in such situations, if one portfolio moves in a specific direction, the other will also move in the same direction with the same magnitude, offering no diversification.

It is clear why Markowitz (1952) had to reject that first traditional rule on portfolio selection. It did not encompass the advantage of diversification, i.e., that hypothesis implied that one should simply concentrate his investment in the security with the largest discounted value. In that context, if there were two or more securities with the same value, investing in either one or any combination would be indifferent.

Moreover, modern portfolio theory, also known as mean-variance analysis, states that by having estimates of returns, volatilities, and covariances of a series of investment opportunities, along with a set of investment restrictions, one can compute an optimal mean-variance efficient frontier (Fabozzi et al., 2002). As summarized by Fabozzi et al. (2002), such frontier is efficient because each point of that curve represents a portfolio that has the maximum expected return for a specific level of risk or, equivalently, the minimum risk available for a certain level of expected return. Those portfolios are known as efficient portfolios, that is, the best possible portfolios than an investor can obtain for a specific level of risk/expected return. This means that MPT enables optimization so that multiple efficient portfolios are generated, with different expected return/risk combinations. Thus, different investors, with different restrictions and profiles, will select different efficient portfolios.

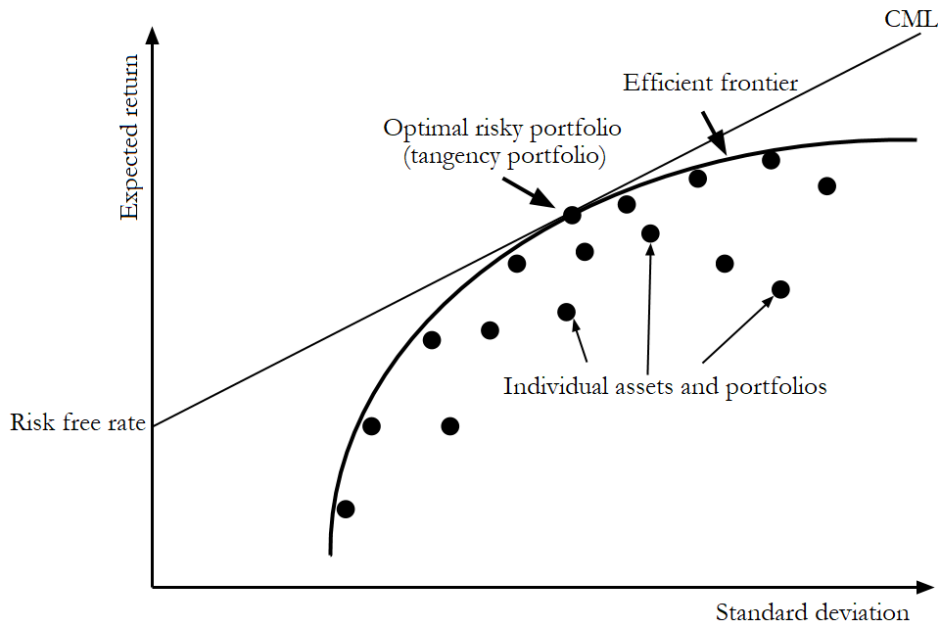
For the testing conducted in this research, we will resort to the work of Tobin (1958), who added leverage to portfolio theory by introducing a risk-free asset. He showed that by forming a portfolio composed of an efficient portfolio and the risk-free asset, it is possible to create portfolios with better performance than those on the efficient frontier (Garcia & Borrego, 2017). In the framework of Tobin's separation theorem, portfolio selection starts with computing the optimal portfolio of risky assets, common to all risk-averse portfolio holders. Then, each investor would combine such a portfolio with the risk-free asset taking into account their degree of risk aversion (Buiter, 2003). This optimal portfolio, that all investors should hold, is the efficient portfolio that is touched by a tangent line drawn from the point of the risk-free asset to the efficient frontier. Therefore, this line, often called the capital market line (CML), represents all feasible combinations of the risk-free asset (f) and the optimal portfolio (P), which present better-expected return/risk combinations than all portfolios on the efficient frontier, with the single exception of the tangent point, the optimal risky portfolio, that is both on the line and on the efficient frontier (see Figure 1).

Formally, we have $E(R_i) = R_f + \frac{E(R_P) - R_f}{\sigma_P} \sigma_i$.

In this framework, we have a linear function in which the expected return of a portfolio i , which holds only the risk-free asset and the optimal risky portfolio, is the risk-free rate plus the risk premium, with the risk premium being the product of risk premium of the optimal portfolio P by the risk of a portfolio i . Therefore, the objective of an investor is to achieve the best-expected return/risk combinations possible, that is, to attain the best CML, by

maximizing its slope, the risk premium per unit of risk $\left(\frac{E(R_P) - R_f}{\sigma_P}\right)$. Hence, the optimal risky portfolio will be the one for which the risk premium per unit of risk, also known as Sharpe ratio (Sharpe, 1966), is maximum. This is the main method that will be used in this research, i.e., we will be building multiple optimal portfolios, for which we will analyze their composition, that is, the assets and their respective weights that maximize the Sharpe ratio of such portfolios.

Figure 1 The optimal risky portfolio²



2.6.2 Investment Performance Measures

Performance measures offer a way to evaluate the performances of different portfolios and the performance of a particular portfolio in different periods (Jobson & Korkie, 1981). Such measures combine the two distinct components of performance, the return, and the risk, into a single measure that adjusts for differences in risk, and thus, at least at a theoretical level, allow an irrefutable ranking of the performance of investments that present different risks and returns (Friend & Blume, 1970).

² Based on the figure provided in <https://www.thewealthyfinn.com/2019/07/risk-return-modern-portfolio-theory.html>

According to Jobson and Korkie (1981), performance measures can be classified into three categories. The first category concerns measures encompassing total risk of return quantified through standard deviation. The second category includes performance measures based on what is known as market, systematic or non-diversifiable risk of return, represented by beta. The third category does not involve a risk pricing model. The measures that will be taken into account in this research are the Sharpe ratio, the Treynor ratio, and Jensen's alpha. The first measure falls into the first category of measures while the other two are included in the second category.

The Sharpe ratio is the better-known performance measure (Eling & Schuhmacher, 2007). Defined by Sharpe (1966) as the reward-to-variability ratio, the numerator represents the difference between the average annual return of a portfolio and the risk-free interest rate, which is the reward obtained by the investor for carrying risk, the risk premium. The denominator is the standard deviation of the annual rate of return, which represents the risk the investor carried. Therefore, this ratio denotes the reward per unit of variability.

$$Sharpe\ Ratio_i = \left(\frac{E(R_i) - R_f}{\sigma_i} \right)$$

Equation (2.7)³

The Treynor ratio is the excess return from the risk-free rate, i.e., the risk premium, per unit of systematic risk, which is represented by the beta (Friend & Blume, 1970). The Treynor ratio only differs from the Sharpe Ratio in the denominator, which considers the beta factor and thus systematic risk instead of the standard deviation which measures total risk.

$$Treynor\ Ratio_i = \left(\frac{E(R_i) - R_f}{\beta_i} \right)$$

Equation (2.8)³

Note that the beta of a security i (β_i) is the division of the covariance between the return of security i and the return of the market by the variance of the return of the market. It measures the non-diversifiable or systematic risk (Friend & Blume, 1970). Usually, the return of the market is proxied by using the return of a market index (Eling & Schuhmacher, 2007).

³ As represented in Friend and Blume (1970)

The beta is a crucial part of a theory of equilibrium in the capital markets, commonly known as the capital asset pricing model (CAPM), formulated independently by William Sharpe, John Lintner, and Jack Treynor in the 1960s, in which the expected return of a security i $[E(R_i)]$ is linked to the expected return of the market $[E(R_M)]$ through the equation $E(R_i) = R_f + \beta_i[E(R_M) - R_f]$ (Friend & Blume, 1970; Jensen, 1968).

Then, the performance measure of Jensen (1968), known as Jensen's alpha, is simply the rate of return of a security that is greater than the one implied by the equilibrium equation mentioned above. That is, it is the return of a security above the one predicted by the CAPM.

$$Jensen's\ alpha_i = [E(R_i) - R_f] - \beta_i[E(R_M) - R_f]$$

Equation (2.9)³

These measures will be computed as a complement to the method mentioned in 2.6.1 to provide more robust conclusions. Note that multiple studies demonstrate that different performance measures yield identical rankings when measuring the performance of investments (Eling & Schuhmacher, 2007; Pfingsten et al., 2004; Pedersen & Rudholm-Alfvén, 2003), so it is expected that these three different measures provide similar conclusions.

3. Data and Methodology

3.1 Data

This task implied collecting a sample of socially responsible investment mutual funds and a sample of sin stocks, and their monthly returns from June 2012 until May 2022. Both samples and the corresponding data were collected from the Refinitiv Eikon and Refinitiv Eikon Datastream databases.

First, a sample of SRI funds had to be identified and collected. The approach to identify SRI funds was similar to the one used by Weber et al. (2010), which did so through SRI-related key words like sustainable, environmental, ethical, or social. We did this in Refinitiv Eikon by selecting equity mutual funds through the “Theme & Strategy” filter and choosing the key word “ethical”. Furthermore, an additional filter was applied. Considering that an SRI label is not enough to ensure that a fund follows a socially responsible investment policy (Utz & Wimmer, 2014), only funds with a Refinitiv’s ESG Combined Score equal to or greater than B+ (66.67/100) were considered. Then, by only retrieving funds with at least ten years of history, we ended up with a sample of 259 SRI mutual funds (see Appendix 1).

Then, we identified and collected a sample of companies from sin sectors ineligible by SRI funds (the “sin stocks”). In this process we looked at the selection methodology applied by SRI indexes, namely the MSCI KLD 400 Social Index, and by academics (Fabozzi et al., 2008; Hong & Kacperczyk, 2009). Launched in 1990, the MSCI KLD 400 Social Index is the oldest SRI index. It rejects companies in nuclear power, tobacco, alcohol, gambling, military weapons, civilian firearms, genetically modified organisms, and adult entertainment industries (MSCI, 2022). Hong and Kacperczyk (2009) considered “sin stocks” public companies producing tobacco, gambling, and alcohol, while Fabozzi et al. (2008) used stocks from adult services, biotech, gambling, defense, tobacco and alcohol industries. These last authors only deemed a company a sin stock if the revenue from one of those industries surpassed 30% of the total firm’s revenue. We applied a similar criterion. We considered sin stocks the companies where at least 30% of total sales originated in the armaments, alcohol, tobacco or gambling sectors. This process obtained a sample of 159 sin stocks (see Appendix 2).

3.2 Methodology

3.2.1 Optimal Portfolios

This research study aims to determine if the efficiency of SRI portfolios increases by adding the neglected sin stocks. That is, to test if investing solely in SRI mutual funds is, in fact, efficient. We use the framework of the mean-variance analysis to check whether SRI funds see their risk-adjusted returns, measured by the Sharpe ratio, increase when adding sin stocks to the portfolio.

In practice, the empirical testing of this research concerns building optimal risky portfolios, i.e., efficient portfolios that maximize the risk premium per unit, commonly referred as Sharpe ratio (see 2.6.1), in a world where there are two available risky assets: a portfolio of sin stocks, which we will call the “Black Sheep” portfolio, and an SRI mutual fund.

Note that if the estimated optimal portfolio, which is the most efficient portfolio available, with the highest Sharpe ratio, holds both the SRI mutual fund and the “Black Sheep” portfolio, then the inclusion of the “Black Sheep” portfolio increases the efficiency of the investment portfolio. It would be equivalent to say that the SRI mutual fund, by adding those sin stocks to its portfolio, would get a larger risk-adjusted return and so the investment exclusively in that SRI mutual fund is not financially efficient. That is, we will be concluding by analyzing the weight of the “Black Sheep” portfolio in the optimal efficient portfolio. If the weight of the “Black Sheep” portfolio in the optimal portfolio is null or negative, then the sin stocks do not improve the Sharpe ratio of SRI funds and the investment restriction imposed by socially responsible investing does not imply a loss of efficiency. However, if the weight of the “Black Sheep” portfolio in the efficient portfolio is positive, then choosing SRI has a cost and harms financial performance. Thus, investors looking for the most efficient investment portfolio should consider investing beyond the realm of socially responsible investments.

We conducted this analysis in nine different time frames using monthly data for the 10 years from June 2012 until May 2022. Utilizing always the previous 24 months of historical returns to do our estimates, we did the intended testing on May 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, and 2022.

First, we had to create nine “Black Sheep” portfolios, combining the 159 sin stocks. We assumed equal weights; thus the expected annual return of such portfolios was estimated as

the average of the annualized returns of such stocks in the previous 24 months. Calculating the risk measure (standard deviation) demanded more work. We then followed the Modern Portfolio Theory, presented in 2.6.1, to compute the standard deviation of the nine portfolios. Finally, as $N = 159$ we had to resort to matrixes. Thus, as we had nine periods, we built nine variance-covariance matrixes from the returns of the 159 stocks and through matrix calculus (see equation 3.1), we obtained the standard deviations of the portfolios (see Appendix 3).

$$\sigma_p^2 = [w_1 \quad w_2 \quad \dots \quad w_N] \begin{bmatrix} \sigma_1^2 & \sigma_{1,2} & \dots & \sigma_{1,N} \\ \sigma_{2,1} & \sigma_2^2 & \dots & \sigma_{2,N} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{N,1} & \sigma_{N,2} & \dots & \sigma_N^2 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_N \end{bmatrix}$$

Equation (3.1)

Then, for each one of the nine time periods, we built 259 optimal risky portfolios for each pair ("*Black Sheep*"; *SRI fund_j*, $j = 1, \dots, 259$) by maximizing the Sharpe ratio of the portfolios. We did so through the Solver add-in in Excel, for which we set to maximize the cell containing the Sharpe ratio formula, by changing the weight of the "Black Sheep" portfolio (w_{BS}) in the whole portfolio. Note that only two assets were considered in the estimation of these optimal portfolios, the "*Black Sheep*" portfolio and a *SRI fund_j*, so $w_{SRI} = 1 - w_{BS}$.

This process also implied computing the correlation between the monthly returns of the "Black Sheep" portfolio and each SRI mutual fund as well as estimating the expected return and standard deviation of each fund, which was done as usual in a mean-variance analysis, considering the returns for the 24 previous months. Moreover, since we were maximizing the Sharpe ratio, we also needed nine risk-free rate inputs, for which we used the 10-year US Treasury Bond rate at the beginning of June for each of the nine years⁴.

For robustness purposes, we ended up repeating this process, considering that the portfolios of sin stocks, the Black Sheep portfolios, incurred in transaction costs that reduced their return by 2.5%, considering nine Black Sheep portfolios.

⁴ Retrieved from https://home.treasury.gov/resource-center/data-chart-center/interest-rates/TextView?type=daily_treasury_long_term_rate

With the optimal portfolios estimated, we then collected and analyzed the weights of the Black Sheep portfolio and each SRI fund in the composition of the efficient portfolios to conclude.

3.2.2 Performance Measures

To complement this research, and to obtain more robust conclusions, we proceeded to compute three measures used to evaluate and rank the performances of investment portfolios: Sharpe ratio, Treynor ratio and Jensen's alpha (see 2.6.2).

Having the returns and standard deviations of the Black Sheep' portfolio for the nine periods, computing the Sharpe ratios was very straightforward. For the SRI funds, we calculated the individual Sharpe Ratio for the 259 funds each year and then estimated the average of the sample each year, obtaining nine SRI Sharpe ratios.

The process for computing the Treynor ratio and Jensens' alpha had two major differences from the aforementioned process. First, we had to estimate the Beta factor, which goes in the denominator for the Treynor ratio and is one of the inputs of the CAPM which is part of Jensen's alpha formula. This implied computing the covariance of returns between our sample portfolios and the market portfolio and the variance of the market portfolio. We considered the usual S&P 500 index as the market portfolio and retrieved monthly returns of the index for the 10-year period from June 2012 until May 2022. Second, we opted for creating a "Combined SRI portfolio" for which we would compute a single Beta for each time period, instead of computing 259 Betas and 259 measures nine times⁵. This portfolio was comprised of 259 SRI funds, assuming equal weights. With the Betas and the market portfolio return estimated (see Appendix 4), we incorporated the risk-free rate to compute the Treynor ratios and Jensen's alphas for the Black Sheep' and the Combined SRI portfolio in the nine time periods.

Finally, we analyzed the measures of the Black Sheep and the SRI funds. Note that the Sharpe and Treynor ratio represent the excess return per unit of risk (be it total or systematic risk), so the higher the ratio, the better. Jensen's alpha is the abnormal return generated by a

⁵ Note that this approach was not viable for computing the Sharpe Ratio, as we would need nine standard deviations from this combined portfolio. That would imply building nine variance-covariance matrixes from the returns of the 259 SRI mutual funds in the sample.

portfolio, that is, the difference between the actual and the expected return predicted by the CAPM, so the larger the alpha, the better the performance.

4. Results

4.1 Weights on The Optimal Portfolio

In this chapter, we will start by analyzing the weights of the Black Sheep portfolio and the SRI funds in the optimal portfolios.

See Table 1. From the nine periods considered, in six of them (2014, 2015, 2016, 2017, 2018 and 2019) the Black Sheep had a positive weight on the optimal portfolio in all 259 portfolios estimated, meaning that sin stocks increased the efficiency of the investment for all 259 SRI mutual funds considered. Note that in 2022, that does not happen only in one case, with the Black Sheep portfolio being part of 258 out of 259 optimal portfolios. In 2021, it still happened for more than 90 percent of the portfolios and in 2020, even though that number is considerably smaller, Black Sheep still make the cut for most portfolios. With the evidence presented, the conclusion seems straightforward. For the samples considered, sin stocks improve the efficiency of SRI funds pretty much all the time and for any SRI fund.

Table 1 The weights of the Black Sheep and SRI funds in the optimal portfolios

	2014	2015	2016	2017	2018	2019	2020	2021	2022
$w_{BS} > 0\%$	259	259	259	259	259	259	159	237	258
Average w_{BS}	65%	102%	200%	262%	148%	309%	>10000%	>10000%	152%
Short sell SRI	11	122	248	253	243	243	159	196	200
$w_{SRI} > 0\%$	235	137	11	6	16	16	100	63	59
Average w_{SRI}	35%	-2%	-100%	-162%	-48%	-209%	<-10000%	<-10000%	-52%

But more than sin stocks being part of the portfolios, they were the crucial element. In fact, they had an average weight larger than 100% in all periods except 2014, which means that, on average, an investor would have to invest all of its funds in the sin stocks, and then short sell (if possible) the SRI fund and use those proceeds to invest more in sin stocks, in order to reach the maximum efficiency, that is, the maximum Sharpe ratio, which describes the risk premium per unit of risk. That also applies to the years 2020 and 2021, although those years present some strange figures, likely due to the drastic and unstable effects of the pandemic

crisis. One can also see that, in fact, in all periods except 2014 and 2015, the optimal portfolio assumed a short position on the SRI fund most of the time. That happened more notably from 2016 to 2019, in which 243 or more optimal portfolios, out of 259, shorted the SRI fund, i.e., the SRI fund had a negative weight on the optimal portfolio, and, thus, the portfolio of sin stocks had a weight larger than 100%.

2014 is the only year in which the SRI funds present an average positive weight, with around one third of the optimal investment going to socially responsible investments, on average.

The evidence is significant and clear. For the samples considered, socially responsible investment is not efficient. By choosing SRI, investors are hindering their financial performance and, thus, investors looking for the most efficient investment portfolio should consider investing beyond the realm of socially responsible investments.

For the purpose of testing the robustness of these results, and because one could argue that SRI mutual funds face transaction costs that worsen their performance, which is not reflected on the constructed portfolio of sin stocks, we repeated this analysis imposing transaction costs on the Black Sheep portfolio. Bear in mind that Edelen et al. (2013) found that mutual funds incurred in average trading costs of 1.44%, while Wermers (2000) observed that mutual funds faced a 1.6% decrease in their returns due to transaction costs. Then, we decided to redo the analysis, considering that the portfolio of sin stocks incurred in transaction costs that reduced its return in 2.5% (see Table 2).

Table 2 The weights of the Black Sheep' and SRI funds in the optimal portfolios

	2014	2015	2016	2017	2018	2019	2020	2021	2022
$w_{BS} > 0\%$	259	259	259	259	259	231	159	223	258
Average w_{BS}	56%	96%	196%	259%	144%	436%	>10000%	>10000%	133%
Shortsell SRI	8	78	238	252	233	211	159	180	172
$w_{SRI} > 0\%$	251	181	21	7	26	48	100	79	87
Average w_{SRI}	44%	4%	-96%	-159%	-44%	-336%	<-10000%	<-10000%	-33%

Even in this the situation the case for SRI funds only got slightly better, with the difference being fairly insignificant from the previous analysis. Then, we determine that the conclusions drawn from Table 1 are robust and still hold when adding transaction costs to the Black Sheep portfolio.

4.2 Performance Measures

To complement the testing done in 4.1, we proceeded to compute three measures used to evaluate and rank the performances of investment portfolios (Sharpe ratio, Treynor ratio and Jensen's alpha) for the Black Sheep' (Black Sheep portfolios with added transactions costs) and the SRI portfolios in the nine time periods (see Table 3). The larger is any measure the better the performance.

Table 3 The performance measures for the Black Sheep' and SRI portfolios

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2014-22
Sharpe Ratio										
BS'	2.07	2.26	1.15	1.17	2.37	0.12	-0.12	0.92	0.98	1.21
SRI	1.86	1.27	0.23	0.13	0.61	-0.09	-0.04	0.68	0.58	0.58
Treynor Ratio										
BS'	0.29	0.33	0.17	0.15	0.28	0.02	-0.03	0.22	0.22	0.18
SRI	0.34	0.31	0.05	0.02	0.12	-0.03	-0.02	0.17	0.12	0.12
Jensen Alpha										
BS'	5.80%	11.87%	9.30%	7.27%	9.17%	-3.68%	-2.14%	-2.33%	5.58%	4.54%
SRI	6.79%	8.18%	0.01%	-3.95%	-0.18%	-6.40%	-0.70%	-4.45%	-1.32%	-0.23%

When looking at the risk premium, the reward obtained by incurring in risky investments, per unit of total risk, represented by the Sharpe ratio, we observe that the sin stocks provided a larger reward to investors in eight of the nine periods. On average, an additional 1% of standard deviation in a portfolio of sin stocks generated an additional 1.21% return while the reward was just 0.58% for socially responsible investment mutual funds.

The conclusion is similar, although not so significant when looking at the Treynor ratio. Once again, the performance of the Black Sheep' portfolio was better than SRI funds, on

average, and in seven out of the nine periods studied. From 2014 until 2022, sin stocks provided a reward of 0.18% per unit of systematic risk, measured by beta, while SRI mutual funds generated a 0.12% unitary reward.

The analysis of Jensen's alpha provides a clearer illation. On average, SRI funds experienced returns close to the expected (-0.23%), while the neglected sin stocks experienced a substantial abnormal return of 4.54%. Moreover, in six out of the nine periods, the Black Sheep portfolio discounted from transaction costs provided larger abnormal returns than socially responsible investment funds.

As expected, the three measures deliver similar insights. On average, and most of the time, the portfolio of sin stocks outperforms socially responsible investment mutual funds. This finding corroborates the results obtained in 4.1, implying that SRI funds could increase their performance by including sin stocks on their portfolios. Therefore, investors who want maximum financial efficiency should not invest in SRI mutual funds.

5. Conclusions

Since the 1960s, we have observed a growing concern with environmental, governance and social issues. Concomitantly, socially responsible investment (SRI) has developed into a very important investment class, representing \$35.3 trillion in assets under management in 2020, accounting for 35.9% of total assets under management in the world (GSIA, 2021). The rising notoriety of socially conscious investments has also been observed in mutual funds. SRI mutual funds have been attracting more flows than conventional funds (Bialkowski & Starks, 2016).

The empirical literature on SRI funds is vast, focusing on studying their financial performance and comparing it with conventional investments. The evidence is mixed (Utz & Wimmer, 2014). Nonetheless, the significant literature demonstrating the financial outperformance of SRI funds is intriguing. Theoretically, it does not hold. *Ceteris paribus*, a portfolio with investment restrictions, should not perform better than an unrestricted portfolio (Renneboog et al., 2008). Therefore, we resorted to the Modern Portfolio Theory of Markowitz (1952) and Tobin's Separation Theorem (Tobin, 1958) to find out if the efficiency of SRI portfolios increases by adding sin stocks, that is, to see if SRI funds would see their risk-adjusted returns increase by adding stocks that socially responsible investors typically reject. We did so by building optimal risky portfolios, i.e., efficient portfolios that maximize the risk premium per unit, commonly referred as the Sharpe ratio, in a world where there were two available risky assets: a portfolio of sin stocks (the Black Sheep portfolio), and an SRI mutual fund. Then, we analyzed the weights of these assets in the optimal portfolios.

The results were strong. For the samples considered, sin stocks improved the efficiency of SRI funds almost every time and for any SRI fund. This means that socially responsible investment is not efficient, representing a financial cost. In most situations, holding even a small portion of SRI mutual funds was detrimental, with results suggesting short selling SRI funds to invest more than 100 percent in sin stocks. The main implication is that, by choosing SRI, investors are hindering their financial performance. Thus, investors looking for the most efficient investment portfolio should consider investing beyond the realm of socially responsible investments.

We also computed three investment performance measures (Sharpe ratio, Treynor ratio and Jensen's alpha) to compare the performance of the Black Sheep and SRI portfolios. All measures delivered similar conclusions. Sharpe and Treynor ratios showed us that sin stocks reward risk better than SRI mutual funds, providing a larger risk premium per unit of risk. Jensen's alpha was significantly greater for sin stocks, evidencing substantial abnormal returns, which did not happen, on average, for socially responsible investing.

Further studies could test if these results hold even when changing the sin stocks universe. We defined sin stocks as firms with at least 30% of total sales originating in the armaments, alcohol, tobacco, or gambling sectors. Sectors such as nuclear power, genetically modified organisms, and adult entertainment can also be taken into account. Additional research could also try to incorporate transaction costs in a different and more refined way than the one employed in this study.

Another area of study could be exploring the rationale behind socially responsible investing. If SRI is characterized as a suboptimal financial investment, why does this investment class keep gaining importance? Indeed, SRI literature appears to be under-theorized, specifically on investors' motivations to engage in SRI and the connection between regulation and SRI and non-financial performance, with most of the attention being aimed at the financial performance of SRI funds.

Appendices

Appendix 1 – SRI Mutual Funds (N = 259)

ISIN Code	Asset Name	Geographical Focus	Domicile	Launch Date	ESG Score
AT0000918297	I-AM GreenStars European Equities A	Europe	Austria	05/02/1993	77.19
DE000A0NAUP7	LBBW Nachhaltigkeit Aktien R	Europe	Germany	15/10/2008	74.76
FR0010156216	BNP Paribas Immobilier ISR Classic C	Europe	France	19/01/2005	74.17
LU0223829341	ASR Fonds Europa Vastgoedfonds Classic	Europe	Luxembourg	03/10/2005	73.77
FR0000444366	CM-AM Objectif Environnement C	EuroZone	France	16/06/2000	73.14
GB00B6WFCT77	Artemis European Sustainable Grth I Dist GBP	Europe exc UK	UK	28/10/2011	73.07
FR0010077859	BNP Paribas MidCap France ISR Classic (D)	France	France	14/09/1992	72.95
FR0010302398	BNP Paribas Actions Europe Responsable Classic C	Europe	France	15/03/2006	72.92
SE0000924649	Aktiespararna Topp Sverige Hallbar	Sweden	Sweden	25/11/1999	72.85
FR0000982761	AXA Euro Valeurs Responsables C	EuroZone	France	31/07/1996	72.84
FR0010077453	BNP Paribas Technologies Europe Classic	Europe	France	05/04/2002	72.64
DE0009752303	Amundi German Equity A ND	Germany	Germany	01/10/1990	72.36
IT0001033486	Arca Azioni Europa ESG Leaders	Europe	Italy	13/03/1995	72.22
FR0000989006	LCL Actions Développement Durable (C)	Europe	France	23/10/2002	72.01
LU0048581077	Fidelity Funds - Iberia A-EUR-DIS	Iberia	Luxembourg	01/10/1990	71.98
FR0000991424	Amundi Valeurs Durables - P (C/D)	Europe	France	24/02/2003	71.97
FR0000994378	AIS Mandarine Active P	EuroZone	France	16/07/2003	71.89
LU0187077218	Robeco Sustainable European Stars Equities D EUR	Europe	Luxembourg	28/05/1991	71.81
IE00B744CK03	Federated Hermes Sust Euro ex-UK Eq R EUR Acc	Europe exc UK	Ireland	08/03/2012	71.80
LU0254565053	PRIMA - Global Challenges A	Global	Luxembourg	01/08/2006	71.79
IE00B3RXPB88	Federated Hermes Sustainable Eupn Eq R EUR Acc	Europe	Ireland	12/11/2011	71.75
FR0010217588	BNP Paribas Actions Entrepreneurs Classic Cap	EuroZone	France	04/10/1996	71.65
LU0545089723	AXA WF ACT Eurozone Impact A EUR Cap	EuroZone	Luxembourg	03/11/2010	71.56
DE0008481821	Allianz Wachstum Europa - A - EUR	Europe	Germany	13/01/1997	71.53
DE0008475005	Concentra - A - EUR	Germany	Germany	26/03/1956	71.50
FR0000992471	La Francaise Actions Monde	Global	France	11/03/2003	71.27
IE00B563Q870	Nippon Growth UCITS Fund A JPY Acc	Japan	Ireland	04/11/2009	71.25
FR0010199091	Ecofi Actions Rendement Euro C	EuroZone	France	04/08/2005	71.14
PTYCXHLP0002	Caixa Acoes Europa Socialmente Responsavel	Europe	Portugal	12/11/1993	71.01
LU0028445327	EDM International Strategy Fund R EUR	Europe	Luxembourg	09/11/1990	71.00
FI0008804760	LocalTapiola ESG Europe Mid Cap A	Europe	Finland	21/09/1999	70.95
FR0010074666	AXA ACT Carbon Offset Eurobloc Equity QI	EuroZone	France	21/06/2004	70.94
LU0093570173	BL Sustainable Horizon B Cap	Global	Luxembourg	06/03/1997	70.89
FR0000989915	ODDO BHF Immobilier CR-EUR	EuroZone	France	12/09/1989	70.85
SE0001838004	SEB Swedish Value Fund	Sweden	Sweden	10/11/2006	70.82
DE000A0Q8HL1	Geneon Global Challenges Select	Global	Germany	02/10/2009	70.81
EP0000004970	Epargne Ethique Actions C	EuroZone	France	03/02/2000	70.78
LU0093570330	BL Equities Europe B Cap	Europe	Luxembourg	28/09/1990	70.71
DK0010246396	ValueInvest Danmark Global A	Global	Denmark	15/07/1998	70.55
FR0000017329	Allianz Valeurs Durables R C EUR	EuroZone	France	15/10/1991	70.48
FR0000970949	MAM Transition Durable Actions C	Global	France	24/11/2000	70.43
LU0496466151	CS (Lux) Eurozone Quality Growth Equity Fd B EUR	EuroZone	Luxembourg	27/06/2011	70.40
AT0000986377	Raiffeisen-Nachhaltigkeit-Europa-Aktien R A	Europe	Austria	17/06/1996	70.37
FR0011051655	Groupama Europe Actions Immobilier N	Europe	France	15/09/2011	70.33
AT0000859293	Raiffeisen-Nachhaltigkeit-OesterreichPlusAktienRA	Austria	Austria	16/10/1989	70.32
GB0006778681	BNY Mellon Sustainable European GBP Inc	Europe exc UK	UK	01/06/1987	70.31
AT0000A0AA78	SUPERIOR 6 - Global Challenges T	Global	Austria	16/10/2008	70.29
FR0000970899	Ethique et Partage - CCFD Part D	Europe	France	15/12/2000	70.27
LU0145456207	Generali IS - SRI European Equity DX	Europe	Luxembourg	26/11/2003	70.19
FR0010546945	Tocqueville Megatrends ISR C	Global	France	22/06/2005	70.15
FR0010863688	Echiquier Positive Impact Europe A	Europe	France	19/03/2010	70.15
LU0542502157	Allianz Europe Equity SRI A-EUR	Europe	Luxembourg	26/10/2010	70.13
FR0000003188	Seeyond Euro Sustainable Minvol R	Europe	France	31/03/1993	70.10
LU0503631714	Pictet-Global Environmental Opportunities-P EUR	Global	Luxembourg	10/09/2010	70.06
LU0068337053	JSS Sustainable Equity - Systematic EM P USD dist	Global Emg Mkts	Luxembourg	05/06/1996	69.99
LU0256839274	Allianz Europe Equity Growth AT-EUR	Europe	Luxembourg	16/10/2006	69.97
LU0119124781	Fidelity Funds - European Dynamic Gth A-EUR-DIS	Europe	Luxembourg	15/01/2001	69.96
SE0001463449	Ohman Etisk Index Sverige A	Sweden	Sweden	24/08/2005	69.93
DE0000704537	ODDO BHF Algo Sustainable Leaders CRW-EUR	Europe	Germany	27/08/2002	69.91
LU0347711466	BNPP Global Environment Cap C	Global	Luxembourg	09/04/2008	69.89
LU0145644893	DWS Invest ESG Top Euroland LC	EuroZone	Luxembourg	03/06/2002	69.88
DE0008490848	DWS Eurovesta	Europe	Germany	07/11/1988	69.87
FR0010703355	MAIF Actions Climat P	Europe	France	30/01/2009	69.86
DE0009771964	LBBW Schwellenlaender Profiteure Nachhaltigkeit	Global Emrg Mkts	Germany	16/06/1997	69.86
CH0002793757	CS Fund 3 - Swissac Equity Fund B	Switzerland	Switzerland	01/12/1982	69.84
US7042237757	Pax Global Environmental Markets Fd;Inst	Global	USA	27/03/2008	69.83

ISIN Code	Asset Name	Geographical Focus	Domicile	Launch Date	ESG Score
SE0000735789	Aktie-Ansvar Sverige A	Sweden	Sweden	01/01/1992	69.73
NL0010066247	InDelta Vastgoed Indexfonds	Global	Netherlands	05/03/2012	69.67
FR0000449431	Allianz Actions Euro Convictions C EUR	EuroZone	France	04/10/2000	69.65
FR0000983819	OFI RS Croissance Durable et Solidaire C	EuroZone	France	26/04/2002	69.63
LU0317020898	Candriam Equities L EMU Innovation C Cap	EuroZone	Luxembourg	23/10/2007	69.60
LU0578134230	Memnon European R EUR	Europe	Luxembourg	01/02/2011	69.56
LU0090707612	UniNachhaltig Aktien Europa	EuroZone	Luxembourg	15/09/1998	69.52
DE000A1H56E7	apo TopDividende Europa	Europe	Germany	02/05/2011	69.51
LU0079556006	JPM Europe Select Equity A Acc EUR	Europe	Luxembourg	29/08/1997	69.50
SE0000837353	Lansforsakringar Europa Aktiv A	Europe	Sweden	10/12/1990	69.48
BE0945524651	Belfius Equities Europe Conviction C Cap	Europe	Belgium	25/06/1998	69.46
FR0010748368	LBPAM ISR Actions Environnement C	Europe	France	11/05/2009	69.45
FR0000003998	Lazard Equity SRI PC EUR	EuroZone	France	01/06/2001	69.40
IE00B5VJPM77	EI Sturzza Stratc Europe Qlty A EUR Acc	Europe	Ireland	29/10/2010	69.39
LU0599612842	Ossiam Europe ESG Machine Learning 1C (EUR)	Europe	Luxembourg	21/06/2011	69.35
LU0153358667	BMO Sustainable Opps European Eq A Inc EUR	Europe	Luxembourg	14/12/2000	69.34
LU0269642889	Cadmos - European Engagement A	Europe	Luxembourg	19/10/2006	69.34
AT0000645973	ERSTE RESPONSIBLE STOCK EUROPE T	Europe	Austria	06/06/2003	69.33
DE0009750216	LIGA-Pax-Aktien-Union	Europe	Germany	05/05/1997	69.32
FR0010077461	BNP Paribas Energie & Industrie Europe ISR Classic	Europe	France	28/03/2002	69.30
NO0010102866	DNB Gront Norden A	Nordic	Norway	05/01/1990	69.29
NO0008001880	Eika Norden	Nordic	Norway	30/11/1998	69.28
FR0010560664	Fourpoints Euro Global Leaders R	EuroZone	France	31/12/2007	69.23
FR0010077412	BNP Paribas Developpement Humain Classic	Europe	France	11/04/2002	69.21
FR0000299356	Norden SRI	Nordic	France	02/01/1995	69.21
US92838V4784	Virtus Water Fund;P	Global	USA	31/03/2008	69.09
LU0260085492	Jupiter European Growth L EUR Acc	Europe	Luxembourg	17/08/2001	69.06
GB0000804335	Barings European Growth A GBP Inc	Europe exc UK	UK	30/06/1983	69.03
US04315J8457	abrdn Global Equity Impact Fund;A	Global	USA	04/05/2005	69.01
AT0000A06Q31	Amundi Oeko Sozial Stock (I)	Global	Austria	19/11/2007	68.99
DE0009769729	DWS Top Europe LD	Europe	Germany	11/10/1995	68.95
LU0354788688	CB - Save Earth Fund R Cap	Global	Luxembourg	09/06/2008	68.95
LU0256946863	ING Direct Mattone Arancio P Dis	Europe	Luxembourg	05/09/2006	68.93
LU0119205192	NN (L) European Real Estate P Cap EUR	Europe	Luxembourg	20/12/1993	68.86
FI4000027974	OP-Nordic Countries Index A	Nordic	Finland	29/09/2011	68.86
LU0314225409	DKB Nachhaltigkeitsfonds Europa AL	Europe	Luxembourg	27/08/2007	68.85
FR0000008674	Fidelity Europe Action A	Europe	France	07/12/2001	68.83
FR0010592022	Ecofi Enjeux Futurs C	Global	France	18/07/2008	68.80
LU0566497433	UBS (Lux) Eq SICAV - Eupn High Div Sust (EUR) Pa	Europe	Luxembourg	10/12/2010	68.80
DE0008475062	Allianz Vermoegensbildung Deutschland - A - EUR	Germany	Germany	01/07/1970	68.78
FR0000170292	AXA Valeurs Euro AC	EuroZone	France	28/07/1999	68.73
FR0010341800	Palatine Planete I	EuroZone	France	07/07/2006	68.72
GB0030927700	M&G European Sustain Paris Aligned A Inc	Europe exc UK	UK	29/09/1989	68.71
SE0000602294	Swedbank Robur Exportfond	Sweden	Sweden	01/02/1993	68.70
FR0000286320	LBPAM Actions Euro R	EuroZone	France	03/09/1993	68.70
FR0000972655	Amundi Actions Foncier - P (D)	Europe	France	28/02/2001	68.69
FR0010285874	SG Actions Immobilier C	Europe	France	01/04/1973	68.67
SE0000735797	Aktie-Ansvar Europa	Europe	Sweden	15/06/2000	68.63
LU0389656892	AXA WF Framlington Sustainable Eurozone A EUR Cap	EuroZone	Luxembourg	23/01/2009	68.63
DE0005152375	DWS Europe Dynamic	Europe	Germany	30/05/2005	68.59
DE0008490822	DWS Qi LowVol Europe NC	Europe	Germany	12/12/1994	68.58
DE0008474057	Baloise-Aktienfonds DWS	Germany	Germany	01/10/1971	68.58
LU0323239441	HSBC GIF Global Equity Climate Change AC USD	Global	Luxembourg	09/11/2007	68.55
DE000A0M6W69	DWS Qi European Equity SC	Europe	Germany	21/04/2008	68.54
NO0010039712	Delphi Europe	Europe	Norway	08/03/1999	68.52
NO0010272396	KLP AksjeNorden Indeks P	Nordic	Norway	16/03/1999	68.51
LU0119750205	Invesco Sust Pan European Structured Eq A Acc EUR	Europe	Luxembourg	06/11/2000	68.51
LU0094541447	AS SICAV I - European SRI Equity A Acc EUR	Europe	Luxembourg	29/01/1993	68.51
DE0008471012	Fondak - A - EUR	Germany	Germany	30/10/1950	68.49
LU0439729368	CS (Lux) European Dividend Plus Equity Fund B EUR	Europe	Luxembourg	09/09/2009	68.48
LU0088814487	FF- Sustainable Europe Equity A-EUR-DIS	EuroZone	Luxembourg	30/09/1998	68.45
LU0037079380	EB-Oeko-Aktienfonds R	Global	Luxembourg	23/08/1991	68.45
FR0007045950	Federis ISR Euro MH	EuroZone	France	16/06/2000	68.44
BE0940002729	DPAM B Equities Europe Sustainable B	Europe	Belgium	31/12/2002	68.44
LU0194779913	Invesco Pan Europ Struct Resp Eq A Acc EUR	Europe	Luxembourg	30/06/2004	68.42
SE0000739153	AMF Aktiefond Europa	Europe	Sweden	30/04/1999	68.41
FR0010541185	Etoile TMT Europe (C)	Europe	France	22/06/2000	68.39
LU0049842692	UBS (Lux) Equity Fd-Mid Caps Europe Sust (EUR) Pa	Europe	Luxembourg	20/01/1995	68.38
AT0000799820	KEPLER Ethik Quality Aktienfonds A	Global	Austria	20/04/1998	68.36
SE0000531881	Storebrand Europa A SEK	Europe	Sweden	30/12/1998	68.32
LU0384405600	Vontobel Fund Clean Technology B EUR	Global	Luxembourg	17/11/2008	68.32
FR0010214213	Ecofi Trajectoires Durables C	EuroZone	France	12/09/2005	68.32

ISIN Code	Asset Name	Geographical Focus	Domicile	Launch Date	ESG Score
GB0030879141	JPM Europe (ex-UK) Sustainable Equity A Net Acc	Europe exc UK	UK	01/11/1964	68.31
FR0010119917	Lazard Actifs Reels C	EuroZone	France	02/11/2004	68.30
FR0007078811	Metropole Selection A	Europe	France	29/11/2002	68.28
LU0030166507	SEB Europe Equity Fund C (EUR)	Europe	Luxembourg	06/12/1988	68.26
GB0005027338	Janus Henderson UK Responsible Income A Inc	United Kingdom	UK	15/05/1995	68.25
LU0187079180	Robeco Sustainable Property Equities D EUR	Global	Luxembourg	03/06/1998	68.23
LU0012157102	Eurizon Fund - Eq Small Mid Cap Europe R EUR Acc	Europe	Luxembourg	10/06/1994	68.18
FR0010599373	Amundi Actions Euro - P (C)	EuroZone	France	09/04/2008	68.15
FR0000447609	AIS Mandarine Opportunités P	France	France	14/02/1986	68.14
FR0007492525	Mitra I	EuroZone	France	01/04/1995	68.13
FR0010541094	Etoile Industrie Europe (C)	Europe	France	23/09/2003	68.10
LU0216734045	AXA WF Framlington Euro Real Estate Secs A EUR C	Europe	Luxembourg	16/08/2005	68.10
LU0288928376	JSS Sustainable Equity - Real Estate Global P EUR	Global	Luxembourg	02/04/2007	68.08
FR0010915181	Export Europe ISR (Palatine)	EuroZone	France	07/07/2010	68.07
SE0000539454	Swedbank Robur Europafond A	Europe	Sweden	18/04/1994	68.06
DE0009769992	LEA-Fonds DWS	Europe	Germany	01/10/1999	68.06
NL0009296649	Kempen European Property Fund N.V.	Europe	Netherlands	26/10/2000	68.05
FR0010602615	GTA France	France	France	06/05/2008	67.98
LU0125946151	MFS Meridian Funds-European Core Equity A1 EUR	Europe	Luxembourg	01/10/2002	67.96
FR0007433669	Euro Convictions ISR GF	EuroZone	France	02/02/1988	67.95
LU0029873410	Templeton Global Climate Change Fd A (Ydis) EUR	Global	Luxembourg	26/04/1991	67.95
FR0010038257	Conservateur Unisic C	Europe	France	19/01/2004	67.92
DE0009778563	DWS Qi Eurozone Equity RC	EuroZone	Germany	30/03/1998	67.91
US7042237427	Pax International Sustainable Economy Fund;Inst	Global Ex US	USA	27/01/2011	67.91
SE0000529992	Storebrand Sverige A SEK	Sweden	Sweden	30/12/1998	67.90
LU0470356352	PRIME VALUES Equity A	Global	Luxembourg	29/12/2009	67.88
SE0000740680	Lannebo Sverige	Sweden	Sweden	04/08/2000	67.88
LU0228636063	NN (L) Euro Income P Cap EUR	EuroZone	Luxembourg	01/09/2005	67.88
FR0010284521	SG Actions Europe Restructurations C	Europe	France	22/09/2000	67.87
FI0008807573	OP-Reaaliomaisuusyhdt A	Europe	Finland	01/11/2004	67.86
IE0004766675	Comgest Growth Europe EUR Acc	Europe	Ireland	15/05/2000	67.86
FR0007075155	R-co OPAL 4Change Equity Europe	Europe	France	06/08/2002	67.84
FR0010116541	BNP Paribas Best Selection Actions Euro ISR Clsc D	EuroZone	France	14/09/1992	67.81
NL0000289627	Kempen Orange Fund NV	Netherlands	Netherlands	07/09/1990	67.80
LU0095527585	NN (L) EURO Equity P Cap EUR	EuroZone	Luxembourg	18/12/2001	67.78
SE0000542987	Swedbank Robur Talenten Aktiefond Mega	Global	Sweden	30/11/1995	67.75
DK0016002496	SEBinvest AKL Europa Højt Udbytte P	Europe	Denmark	29/01/1999	67.72
IE00B572T065	Sarasin IE Sustainable GI Real Estate Eq A GBP Acc	Global	Ireland	06/12/2004	67.72
LU0344046155	Candriam Equities L Europe Innovation C Cap	Europe	Luxembourg	30/06/2008	67.71
LU0145634076	DWS Invest European Equity High Conviction L	Europe	Luxembourg	03/06/2002	67.70
IE00B4ZJ4634	Comgest Growth Europe S Fund EUR Acc	Europe	Ireland	08/12/2010	67.69
LU0125951151	MFS Meridian Funds-European Value A1 EUR	Europe	Luxembourg	01/10/2002	67.69
AT0000677901	Raiffeisen-Nachhaltigkeit-Aktien R A	Global	Austria	13/05/2002	67.66
FR0010834390	LFIP Multi Trends	Europe	France	29/01/2010	67.66
LU0389811372	Amundi Index MSCI EMU ESG Leaders Select AE (C)	EuroZone	Luxembourg	23/09/2008	67.65
SE0000577975	Ohman Marknad Europa	Europe	Sweden	20/10/1999	67.65
FR0000977530	Seeyond Actions Europeennes ESG R C	Europe	France	05/10/2001	67.65
FR0010271528	G FUND Equity Convictions ISR N C	EuroZone	France	25/04/2006	67.65
FR0010148007	Maxima A	Europe	France	27/01/2005	67.64
FR0010286732	SG Actions Euro Largecap C	Europe	France	22/10/2002	67.63
FR0010319434	BNP Paribas Actions Croissance ISR Classic	Europe	France	13/06/2006	67.63
SE0000625238	Nordea Swedish Stars icke-utd	Sweden	Sweden	26/10/1999	67.59
LU0125727601	AXA WF Framlington Europe Opportunities A EUR C	Europe	Luxembourg	09/03/2001	67.59
IT0001338414	Alto ESG Innovazione Sostenibile A	Europe	Italy	18/10/1999	67.58
LU0415391860	Bellevue F (Lux) Bellevue Sust Entrep Europ B EUR	Europe	Luxembourg	30/04/2009	67.58
FR0000970972	Nouvelle Strategie 50 C	EuroZone	France	22/04/1983	67.57
SE0000429789	Carnegie Sverigefond A	Sweden	Sweden	08/01/1987	67.54
FR0007394762	Portzamparc Opportunités ISR C	Europe	France	14/03/1986	67.54
SE0000984171	SEB Europafond	Europe	Sweden	28/12/1990	67.51
LU0094707279	Swiss Life Funds (LUX) Eq ESG Euro Zone R Cap	EuroZone	Luxembourg	30/06/1999	67.51
SE0000837221	Lansforskringar Sverige Vision A	Sweden	Sweden	10/12/1990	67.50
FR0010263806	LBPAM ISR Actions Euro Large Cap R	EuroZone	France	24/02/2006	67.50
LU0073680463	AXA WF Framlington Euro Selection A EUR C	EuroZone	Luxembourg	31/12/1992	67.49
GB0001615102	Royal London Sustainable Leaders Trust A Inc	United Kingdom	UK	29/05/1990	67.48
US6412247537	Neuberger Berman International Select Fund;Trust	Global Ex US	USA	01/08/2006	67.44
NL0006354425	AEGON Vastgoed Fund Internationaal	Global	Netherlands	01/07/1990	67.40
FR0007074208	BNP Paribas Actions Rendement ISR Classic	EuroZone	France	28/06/2002	67.38
NL0006354433	AEAM Global Sustainable Real Estate Fund	Global	Netherlands	02/01/1997	67.35
FR0000990095	ODDO BHF Avenir Euro CR-EUR	EuroZone	France	30/12/1998	67.35
FR0010102095	BNP Paribas Rendactis ISR	EuroZone	France	21/09/2004	67.32
LI0014803386	VP Bank Risk Optimised ESG Equity Europe EUR B	Europe	Liechtenstein	17/09/2002	67.30
NL0006311748	NN Premium Dividend Fund	EuroZone	Netherlands	01/11/2005	67.29

ISIN Code	Asset Name	Geographical Focus	Domicile	Launch Date	ESG Score
US74316J1108	Boston Common ESG Impact International Fund	Global Ex US	USA	29/12/2010	67.28
LU0048578792	Fidelity Funds - European Growth A-EUR-DIS	Europe	Luxembourg	01/10/1990	67.27
US01879X1037	AB Sustainable International Thematic Fund;A	Global Ex US	USA	02/06/1994	67.25
FR0010648741	BNP Paribas Valeurs Euro ISR I	EuroZone	France	31/07/2008	67.24
LU0246035637	Schroder ISF Europ Special Situations A Acc	Europe	Luxembourg	31/03/2006	67.23
CH0011980981	Raiffeisen Futura Swiss Stock A	Switzerland	Switzerland	08/06/2001	67.22
LU0578704941	Manavest-Europe Evolution Equity EUR	Europe	Luxembourg	24/01/2011	67.21
AT0000647698	KEPLER D-A-CH Plus Aktienfonds T	Austria	Austria	23/04/2003	67.15
FR0010165944	Amundi Actions Restructurations P (C)	Europe	France	27/12/1996	67.14
LU0119124278	Fidelity Funds - European Larger Cos A-EUR-DIS	Europe	Luxembourg	16/09/2002	67.13
FR0011169341	Sycomore Selection Responsable R	EuroZone	France	23/12/2011	67.12
LU0231484808	AS SICAV I - Europe ex-UK SRI EqFd A Acc EUR	Europe exc UK	Luxembourg	24/03/2006	67.11
DE0008470337	Invesco Europa Core Aktienfonds	Europe	Germany	25/01/1991	67.11
SE0001057928	Nordic Equities Strategy	Nordic	Sweden	29/12/2000	67.10
FR0010546903	Tocqueville Small Cap Euro ISR C	EuroZone	France	07/10/1993	67.10
SE0000427874	Nordea Alfa	Sweden	Sweden	02/04/1984	67.08
DE0007560849	Monega FairInvest Aktien (R)	Europe	Germany	19/10/2006	67.07
LU0591897516	Schroder ISF European Innovators A EUR Acc	Europe	Luxembourg	03/03/2011	67.05
SE0000885105	KPA Etisk Aktiefond	Global	Sweden	01/03/1999	67.04
SE0000427882	Nordea Olympiadfond	Sweden	Sweden	05/01/1988	67.02
SE0000691750	SEB WWF Nordenfond	Nordic	Sweden	27/01/1999	67.02
DK0060130235	SEBinvest AKL Nordiske Aktier P	Nordic	Denmark	24/04/2008	67.02
NL0006354151	AEGON Dutch Equity Index Fund	Netherlands	Netherlands	02/01/1997	67.00
IE0000829121	Barings Europa A USD Inc	Europe	Ireland	21/04/1987	66.97
LU0085870433	UBS (Lux) Eq Fd - Euro Co Opportunity Sust (EUR)Pa	EuroZone	Luxembourg	07/10/2004	66.94
SE0000810772	Skandia Europa Exponering	Europe	Sweden	05/05/1995	66.93
LU0030165871	SEB Nordic Equity Fund C (EUR)	Nordic	Luxembourg	06/12/1988	66.93
SE0000984189	SEB Nordenfond	Nordic	Sweden	06/06/1997	66.91
FR0010178665	Gay-Lussac Green Impact A	Europe	France	03/06/2005	66.88
LU0326732954	Lyxor MSCI EMU ESG Broad CTB (DR) -IE	EuroZone	Luxembourg	02/11/2006	66.85
DE0008474156	DWS European Opportunities LD	Europe	Germany	11/07/1985	66.85
US89155H5798	Touchstone International ESG Equity Fund;A	Global Ex US	USA	03/12/2007	66.85
LU0302976872	Swisscanto (LU) EF Sustainable Global Water AT	Global	Luxembourg	18/09/2007	66.83
FR0010028910	BNP Paribas Actions Patrimoine ISR Classic C	Europe	France	13/08/1985	66.82
BRETCACTF006	Santander Ethical Acoes Sustentabilidade FI	Brazil	Brazil	06/11/2001	66.81
LU0705775699	Janus Henderson HF Pan European Equity A2 USD	Europe	Luxembourg	12/12/2011	66.80
FI0008801774	Seligson & Co Europe Index A	Europe	Finland	15/06/1998	66.80
DE0009789842	Allianz Wachstum Euroland - A - EUR	EuroZone	Germany	05/07/1999	66.78
US6412248113	Neuberger Berman International Equity Fund;Inst	Global Ex US	USA	17/06/2005	66.78
LU0106235293	Schroder ISF EURO Eq A Acc	EuroZone	Luxembourg	17/01/2000	66.74
IE00B0689000	SEI European (ex UK) Eq GBP Wlth Dist A	Europe exc UK	Ireland	21/10/2009	66.73
FR0010458745	Amundi Actions Euro ISR P (C)	EuroZone	France	21/05/1999	66.72
FR0000294613	Lazard Alpha Europe A	Europe	France	14/05/1990	66.71
IT0001053138	Investimenti Azionari Europa ESG A	Europe	Italy	29/09/1995	66.71
FR0000971186	OFI Actions Euro C	EuroZone	France	02/02/2001	66.70
LU0319773478	VP SICAV Tareno Global Water Solutions Fd R1 EUR	Global	Luxembourg	10/09/2007	66.69
SE0000540593	Folksam LO Sverige	Sweden	Sweden	18/03/1999	66.69
LU0107398538	JPM Europe Strategic Growth A Dis EUR	Europe	Luxembourg	14/02/2000	66.68
LU0185496469	OFI Invest - RS Ethical European Equity (R EUR)	Europe	Luxembourg	14/08/2006	66.67

Appendix 2 – Sin Stocks (N = 159)

Armaments (n = 52)

ISIN	Company Name	Armaments (% Sales)	Net Sales (USD Million)
AU000000EOS8	Electro Optic Systems Holdings Ltd	78%	154.15
CA00927V2003	AirBoss of America Corp	46%	586.86
CA5589122004	Magellan Aerospace Corp	48%	544.85
CA42774L1094	Heroux Devtek Inc	70%	428.90
CNE000001JY5	AVIC Electromechanical Systems Co Ltd	74%	2 360.20
CNE000000N30	China Marine Information Electronics Co Ltd	73%	767.32
CNE000000198	North Industries Group Red Arrow Co Ltd	58%	1 182.86
CNE000000DM5	Addsino Co Ltd	38%	652.36
FR0000121329	Thales SA	54%	18 407.11
FR0014004L86	Dassault Aviation SA	48%	8 237.50
DE0007030009	Rheinmetall AG	71%	6 432.03
INE263A01024	Bharat Electronics Ltd	73%	2 024.76
IL0010811243	Elbit Systems Ltd	86%	5 278.52
IT0003856405	Leonardo SpA	74%	16 068.71
NO0003043309	Kongsberg Gruppen ASA	37%	3 116.83
SE0000112385	Saab AB	90%	4 331.58
TRAASELS91H2	Aselsan Elektronik Sanayi ve Ticaret AS	100%	1 512.38
TRAO'TKAR91H3	Otokar Otomotiv ve Savunma Sanayi AS	54%	338.60
GB00B0YD2B94	Cohort PLC	88%	197.97
GB0000667013	Avon Protection PLC	80%	248.30
GB0009123323	Ultra Electronics Holdings PLC	57%	1 150.92
GB0005758098	Meggitt PLC	52%	2 014.75
GB00B45C9X44	Chemring Group PLC	100%	538.46
GB0007973794	Serco Group PLC	31%	5 986.07
US05464C1018	Axon Enterprise Inc	42%	863.38
US5253271028	Leidos Holdings Inc	53%	13 737.00
US0970231058	Boeing Co	42%	62 286.00
US3695501086	General Dynamics Corp	34%	38 469.00
US2315611010	Curtiss-Wright Corp	55%	2 505.93
US0003611052	AAR Corp	51%	1 652.30
US4282911084	Hexcel Corp	34%	1 324.70
US6372151042	National Presto Industries Inc	67%	355.78
US8968181011	Triumph Group Inc	47%	1 459.94
US1271903049	CACI International Inc	69%	6 044.14
US4611481080	Intevac Inc	53%	38.52
US5006001011	Kopin Corp	40%	45.67
US9182841000	VSE Corp	34%	750.85
US4835481031	Kaman Corp	51%	708.99
US8936411003	TransDigm Group Inc	45%	4 798.00
US0080731088	AeroVironment Inc	34%	394.91
US50077B2079	Kratos Defense and Security Solutions Inc	70%	811.50
SE0001200015	Invisio AB	100%	65.60
GB0002634946	BAE Systems PLC	100%	26 410.07
SG1F60858221	Singapore Technologies Engineering Ltd	35%	5 702.64
US5398301094	Lockheed Martin Corp	63%	67 044.00
US0995021062	Booz Allen Hamilton Holding Corp	66%	8 363.70
US4464131063	Huntington Ingalls Industries Inc	90%	9 524.00
GB00B63H8491	Rolls-Royce Holdings PLC	30%	15 176.89
US6668071029	Northrop Grumman Corp	100%	35 667.00
GB00BNR5MZ78	Melrose Industries PLC	34%	9 312.05
US6882392011	Oshkosh Corp	100%	1 791.70
CA1247651088	CAE Inc	36%	2 697.26

Alcohol (n = 43)

ISIN	Company Name	Alcohol (% Sales)	Net Sales (USD Million)
AU000000MTS0	Metcash Ltd	31%	11 063.73
CA2183491083	Corby Spirit and Wine Ltd	69%	128.92
CLP9796J1008	Concha y Toro Winery Inc	100%	983.10
CNE0000009Y3	Tsingtao Brewery Co Ltd	98%	4 749.11
CNE0000018R8	Kweichow Moutai Co Ltd	97%	17 232.77
CNE000000MD5	Anhui Gujing Distillery Co Ltd	74%	2 089.05
CNE000000S92	Jiugui Liquor Co Ltd	52%	537.52
CNE000001568	Yantai Changyu Pioneer Wine Co Ltd	100%	622.32
CNE000000DH5	Shanxi Xinghuacun Fen Wine Factory Co Ltd	68%	3 144.00
CNE000000XH3	Beijing Shunxin Agriculture Co Ltd	67%	2 340.86
CNE000000TL3	Chongqing Brewery Co Ltd	98%	2 065.35
CNE000000GF2	Luzhou Laojiao Co Ltd	99%	3 249.68
CNE000000S84	Beijing Yanjing Brewery Co Ltd	82%	1 883.00
CNE000000NH4	Sichuan Swellfun Co Ltd	63%	729.19
CNE000000VQ8	Wuliangye Yibin Co Ltd	77%	10 423.18
DK0060634707	Royal Unibrew A/S	48%	1 337.21
FR0000130395	Remy Cointreau SA	82%	1 452.72
FR0000120693	Pernod Ricard SA	100%	10 460.80
FR0000060873	Marie Brizard Wine and Spirits SA	100%	189.49
HK0291001490	China Resources Beer Holdings Co Ltd	92%	5 256.06
IE00B010DT83	C&C Group PLC	55%	1 613.40
JP3116000005	Asahi Group Holdings Ltd	38%	19 430.62
MYL2836OO004	Carlsberg Brewery Malaysia Bhd	100%	425.75
PHY003341054	Alliance Global Group Inc	39%	2 803.42
ZAE000026480	Remgro Ltd	43%	4 612.06
TH0902010014	Thai Beverage PCL	89%	7 144.14
TRAAEFES91A9	Anadolu Efes Biracilik ve Malt Sanayii AS	56%	2 951.01
GB00B021F836	Naked Wines PLC	100%	468.12
US1005571070	Boston Beer Company Inc	100%	2 057.62
US60871R2094	Molson Coors Beverage Co	94%	10 279.70
US1156372096	Brown-Forman Corp	98%	3 461.00
US21036P1084	Constellation Brands Inc	98%	8 820.70
US74934Q1085	RCI Hospitality Holdings Inc	30%	195.26
JP3320800000	Sapporo Holdings Ltd	73%	3 798.74
CNE100000HB8	Jiangsu Yanghe Brewery Joint-Stock Co Ltd	97%	3 990.83
CNE1000011K6	Shanghai Bairun Investment Holding Group Co Ltd	88%	408.43
AU000000TWE9	Treasury Wine Estates Ltd	91%	2 012.39
US55303J1060	MGP Ingredients Inc	44%	626.72
BE0974293251	Anheuser-Busch Inbev Afgekort Ab Inbev NV	91%	54 304.00
ZAE000248811	Distell Group Holdings Ltd	100%	1 980.33
CA03444Q1000	Andrew Peller Ltd	100%	312.98
US67098H1041	O-I Glass Inc	61%	6 357.00
NL0015435975	Davide Campari Milano NV	88%	2 469.93

Gambling (n = 49)

ISIN	Company Name	Gambling (% Sales)	Net Sales (USD Million)
AU000000JIN0	Jumbo Interactive Ltd	90%	62.61
AU000000TAH8	Tabcorp Holdings Ltd	100%	4 263.36
AU000000AGI3	Ainsworth Game Technology Ltd	100%	119.61
AU000000ALL7	Aristocrat Leisure Ltd	87%	3 422.67
AU000000DNA0	Donaco International Ltd	93%	7.74
AU000000CWN6	Crown Resorts Ltd	100%	1 152.29
KYG6382M1096	Nagacorp Ltd	99%	225.86
US5854641009	Melco Resorts & Entertainment Ltd	73%	2 012.36
DE000A0DNAY5	bet-at-home.com AG	80%	67.47
GRS419003009	Greek Organisation of Football Prognostics SA	79%	1 749.36
HK0200030994	Melco International Development Ltd	73%	2 006.06
HK0027032686	Galaxy Entertainment Group Ltd	71%	2 526.43

BMG4769M1230	Imperial Pacific International Holdings Ltd	79%	3.42
IE00BWT6H894	Flutter Entertainment PLC	100%	8 166.41
JP3326410002	Sankyo Co Ltd	75%	697.49
KR7034230003	Paradise Co Ltd	39%	348.89
KR7035250000	Kangwon Land Inc	88%	663.69
MYL47150O008	Genting Malaysia Bhd	78%	998.25
MYL1562O0007	Sports Toto Bhd	48%	1 163.65
NZSKCE0001S2	Skycity Entertainment Group Ltd	82%	497.97
ZAE000097580	Sun International Ltd	80%	521.13
ZAE000273116	Tsogo Sun Gaming Ltd	92%	385.06
SE0017767742	Betsson AB	72%	747.68
GB00B1L5QH97	Rank Group PLC	87%	455.74
GI000A0F6407	888 Holdings PLC	83%	980.10
SE0007871645	Kindred Group PLC	91%	1 704.11
US1033041013	Boyd Gaming Corp	53%	3 369.81
US5529531015	MGM Resorts International	55%	9 680.14
US1714841087	Churchill Downs Inc	100%	1 597.20
US6090271072	Monarch Casino & Resort Inc	59%	395.38
US7075691094	Penn National Gaming Inc	84%	5 905.00
US5178341070	Las Vegas Sands Corp	68%	4 234.00
US1564921005	Century Casinos Inc	65%	388.51
US3596781092	Full House Resorts Inc	72%	180.16
US9831341071	Wynn Resorts Ltd	33%	3 763.66
US36467X2062	Gaming Innovation Group Inc	51%	75.90
HK0880043028	SJM Holdings Ltd	73%	1 292.49
SE0001863291	Acroud AB	44%	28.16
US30034T1034	Everi Holdings Inc	57%	660.39
MYL3395O0000	Berjaya Corporation Bhd	33%	1 798.68
KYG981491007	Wynn Macau Ltd	47%	1 508.59
KYG7800X1079	Sands China Ltd	41%	2 874.00
KYG607441022	MGM China Holdings Ltd	47%	1 207.16
IM00B5VQMV65	Entain PLC	94%	5 181.61
AU000000SGR6	Star Entertainment Group Ltd	74%	1 158.74
IM00B7S9G985	Playtech PLC	96%	1 370.30
CA73150R1055	Pollard Banknote Ltd	90%	363.32
US80874P1093	Light & Wonder Inc	79%	2 153.00
SGXE21576413	Genting Singapore Ltd	67%	791.18

Tobacco (n = 15)

ISIN	Company Name	Tobacco (% Sales)	Net Sales (USD Million)
EGS37091C013	Eastern Company SAE	100%	1 023.12
INE154A01025	ITC Ltd	38%	7 267.88
ID1000074008	Hanjaya Mandala Sampoerna Tbk PT	95%	6 938.58
ID1000068604	Gudang Garam Tbk PT	92%	8 763.60
JP3726800000	Japan Tobacco Inc	89%	20 201.93
KR7033780008	KT&G Corp	56%	4 401.12
MYL4162O0003	British American Tobacco (Malaysia) Bhd	100%	633.35
SE0015812219	Swedish Match AB	90%	2 045.42
GB00B0744359	Essentra PLC	31%	1 298.38
GB0004544929	Imperial Brands PLC	100%	44 176.05
GB0002875804	British American Tobacco PLC	100%	34 747.88
US02209S1033	Altria Group Inc	98%	26 013.00
US8085411069	Schweitzer-Mauduit International Inc	30%	1 440.00
US9134561094	Universal Corp	88%	2 103.60
US92240M1080	Vector Group Ltd	99%	1 220.70

Appendix 3 – Return and Standard Deviation of the Black Sheep Portfolios

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Return	25.52%	24.47%	18.08%	18.95%	22.15%	6.55%	0.81%	28.37%	21.93%
Std. Deviation⁶	9.61%	8.51%	11.54%	11.79%	7.02%	13.41%	24.95%	25.66%	16.52%
<i>Avg. Std Dev Equities</i>	<i>32.17%</i>	<i>32.12%</i>	<i>34.25%</i>	<i>32.42%</i>	<i>27.96%</i>	<i>32.51%</i>	<i>42.66%</i>	<i>46.75%</i>	<i>41.21%</i>

Appendix 4 – Betas and Market Portfolio

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Market (S&P500)									
Return = R _m	23.42%	15.38%	7.27%	9.94%	15.71%	9.07%	0.47%	25.87%	17.58%
Var (R _m)	0.10%	0.10%	0.14%	0.13%	0.06%	0.17%	0.48%	0.42%	0.22%
BS'									
Return = R _p	23.02%	21.97%	15.58%	16.45%	19.65%	4.05%	-1.69%	25.87%	19.43%
Beta	0.69	0.58	0.80	0.89	0.59	0.80	1.03	1.10	0.74
<i>Cov (R_p, R_m)</i>	<i>0.07%</i>	<i>0.06%</i>	<i>0.11%</i>	<i>0.11%</i>	<i>0.04%</i>	<i>0.13%</i>	<i>0.48%</i>	<i>0.47%</i>	<i>0.16%</i>
Combined SRI									
Return = R _p	19.96%	16.48%	5.70%	4.50%	9.22%	0.68%	0.02%	14.59%	12.06%
Beta	0.50	0.44	0.68	0.79	0.50	0.70	0.70	0.71	0.71
<i>Cov (R_p, R_m)</i>	<i>0.05%</i>	<i>0.05%</i>	<i>0.09%</i>	<i>0.10%</i>	<i>0.03%</i>	<i>0.12%</i>	<i>0.33%</i>	<i>0.30%</i>	<i>0.15%</i>
Rf	3.10%	2.74%	2.36%	2.71%	3.00%	2.43%	1.30%	2.21%	3.25%

⁶ Note the diversification effect, with the standard deviation of the portfolios being significantly lower than the average standard deviation of the equities in the portfolio.

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