Do German Green Mutual Funds Perform Better Than Their Peers?

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Abstract: *Due to current environment awareness, there has been an increase in investment opportunities concerning mutual funds with a focus on environmental issues. This paper analyzes the performance and risk sensitivities of German green mutual funds in comparison with their German socially responsible investment (SRI) and conventional peers. We also evaluate the results of the German green mutual funds in different market conditions. Because of this, we use and compare this performance during three periods, differentiating crises and non-crisis periods. In order to implement this analysis, we apply a CAPM-1 factor and a Carhart 4-factor methodology and find that in the full sample period 2007–2018 period, environmental funds had lower performance than conventional funds and SRI funds with similar characteristics. However, if we focus on crisis and non-crisis periods, the results change. During the financial crisis (2007–2009), green funds achieved adjusted returns slightly better than their peers; in the Eurozone sovereign debt crisis (2010-2012), the results are again similar to the results from the full sample period. And during the non-crisis period, they are not significantly different from conventional mutual funds, but they perform better than SRI mutual funds.*

1. Introduction

The past decades have witnessed a steady increase in social and environmental awareness, which has affected many different aspects of human lives. This trend has led to many changes in political issues, laws, environmental and social arrangements between countries and, of course, the financial world. *Socially responsible investment* (SRI) funds appeared in this context to meet the financial needs of investors.

In order to choose the different investments, SRI funds consider both social and financial criteria as well as environmental and ethical criteria. These investments have been the focus of many academic studies regarding to their risk-return perspective. Some of them maintain that, due to the reduction of the range of possible investment choices in stock markets, the SRI funds suffer a negative impact on their performance since they are not well diversified in line with conventional portfolio theory (Markowitz, 1952). Following this reasoning, many studies conclude that SRI results in unfavorable risk-return conditions, since they are formed taking into account non-financial criteria (see for example Renneboog, Horst, & Zhang, 2008). On the other

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hand, these statements have been increasingly rejected over the years, since the literature in corporate social responsibility indicate that focusing on social aspects improves the long-term performance of portfolios, due to the encouragement of managers to pick firms that are better managed (Bollen, 2007). The reasons why investors are putting their confidence in this kind of investment are not limited to non-financial compensation. They seek to make money with their investments; that is, even SRI investors aim at financial compensations (see Statman, 2000). These arguments are backed by the Global Sustainable Investment Review (GSIA), 2016, which reported that SRI assets under management grew to $22.9 trillion in 2016 (26.3% of global market), which is $4.6 trillion more than in 2014 and represents an annual growth rate of 11.9%.

Analyzing the figures in more depth, we realize that Europe plays the most important role in this growth, accounting for over $12 trillion and representing 52.6% of the global SRI asset under management. But not every country in Europe contributes to the same extent to this growth in sustainable investments. According to the Brussels-based association for the promotion of (SRI), which is commonly known as the European Social Investment Forum (Eurosif), 2017, Switzerland, Austria and Germany registered the highest growth rates in Europe with 39%, 24% and 15% respectively (European Environment Agency, 2017).

In the same vein, but considering the nature of SRI investment, we can declare that not all the SRI sub-fields (environment, social, governance, ethics, etc.) respond in the same way to changes in financial world, and even a particular factor can influence their performance in completely opposite directions. This is one important motive why some academic research, for example Galema, Plantinga, & Scholtens, 2008, do not agree with the connection between SRI and expected returns.

Following the statement mentioned above and due to the important contribution of green investment to Europe's outstanding growth regarding sustainable investments, this study is based on environmental funds as a much more concrete sub-group of SRI investment with the objective of avoiding confounding conclusions.

The purpose of these kinds of investment, *green investments*, is to give financial support to firms, businesses and projects involved in the protection and preservation of natural resources, renewable and alternative energy sources, water and air, and other environmental activities. European green investments showed an enormous step-up in recent years: For example, increasing from €22 billion to €32.2 billion in 2017 (+49%) between 2016 and 2017. These figures indicate an extraordinary outcome in comparison to the year-on-year increase of the European market (+12%) (Novethic, 2018).

In order to provide a more specific research focus, we concentrate our analysis on environmentally friendly mutual funds in Germany, since Germany represents 7% of the total of asset under management in green funds (ranking it 4th in Europe with €2.25 billion AUM), and was considered in 2015 as the second biggest contributor in Europe for renewable energies (Eurosif, 2017).

Green investment is a very interesting subject of study due to the facts mentioned above and considering the relative lack of academic studies about the performance of green funds, the continuous increase in environmental concern throughout the world, as well as the important political decisions and economic changes in the last decade, such as the financial crisis 2008-2010, the Paris Agreement on climate change in 2015 and the U.S. withdrawal from the Paris climate agreement in 2017.

We can divide the purpose of our analysis into two main objects. Firstly, we examine whether German green mutual funds outperform their SRI peers and conventional peers. Following G. Ibikunle & Steffen (2017), we develop a reasonable comparison between fund classes using a match-pair analysis in order to overcome biases. The data covers the period 2007–2018, and the measurement of performance has been estimated using the Carhart four-factor model, which is an extension of the Fama and French three-factor model (1993) and is one of the most used asset pricing models in previous performance analysis on SRI equity mutual funds.

The second aim is to investigate the risk-return characteristics of green investment funds in different phases during the selected period (2007–2018). Similarly to some previous papers, we differentiate three periods of time – "during the financial crisis" (2007–2009), "recovery financial crisis" (2010–2014) and "post-

financial crisis" (2015–2018) – and draw conclusions about how well or poorly environmental funds resisted the global financial crisis (Nofsinger & Varma, 2014).

Our paper differs from the existing literature in the following aspects. First, there are many papers that address the performance development of SRI Mutual funds in general, but we cannot say the same regarding green mutual funds. This fact makes our paper different from many academic studies since we solely focus on environmental mutual funds. Second, the analysis of our paper is much more specific than most of the green environmental papers, since it is based on German green mutual funds. Many studies about environmental mutual funds, by contrast, examine larger territories, for example, the U.S. and Europe as a whole. Third, we also deal with the issue of the evolution of German green mutual funds during and after the financial crisis. As far as we know, there is just one paper that specifically analyzes environmental mutual funds and its performance in crisis and non-crisis periods (Silva & Ceu-Cortez, 2016); however it does not focus in particular on German mutual funds as we do. Finally, it is also important to consider that the analyzed data comprises the period between 2007 and 2018. This last decade has been marked by important social, political and financial events that have led to changes in investment trends and a huge growth in green investments. Moreover, there are very few studies on this issue analyzing data from 2015 to 2018, when relevant political decisions and agreements regarding climate change took place. These facts make this period a very interesting time period to develop a paper regarding green mutual funds.

The remainder of the paper is structured as follows. Section 2: Literature review of green mutual fund performance and SRI fund performance; Section 3: Data; Section 4: Methodology; Section 5: Results are presented; Section 6: Concludes the paper.

2. Literature Review

SRI studies mainly focus on two different topics. Many papers address the nature and modalities of these investments, while others analyze SRI performance using performance measurement processes and comparing the results with different investment strategies. Our investigation is deeply associated with the SRI performance analysis studies. On average, the papers addressing this issue conclude that SRI performance is really similar to different investment alternatives. Galema et al. (2008) established the basis for important academic discussions on SRI performance.

First, studies in this field reported no differences in risk-adjusted returns between SRI funds and conventional funds (Hamilton & Statman, 1993; M. Statman, 2000) and a weaker performance (Girard, Rahman, & Stone, 2007). According to Renneboog et al. (2008), socially responsible investments involve an "extra high-price" since, in line with his conclusions, they are not able either to outperform their domestic benchmarks or equal them. However, differences between performance of SRI funds and their peers are not usually substantial. Furthermore, contrary to the previous statements, some research supports the idea of a more attractive performance of SRI than classical funds under close to identical conditions (Gil-Bazo, Ruiz-Verdú, & Santos, 2010; Kempf & Osthoff, 2007) on US portfolios and Spanish/ US mutual funds respectively).

Other authors use a different process for the purpose of researching this topic from another perspective. They analyzed companies individually instead of going over socially responsible funds or benchmarks. From this perspective, the conclusions are quite different than the results mentioned above, although few studies maintain that sin stocks reach about +3% abnormal returns (Kim & Venkatachalam, 2011), many papers assure that companies with a significant job satisfaction among workers and a successful implementation of corporate governance principles and practices culminate in positive abnormal returns (Edmans, 2011). The same conclusions were also delivered by Meir Statman & Glushkov, 2009, for environmental-friendly companies.

The question that arises is the following: In considering companies separately, why do many studies report an outperformance of SRI firms against the market, while most papers analyzed SRI mutual funds do not?

This has been answered arguing that just a few companies with positive alphas are taken into account in order to create funds but many positive alpha companies are excluded, for example those that support immoral, or unethical, such as tobacco companies or liquor distributors. This fact hinders many SRI portfolios, making them ultimately reach positive risk-adjusted returns. In addition to this statement, Guenster (2012) observed that many SRI companies that presented positive performance indicators were closed at the end. According to Bebchuk, Cohen, & Wang, 2013, this could be caused by a learning effect in corporate governance practices, since these activities progressively add less value to the financial performance. Another fact to be consider is that stocks with a good ESG rating outperform those that reported a lower ESG rating. Borgers, Derwall, Koedijk, & Horst (2013) noticed that this just happened between 1992 and 2004 but not between 2004 and 2009. They indicate that the reasons are the wrong pricing estimations linked to investor's expectations before 2004, which changed after 2004 toward paying attention to others matters. This let us know how fast the perspective of markets and investor's decisions can change, and how this affects financial performance studies. If we take this into account, it makes sense to devote a paper to SRI funds, and in our case also green funds, considering different time of periods, depending on market conditions. Even with all the difficulties presented above, the total assets managed in SRI mutual funds has maintained continuous growth throughout the world: for example, in the U.S. (2000-2011) a 305% growth-rate vs just 65% growth rate of U.S. conventional equity funds (Nofsinger & Varma, 2014). There are several explanations for that development. First, the different attitude of environmental, social and governance investors, which is not limited in scope to optimal financial performance (Bollen, 2007) but also considers social value. Following this reasoning, Renneboog et al. (2008) confirm in their study that socially responsible investors are more loyal to their fund's investments than are non-SR investors, arguing that non-SRI flows are more sensitive to negative results in the past than are socially responsible investment flows. On the other hand, they certified that investors do not behave in the same way making decisions for every single SRI subdivision. For example, while social SRI funds based on ethical screening show flows that are not really sensitive to negative returns, flows of SRI "green" funds respond more sensitively to past returns. This statement motivates the study of individual SRI subfields, since, following Renneboog, investors behave differently depending on which SRI component we are referring to.

According to Climent & Soriano (2011), environmental funds are different from the rest of SRI funds due to the following reasons. First, the environmentally friendly and eco-friendly attitude is increasing year by year, which is changing, among other sectors, industry, for example with the launch of electric and hybrid vehicles. This makes recent studies of green mutual funds always interesting, since this "green mentality" is expected to grow over the years, as mentioned above. Third, the risk diversification aspect should be considered. Here we found opposed statements about the diversification benefits or disadvantages in green mutual funds against their SRI peers. While Mallett & Michelson (2010) say that green funds benefit from a better diversification effect than SRI funds, since there is a wider range of firms to choose, Climent & Soriano (2011) consider that environmental funds are concentrated within a low number of industries. Finally, Chang, Nelson, & Witte (2012) indicate that this environmental awareness has also been supported by most governments through new legislations and important agreements between them. All these factors turn green funds, in particular, into an interesting field to explore.

The discussion about the positive or negative effect of green activities in corporate financial results is, as occurs with SRI financial performance discussions, a topic of broad academic discussion. A conservative point of view (Walley & Whitehead, 1996) assumes that environmental performance involves extra costs, which are more relevant than earnings. It also implies that firms cannot focus more on their main activities, since they embrace environmental issues (Dixon-Fowler, Slater, Johnson, Ellstrand, & Romi, 2013). Consequently, they claim that environmental costs should be reduced by firms to the level mandated by the legislation of each country, with the objective of protecting their shareholder value. In contrast, a more current opinion explains that environmental activities in firms lead to a better utilization of resources and, as a result, a business strength against other competitors and improvement of corporate financial performance (Porter & Linde, 2000). This perspective has been supported by many authors, such as Martí-Ballester (2015), who indicated that developing eco-friendly practices in companies creates a better costs-income

relationship, since this strategy improves the marketability and attractiveness of products and has positive effects on operational activities.

But in general, as confirmed by Molina-Azorín, Claver-Cortés, López-Gamero, & Tarí, (2009) and Dixon-Fowler et al. (2013) we can affirm that environmental performance results in financial performance.

Despite the great attention devoted to firm performance in the literature, there is a lack of studies focusing on the performance of green mutual funds. This make this kind of studies in a very interesting topic to be address. Until now, the literature based on green mutual funds has received just a handful of analysis. White (1995) was the first one, followed by Mallett & Michelson (2010), Climent & Soriano, (2011), Chang et al. (2012), Ito, Managi, & Matsuda (2013), Muñoz, Vargas, & Marco (2014), G. Ibikunle & Steffen (2017) and F. Silva & Ceu-Cortez (2016). But although Europe is the first contributor to green mutual funds, just the last two and more current studies mentioned above are focused on European environmental mutual funds; the rest consider funds in United States. Mallett & Michelson (2010) found that U.S. green funds perform similarly in comparison to SRI funds and index funds. In order to analyze funds' risk-adjusted returns, they compare funds and indexes. But this is a method that is not used in current studies, since match-pair-analysis between funds, as we employ in this analysis, provide more accurate results. One year later, Climent & Soriano (2011) developed a research study for a period of 22 years ending in 2009. They noticed that U.S. green funds performed just a bit worse than their conventional peers, but Mallett and Michelson as well as Climent and Soriano did not report big differences in the performance of the green funds and their peers. The problem presented in the paper of Climent and Soriano is that the sample considers 22 years, but they do not analyze different periods within this sample. As we mentioned above, long time periods involve different market conditions, which has to be taken into account in order to make proper statements. The same happens with G. Ibikunle & Steffen (2017) in a study about European environmental friendly funds compared to their black and conventional peers. Chang et al. (2012) show in their study that U.S. environmental funds had a lower financial performance in comparison with non-SRI funds. Muñoz et al.(2014) study the risk-adjusted return of environmental funds during crisis/non-crisis times in US and Europe. The criticism in this analysis is that they use information of U.S. financial crisis to detect European crisis periods.

But, considering European markets, the risk-adjusted return of socially responsible investment funds, and in particular green funds, distinguishing crisis/non-crisis periods is an analysis issue even more unexplored. We know just two academic studies addressing this topic: Muñoz et al.(2014) and F. Silva & Ceu-Cortez (2016). Both take into account environmental funds during crisis/non-crisis times in US and Europe, but following the statements of F. Silva & Ceu-Cortez (2016), the main shortcoming of the study by Muñoz, Vargas, and Marco is that they use information from the U.S. financial crisis to detect European crisis periods, and they do not calculate the performance of non-crisis periods (just during the whole period and crisis period). Consequently, it is impossible to notice properly if there is an important difference in risk-adjusted returns during crisis and non-crisis periods. On the other hand, Silva and Cortez conducted a thorough analysis of the mentioned above funds, but they use a conditional models of performance evaluation, which is not usual in this kind of studies and has been recently criticized by some authors (Graham, Peltomäki, & Sturludóttir, 2015).

Taking into account the literature already mentioned and following, in particular, papers like Climent & Soriano (2011) and Silva & Ceu-Cortez (2016)(Silva & Ceu-Cortez, 2016), we have developed a study with a particular reference to environmental German funds. This is not new. Leite & Cortez (2015) analyzed the performance of European socially responsible funds during market crises just considering the evidence from France. We also differentiate the performance by market conditions, with the objective of making more accurate and concrete statements than other studies.

3. Data

3.1. Sample

The sample of funds includes data of mutual funds domiciled in Germany and those funds that are domiciled in Luxembourg but with a license to be sold in Germany, which invest globally. The reason why we have also chosen funds that are domiciled in Luxembourg is because many German entities, for example Deka Bank, register their funds in Luxembourg because it offers some tax-advantages for investors, but they focus on German investors and not on Luxembourgian investors. We decided to analyze funds with a global character, since they are optimal for calculating the risk-adjusted return using the data from Kenneth R. French website; otherwise it is not possible to use his data to develop a Fama-French (1993) three-factor-model-based or, as in our case, a Carhart (1997) 4-factor-based performance measures, meaning the search for data would become much more difficult. There are many analyses based on data from Kenneth R. French to make performance assessments (Muñoz et al., 2014; Nofsinger & Varma, 2014). We analyze the results comparing risk-adjusted returns from three different German funds groups: environmental mutual funds, SRI-mutual funds and conventional mutual funds. In order to avoid biases and make a proper comparison between funds, we have used a matched-pair (see table 1) analysis considering age, size, style, investment scope and type of yield. Following most authors of this type of papers, due to the difficulty to match funds size among the three categories, we have done a comparison based on built portfolios, so that for each green fund, we consider two SRI funds and three conventional funds (Climent & Soriano, 2011). Using this process, we correct size bias. To create our matched-portfolios we collected funds information from yoursri.com, for green funds and SRI funds, and also from morningstars.de, for conventional funds, websites. YourSRI is a leading database and research engine for ESG & Carbon reporting, monitoring and controlling, which provides a wide range of search, comparison, assessment and screening functions. In order to select the proper environmental and SRI funds, we used an advanced search of funds picking as key criteria the following: equity (as asset type), mutual funds (asset universe), Germany (as sales registration), global (as regional focus), euro (as currency), sustainable funds and more than 50 score in ESG Rank. This first sample contained 90 funds that met all the requirements, and both green funds and SRI were included. They had to be checked one by one in order to differentiate green from SRI funds and also to meet the other match criteria, such as size, age, investment scope etc. In order to do that, we examined the information from the fact sheet of every single fund, which is available in this database. The fund classes were differentiated though the funds' description, since it provides good information about the main businesses of the companies that the fund is investing in. But we double checked this point using Morningstar database, which categorizes SRI funds as "ESG-focus funds" and green funds as "environmental-focus funds", so we could be sure that we were working with a correctly categorized sample. Funds with an inception date before 1999 and those that did not cover the period studied (2007-2018) were not considered. Regarding the size screening we just didn't consider those funds which don't reach a total asset of €15 million, as we mentioned above, the differences in size are going to be avoided through the comparison of portfolios and not comparing funds against funds. Because of this, we were not restrictive with the size of funds. Finally, we just selected funds with a global multi-cap focus and with a retail character.

In the case of conventional funds, we just used Morningstar database. We carry out the same procedure, but this time was easier to match the criteria, since there are much more non-SRI funds than SRI and environmental funds in the market.

At the end it, a sample emerged with 4 environmental funds, 8 SRI funds and 12 conventional funds, which have to cover the period between 2007 and 2018 and provide daily historical prices in euro.

Table 1. Funds Matched-Pair Criteria for Selection

Criteria	Green mutual fund	SRI mutual funds	Conventional mutual funds
1. Open-ended	✓	✓	✓
2. Equity	✓	✓	✓
3. Debt, mixed and balanced	✗	✗	✗
4. Retail/Institutional	Retail	Retail	Retail
5. Fund of funds?	✗	✗	✗
6. Type of yield	Reinvestment	Reinvestment	Reinvestment
7. Size AuM	> €15 Million	> €15 Million	> €15 Million
8. Inception date	> 01.01.1999	> 01.01.1999	> 01.01.1999
9. Data cover from 2007 to 2018	✓	✓	✓
10. ESG-Rating	≥ BBB	≥ BBB	✗
11. Investment scope (Global multi-cap)	✓	✓	✓
Statistics	**Green mutual fund**	**SRI mutual funds**	**Conventional mutual funds**
1. Number of funds	4	8	12
2. Average size (AuM in Million €)	82	72	80
3. Average fund age (in years)	17	15	16

3.2. Fund Returns, Benchmark Indices and Factors

For calculating the returns, we use funds historical daily prices from 01.01.2007 to 30.04.2018. The prices for each fund were collected from the website Ariva.de and presented a problem regarding the dividends, since the data does not include the reinvestment of dividends. In order to deal with this, we just considered funds with a reinvestment character as a type of yield. As mentioned above, the comparison between the equal weighted portfolios has been developed using data from Kenneth R. French that provides market returns collected from CRSP database and uses 10 years U.S. treasury bonds as a risk free rate. Size, book-to-market and momentum have been considered in order to add additional risk factors. The small minus big (SMB) is the difference in returns between a portfolio of small caps, represented by the MSCI World Small Cap index, and a portfolio of large caps, represented by the MSCI World Large Cap index. The high minus low (HML) factor is the difference in returns between a portfolio of high book-to-market stocks (value stocks) and a portfolio of low book-to-market stocks (growth stocks), represented by the MSCI World Value and MSCI World Growth indices, respectively. Momentum (MOM) is the difference in returns between a portfolio of past winners and a portfolio of past losers.

We also use a CAPM-1 factor model as an additional performance measure, and we use for calculating market returns two different indices. Firstly we apply a calculation based on an environmental based index, the "Dax global alternative energy index", and second taking into account a SRI based index, "DJSI World composite index." The data for both indices has been provided again by Ariva.de.

4. Methodology

As we pointed out in table 1, we used a matched-pair analysis in order to select the samples of environmental funds, SRI funds and conventional funds to be studied, instead of determining comparisons between funds through means of groups, as has been used in past academic papers. Accordingly, we determined the risk-adjusted return of the selected environmental funds and looked for the differences compared to their SRI and conventional peers, in order to find out if investors who opt for green investments are paying an extra price for this kind of investments strategy.

The performance evaluation of environmental, SRI and non-SRI mutual funds was carried out using equally weighted portfolios returns in three different periods, as listed in table 2: 2007-2009 during the financial crisis, 2010-2012 covering the euro sovereign debt crisis, Leite & Cortez (2015) in their study identify this period as a crisis period in Europe, and because we are referring to German funds and there are not

many studies considering this period in their evaluation, it is a subject of interest for our study to analyze the results also in this period) and 2013-2018 post crisis period. The prices of all the funds are in euros but they are converted into dollars to obtain returns based on dollars, since this way we are able to use the risk factors provided by Kenneth R. French website, and thus implement the desired 4-factor performance evaluation model. The evaluation was done based on German investors with global investment perspectives, and using noted global benchmarks and a global standardized risk-free rate section 3.

Table 2. Market Periods

	Market conditions	Start date	End date	Length (Month)
1st period	Financial crisis	01.01.2007	31.12.2009	36
2nd period	Eurozone sovereign debt crisis	01.01.2010	31.12.2012	36
3rd period	Post-crisis period	01.01.2013	30.04.2018	64
Total period	Total period	01.01.2007	30.04.2018	136

Our methodology to evaluate the different investment strategies is based on risk-adjusted returns, since it is the proper and most expanded process in the literature. The approach relies on the CAPM-based Jensen (1968) measure, which offers us the differences between investment returns and the returns in just one market benchmark. Nonetheless, this approach has received criticism, since some important academics, for example Fama and French or Carhart, maintain that a single factor benchmark is not enough to calculate expected returns. For this reason, we also carry out an evaluation based on Carhart (1997) 4-factor model, which is an extension of the Fama–French three-factor model including a momentum factor for asset pricing of stocks.

The equation (1) for 1-factor model is as follows:

$$r_t - r_{t,f} = \alpha + \beta_{MKT}(r_t^m - r_{f,t}) + \eta_t \tag{1}$$

where r_t, is return on an equally weighted portfolio of funds in month t, $r_{t,f}$, is the return on a risk-free deposit, r_t^m, is the return of a market proxy, α, is the 1- factor-adjusted return of the fund, β_{MKT}, measures the fund's market-risk exposure and η_t stands for the idiosyncratic return.

The Carhat (1997) 4-factor considers the following four risk factors in the calculation: market size (SMB), book-to-market (HML) and momentum (MOM) to explain the effect on performance of the different investment strategies, and takes the following formula 2):

$$r_t - r_{t,f} = \alpha + \beta_{MKT}(r_t^m - r_{f,t}) + \beta_{SMB}r_t^{smb} + \beta_{HML}r_t^{hml} + \beta_{MOM}r_t^{mom} + \eta_t \tag{2}$$

where r_t is return on an equally weighted portfolio of funds in month t, $r_{t,f}$, is the return on a risk-free deposit, r_t^m, is the return of a market proxy, α, is the 4- factor-adjusted return of the fund, β_{MKT} measures the fund's market-risk exposure. β_{SMB}, measures the effect of small firms in our portfolio, r_t^{smb}, is the average return on a small cap portfolio minus the average return on the a big cap portfolio in day t, β_{HML}, measures the value premium of our portfolio, r_t^{hml}, is the average return on a value stock portfolio minus the average return on a growth stock portfolio in day t, β_{MOM}, determine the momentum effect of our portfolio in day t, r_t^{mom}, is the average return on a portfolio of past 12 months winners minus the average return on a portfolio of past 12 months losers in day t and η_t stands for the idiosyncratic return.

5. Empirical Results.

5.1. CAPM 1-Factor Regression Results.

5.1.1. Global Index

Table reports the results of implementing equation **Hata! Başvuru kaynağı bulunamadı.** for each of our environmental, SRI and conventional fund portfolios, which were constructed through a matched-pair analysis, as indicated in the table. Jensen's alpha was calculated for all the three portfolios considering a global benchmark collected from the Kenneth R. French data library as market proxy.

Table 3. Empirical Results For 1-Factor Regressions

Portfolio	α	β	Adj. R^2
Green(1)	-0.0135(-0.186)	0.1976(10.035)***	0.034769
SRI (2)	0.0526(1.031)	0.2312(16.741)***	0.091618
Conventional (3)	0.0296(0.631)	0.21690564(17.078)***	0.094993

Note: This table reports the results of the CAPM-based regression. To measure environmental, SRI and conventional mutual fund performance the results has been calculated using the 1-factor model formulated by equation (1), using as a proxy market a global benchmark collected from the Kenneth R. French data library. All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2007-30.04.2018.

The first observation from the results in table 3 is that the green funds slightly underperform the benchmark, while their SRI and conventional peers slightly outperform the market benchmark over the full, analyzed period. However, these estimations -0.0135% in green funds, 0.053% in SRI-funds and 0.023% in conventional funds are very close to zero. Furthermore, they do not present a statistical significance according to their p-value. Second, unexpectedly, all fund portfolios have a market beta of less than 0.25, even though we have selected a global market proxy. The market beta estimations indicate that green funds tend to be less market sensitive than their SRI and conventional peers with 0.198, 0.2312 and 0.217 respectively, all with a statistical significance at 1% level. Finally, this table reports very low adjusted R-squared numbers in green, SRI and conventional fund portfolios. This means that the model is not very suitable for explaining the risk-adjusted return behavior, since they are more influenced by other factors. As expected, the model least fits the environmental green fund returns (R-squared adj. = 0.035) and fit better with conventional funds returns (R-squared adj. about 10%).

5.1.2. Green Index

We ran more regressions changing the market factor of equation 1. Due to our green fund performance estimations, there could be biases because of the focus of environmental fund managers on environmental screening, and thus it is reasonable to run the regression again considering a green equity index to calculate the risk-adjusted return of green mutual funds. We again apply the same formula 1 but this time integrating the return on the DAX global alternative energy Index as the market factor. The results are presented in table 4.

Table 4. Empirical Results For 1-Factor Regressions (DAX Global Alternative Energy Index)

Portfolio	α	β	Adj. R^2
Green(1)	-0.0327 (-0.4347)	0.1613(12.68)***	0.0578
SRI (2)	0.0612(1.1703)	0.1831(20.89)***	0.1425
Conventional (3)	0.04388(0.9139)	0.1644(20.27)***	0.1353

Note: This table reports the results of the CAPM-based regression. To measure environmental, SRI and conventional mutual fund performance the results has been calculated using the 1-factor model formulated by equation 1, using as a proxy market a green equity index (DAX global alternative index). All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2007-30.04.2018.

5.1.3. SRI Index

The same process as in the previous paragraph has been repeated to compute a one index regression (CAPM), but using a SRI index as the market proxy. More specifically, we used the Dow Jones Sustainable world index. See the results below in table 5.

Regarding the green fund portfolio, the estimations of performance against both green market index and SRI market index (Alpha in table 4 and Alpha in table 5) are negative (-0.033% and -0,043 respectively) and not considered as statistically significant. Taking into consideration these results, we can conclude that, although the difference between green mutual funds intercepts ("alphas") against their SRI and conventional counterparts in table 4 and table 5 is just about 1%, German green funds are not able to outperform German SRI mutual funds and German conventional mutual funds. Surprisingly, the adjusted R-squared of green mutual funds in table 4, where an environmental index were used, is lower (0.058) than the R-squared from the model with the SRI index (0.063). Based on this outcome, let us draw the following conclusions. Firstly, the SRI index is more suitable for explaining green mutual fund performance than the global index or green equity index. This fact may be explained because the green index used as proxy market (DAX global alternative energy index) focus just on alternative energy sector ignoring other environmental sectors, such as sustainable water or ecological food and agriculture. Second, adjusted R-squared in table 4 and table 5 are really similar (about 6% in green funds and 14% in SRI-funds and conventional funds) and higher than in table 3 in all funds (about 3 percent points higher regarding green funds, and about 4 percent points higher in SRI and conventional funds). However, we cannot overlook that the adjusted R-squared of all fund portfolios in both tables, table 4 and table 5, are quite low, consequently we can say that the models, using the green and SRI indexes as a market factor, does not fit really good the returns of green, SRI and conventional funds. The fund betas reveal that environmental fund portfolio is more exposed to SRI market index (β = 0.22) than to the green index (β = 0.16) and tend to be slightly less market sensitive than their SRI and conventional peers, with a statistical significance at 1% level. The principal reason for these results can be that the green funds' performance is more influenced by other risk factors; accordingly cannot be good explained based just on a benchmark risk factor. Because of this, we analyze in the next sections the risk-adjusted returns taking into consideration three more risk factors.

Table 5. Empirical Results For 1-Factor Regressions (Dow Jones Sustainable World Index)

Portfolio	α	β	Adj. R^2
Green(1)	-0.04252(-0.5667)	0,2194(13.2652)***	0.062533
SRI (2)	0.0508(0.982)	0.24052(21.055)***	0.1443
Conventional (3)	0.03359(0.7056)	0.22415(31.357)***	0.14786

Note: This table reports the results of the CAPM-based regression. To measure environmental, SRI and conventional mutual fund performance the results has been calculated using the 1-factor model formulated by equation 1, using as a proxy market a SRI equity index (Dow Jones sustainable world index). All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2007-30.04.2018.

5.2. Carhart Multi-Factor Regression Results

Table 6, table 7, table 8 and table 9 summarize the results of estimating the Carhart (1997) multi-factor model for three sample periods. Table 6 reports the results if we take the full sample period.

Unexpectedly, the results do not report a big difference on average adjusted R-squared for the multi-factor models against the 1-factor CAPM models. This fact shows evidence that, contrary to other academic papers, multifactor models are not always superior in explaining mutual fund returns. Furthermore, green funds show a similar exposure to the market portfolio in comparison to both SRI and conventional funds, which confirm the 1-factor results calculated in the prior section. However, the betas are higher on average than the estimated betas using the 1-factor CAPM models. Moreover, environmental funds are more exposed to small caps than SRI and conventional funds and also presents a higher exposure to the value style (HML). On the other hand, green funds report no significant differences in momentum factor (MOM) than their SRI and conventional counterparts, in addition these results (MOM) are not statistically significant. Corroborating the results using the CAPM 1-factor models, in the period between 2007 and 2018, green funds hardly underperform their SRI and conventional peers, but this is not a significant difference to be underlined.

Table 6. Multifactor Regression

Portfolio	α	β	SMB	HML	MOM	Adj. R²
Green(1)	-0.0165(-0.24)	0.26(10.9)***	0.388(6.676)***	0.282(4.251)***	0.0003(1.010)	0.054
SRI (2)	0.0511(1.01)	0.28(16.6)***	0.291(7.151)***	0.118(2.568)**	-0.00007(-0.304)	0.109
Conventional(3)	0.0278(0.60)	0.25(16.4)***	0.232(6.194)***	0.147(3.492)***	0.00009(0.397)	0.109

Note: This table reports the results of the Carhart (1997) four-factor model-based multifactor regression formulated by Equation 2. The global factor portfolios collected from the Kenneth R. French data library are used as factors to measure the risk-adjusted returns of the green, SRI and conventional mutual funds. **α** measures the risk-adjusted abnormal return relative to the applied proxies. SMB shows the difference in return between a small cap portfolio and a large cap portfolio, HML shows the return between a value portfolio and a growth portfolio and MOM is the return difference between a previous 12-month winner portfolio and a previous 12-month loser portfolio. All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2007-30.04.2018.

With the aim of having a better basis to explain the results, we differentiate three periods from the full sample period (2007–2009, 2010–2012 and 2013–2018). Table 7 shows the results of the period during the financial crisis of 2007–2009.

Table 7. Multifactor Regression Results 2007–2009 Financial Crisis

Portfolio	α	β	SMB	HML	MOM	Adj. R²
Green(1)	0.0626(0.395)	0.33(7.17)***	0.502(4.77)***	0.397(3.19)**	0.00159(2.68)	0.076
SRI (2)	-0.0053(-0.048)	0.33(10.52)***	0.314(4.33)***	0.041(0.5)	0.0011(2.72)**	0.138
Conventional (3)	-0.0371(-0.371)	0.30(10.51)***	0.272(4.11)***	0.185(2.37)**	0.0013(3.5)***	0.151

Note: This table reports the results of the Carhart (1997) four-factor model-based multifactor regression formulated by Equation 2.The global factor portfolios collected from the Kenneth R. French data library are used as factors to measure the risk-adjusted returns of the green, SRI and conventional mutual funds. **α** measures the risk-adjusted abnormal return relative to the applied proxies. SMB shows the difference in return between a small cap portfolio and a large cap portfolio, HML shows the return between a value portfolio and a growth portfolio and MOM is the return difference between a previous 12-month winner portfolio and a previous 12-month loser portfolio. All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2007-31.12.2009.

Regarding to the risk factors table 7 (2007-2009) reports similar results compared to the information shown in the full sample period in the previous paragraph. For instance, environmental funds have similar exposure to the market portfolio as compared with SRI and conventional funds (about 0.30). Moreover, confirming previous literature, environmental funds are strongly exposed to small caps if we compare them with their SRI and conventional counterparts. Furthermore, environmental funds also present a higher exposure to the value style (HML) during the financial crisis (β HML = 0.5), and there are no significant differences in momentum factor (MOM), which show values close to 0, in comparison to SRI funds and conventional funds. On the other hand, the intercepts "alphas" of funds during the financial crisis bring interesting results, since they are completely the opposite to the values presented in Table 6 (full sample period). The German green fund portfolio reported a positive alpha (+ 0.06%), which means that during this period it outperformed the benchmark, while German SRI funds and German conventional funds slightly underperformed the benchmark (-0.005% and -0.04% respectively). Based on these results, we can confirm the statements of previous studies, which maintain that environmental green funds perform better than their SRI and conventional counterparts during the financial crisis-period.

In order to make stronger statements, it is relevant to study what happens also during other crisis periods to determine if green funds can outperform their SRI and conventional peers in all recent crisis period. Table 8 shows the results of the period during the Eurozone sovereign debt crisis 2010–2012.

Table 8. Multifactor regression 2010-12 Eurozone Sovereign Crisis

Portfolio	α	β	SMB	HML	MOM	Adj. R²
Green(1)	-0,2398(-1,417)	0,30(6,05)***	-0,016(-0,10)	0,379(2,24)**	-0,00097(-1,02)	0,089
SRI (2)	0,0493(0,552)	0,33(12,75)***	-0,045(-0,54)	0,216(2,42)**	-0,00189(-3,80)**	0,296
Conventional (3)	0,0241(0,287)	0,32(12,86)***	-0,08(-1,03)	0,183(2,192)**	-0,00176(-3,76)**	0,302

Note: This table reports the results of the Carhart (1997) four-factor model-based multifactor regression formulated by Equation 2. The global factor portfolios collected from the Kenneth R. French data library are used as factors to measure the risk-adjusted returns of the green, SRI and conventional mutual funds. **α** measures the risk-adjusted abnormal return relative to the applied proxies. SMB shows the difference in return between a small cap portfolio and a large cap portfolio, HML shows the return between a value portfolio and a growth portfolio and MOM is the return difference between a previous 12-month winner portfolio and a previous 12-month loser portfolio. All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2010-31.12.2012.

In line with the previously calculated multifactor regression results, green funds tend to have similar exposure to the market, report a higher exposure to the value style (HML) and again show no relevant differences in beta with respect to momentum factor (MOM), in comparison to the results of SRI mutual funds and conventional mutual funds. In contrast to the results during the financial crisis and during the full sample period, green, SRI and conventional funds are more exposed in this case to big caps, but these results are not statistically significant. Finally, we observe that green funds (-0.24%) slightly underperform again compared to their conventional (0.024%) and SRI (0.05%) counterparts. Following these results, we cannot conclude, as other academic papers have, that green funds perform better than their SRI and conventional peers in all recent crisis periods. On the other hand, these results might also be explained on account of working with German green funds with a global character, which invest in Europe about 20% on average, since German investors could not see environmental funds as a risk avoiding investment anymore. Furthermore, this crisis had a negative effect on liquidity in Europe (Ito et al., 2013) which, combined with declining environmental legislation and a reduced awareness of climate change subjects, caused by a poor economic activity, generated a reduction in financing activities focus on environmental projects (Ibikunle & Steffen, 2017). In order to draw better conclusions in this crisis period, it would be interesting in future papers to research the performance behavior taking into consideration the funds' focus on different investment geographical areas.

Finally, after interpreting the results in crisis periods is reasonable to analyze what happened during non-crisis periods in order to be able to compare both market conditions (crisis/non-crisis). Table 9 shows the results of the period after the crisis 2013-2018.

Table 9. Multifactor Regression 2013-2018 After Crisis

Portfolio	α	β	SMB	HML	MOM	Adj. R²
Green (1)	0.098(1.248)	0.11(3.117)***	0.441(6.223)***	0.058(0.737)	-0.0010(-1.88)*	0.032
SRI (2)	0.012(1.732)	0.13(4.173)***	0.378(6.030)***	0.084(1.198)	-0.0012(-2.56)**	0.038
Conventional (3)	0.1004(1.579)	0.10(3.556)***	0.301(5.228)***	0.057(0.881)	-0.0010(-2.05)**	0.027

Note: This table reports the results of the Carhart (1997) four-factor model-based multifactor regression formulated by Equation 2. The global factor portfolios collected from the Kenneth R. French data library are used as factors to measure the risk-adjusted returns of the green, SRI and conventional mutual funds. **α** measures the risk-adjusted abnormal return relative to the applied proxies. SMB shows the difference in return between a small cap portfolio and a large cap portfolio, HML shows the return between a value portfolio and a growth portfolio and MOM is the return difference between a previous 12-month winner portfolio and a previous 12-month loser portfolio. All parameters are annualized. T-statistics (in parentheses). * Statistical significance at 10% level; ** Statistical significance at 5% level; *** Statistical significance at 1% level. Period analyzed 01.01.2013-30.04.2018.

According to the results in table 9, environmental funds tend to have the same exposure to the benchmark when compared with SRI and conventional funds (β MKT about 0.11), as happened in the crisis periods. However, this betas with respect to the market are quite lower than the market betas presented in crisis periods (β MKT difference about -0.20). These results are very unusual since we are working with equity funds, which are more likely to have higher market betas. However, the reason for this abnormality could be linked to the huge inflow in recent years in Germany of smart beta strategies seeking lower volatility (Paul, 2017). Regarding SMB betas, environmental funds are more exposed to small caps compared to SRI and conventional funds, as happened in financial crisis periods. On the other hand, all funds report a statistically insignificant exposure to the value style (HML), and, as reported in all periods, the momentum factor (MOM) does not show any relevance. According to this, we can confirm that MOM is not significant as a risk factor in our model. Different results are shown in table 9 regarding the performance behavior of environmental, SRI and conventional German funds. While the SRI funds in this period are not able to outperform the benchmark during this period, green funds and conventional funds outperformed similarly the benchmark (α = + 0.1; + 0.12, respectively). According to these results, we point out that during non-crisis periods green funds outperform their SRI counterparts and perform analogously to conventional funds.

Summarizing conclusions of the analysis of German green fund behavior during crisis and non-crisis periods, we have to focus on the performance of these investments against the benchmark ("alpha"). As mentioned before, during the financial crisis, German green mutual funds were able to outperform their SRI and conventional peers, and even during the last four years of analysis ("post- crisis period") present a better alpha than German SRI funds and a are similar to German conventional mutual funds. But they underperform theirs SRI and conventional counterparts during the Eurozone sovereign debt crisis. For this reason, unlike other academic analyses (Nofsinger & Varma, 2014; Silva & Ceu-Cortez, 2016), we cannot conclude that green funds perform better than other funds during crisis periods, and these results more likely depend on what kind of crisis we are referring to and how this affects the investors decisions. On the other hand, according to the positive estimations during the post-crisis period we partly agreed with the results obtained by Ibikunle & Steffen (2017), since green mutual funds perform better than their SRI and conventional peers over the years, and contrast with F. Silva & Ceu-Cortez (2016), who claim that that alphas of green mutual funds in Europe and U.S. are negative in non-crisis periods.

It is important to consider that our statements are just simple opinions based on some evidence in results, but we cannot make firm conclusions for the following reasons. First, our results show positive and negative alphas but they do not differ too much from zero and the differences between them are not big enough. Second, the adjusted R-squared in all the tables report low values, which means that the models

used do not really fit well with the sample analyzed. And third, and very important, many results in our tables do not have a relevant statistical significance according to the standard limit levels.

6. Conclusions

In this analysis, we have researched the performance of German environmental mutual funds, comparing them with their socially responsible and traditional counterparts in order to draw conclusions about whether German environmentally friendly investors pay a premium for going green or not during the period between 2007 and 2018.

Previous academic research has maintained that green funds suffer a negative impact on their performance since they cannot be as well diversified as classic funds (Renneboog et al., 2008). However, these statements are less and less supported, since the literature in corporate social responsibility indicates that focusing on environmental aspects improve the long-term performance of portfolios for several reasons: imply better managers motivation, better reputation and better expected performance in the future. These are reasons why a German investor can pay more for green investments.

But is it already time to show good results for green mutual fund performance? In order to answer this question, we analyzed an environmentally conscious market, the German market, not just during the full sample period, but also during three different market conditions sub-periods, which allow us to produce evidence about the changes over the years as well as control the performance behavior of green mutual funds against crisis and non-crisis conditions. We have used a CAPM single-factor model and Carhart-multifactor model.

If we take into account the full sample period (2007-2018), our estimations match somewhat with the conclusions drawn by Climent & Soriano (2011). They concluded that the environmentally friendly investors pay an extra price, which is not financially rewarded. Nevertheless, these results tell us a different story if we take into considerations single sub-periods in order to make our estimations. During the financial crisis 2007-2009 German environmental mutual funds reported outperformed the SRI and conventional funds, even though it is true that differences are not really important. In our point of view, this does not mean that green investments perform better than their peers in crisis periods, since in the second analyzed crisis period, with a focus on the Eurozone, the results show again an underperformance of German green mutual funds in comparison with SRI and conventional funds. According to the results from the post-crisis period, German green funds outperformed their SRI counterparts and similarly the benchmark in comparison to classical funds. This approach from green investment performance to the conventional investment performance could indicate that German managers and German investors have gained experience with environmentally friendly investment, investment opportunities have increased, and that maybe the time has come to report good financial results by German green mutual funds.

Due to low performance of environmental mutual funds, when analyzing the full period, it is interesting to apply a CAPM single-factor model using green and SRI indexes as a proxy market, since, according to White (1995), it might be not appropriate to calculate the returns of these funds using a standard global index as a proxy market. In our case, after running the regression, results do not differ too much from the results obtained using a global index, and are in fact very similar to the results provided by the multifactor regression model in the full period sample. In addition to this, the adjusted R-squared of green mutual funds using a green index, were lower than the R-squared from the model with the SRI index. However, both R-squared were very low (about 0.06), so that using SRI and green indexes as market proxy did not guarantee us a good explanation of our mutual funds' performance.

Other explanations for the low performance in German green funds might include management questions or even selection criteria. Other theories suggest that the utility functions of investors have to be based on social, environmental and financial performance, and not just on financial performance as we have calculated. Considering these three utility functions, if environmental funds' performance were still lower than those of traditional funds, we might then confirm that investors pay an extra price for these green investments. For instance, we must be cautious drawing conclusions from our results.

In summary, despite the limitations of this study, the results of our analysis demand attention, since they are based on current data and on German green mutual funds, providing a new perspective of prior studies. And although the results are not conclusive, they give us a good amount of evidence, mentioned above, which allows us to support and disprove the conclusions of other academic studies, and also to lay the ground for future papers.

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