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IS SOCIALLY RESPONSIBLE INVESTING (SRI) IN STOCKS A COMPETITIVE CAPITAL INVESTMENT? A COMPARATIVE ANALYSIS BASED ON THE PERFORMANCE OF SUSTAINABLE STOCKS.

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Is socially responsible investing (SRI) in stocks a competitive capital investment? A comparative analysis based on the performance of sustainable stocks.

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Abstract:

In the last few decades, socially responsible investments (SRI) have growingly become a relevant issue. The market size in the United States grew from less than a trillion US Dollars to 8.72 trillion US Dollars in 2016, in the past 20 years (US SIF 2016). Approximately 11 trillion Euro was invested in sustainable investments in Europe (EuroSIF 2016). Previous research focused on SRI mutual funds but rarely on green stocks for different reasons. Investing directly in stocks can have different advantages than investment in mutual funds. This article focus on the risk-adjusted competitiveness of a sustainable portfolio based on stocks. We show that a sustainable portfolio does not perform significantly different than a conventional one. The consideration of sustainable criteria does not influence the investment result negatively and could be applied by investors without the need to sacrifice returns.

Keywords: Socially Responsible Investing, Sharpe Ratio, Sustainable portfolios, ethical investing

Highlights:

- Comparative analysis of sustainable stocks (performance based) on the base of the Sharpe Ratio
- Analysis of a green and a conservative portfolio (covering 20 different stocks)
- Literature review of SRI

1. Introduction

The presence of climate change and global warming emphasizes the importance of sustainable investments and the achievement of a green economy is a tremendous challenge that requires large amounts of capital (IEA, 2012). For instance, sectors like energy, technology, IT, finance, logistics or transport are requested to cope with these challenges due to required investments in fostering energy efficiency and providing modern energy (Zuckermann et al., 2016). In the last few decades, socially responsible investments (SRI) have growingly become a relevant issue. In the past 20 years in the United States, the market size grew from less than a trillion US Dollars to 8.72 trillion US Dollars in 2016 (US SIF, 2016). The recent European SRI study (2016) indicates that approximately 11 trillion Euro in Europe are invested in sustainable investments (EuroSIF, 2016). In this context, financial markets (Michelson et al., 2004) and particularly SRI (Heinkel et al., 2001) may have an influence on the behavior of companies and could be indirectly appropriate to mitigate climate change. It is worthwhile noticing that there are no explicit parameters, which exactly indicate sustainable assets. There are different strategies for SRI but not all of them are expected to be green or sustainable (FNG 2016).

There is already a vast range of literature about the competitiveness of SRI and most studies indicate that SRI seem to perform predominantly equal (Climent and Soriano, 2011; Bello,2005; Kreander et al., 2005), sometimes even better (Cummings, 2000; Mallin et al., 1995) or at least not worse (Bauer et al., 2005,2007; van Liedekerke et al., 2007) than their conventional counterparts (for a review, see e.g. Peylo, 2014). But this previous research focused mostly on SRI mutual funds and only rarely on green stocks. Our work adds to previous work like the analysis of Chan and Walter (2014), who test the risk-adjusted performance of 748 environmentally friendly stock-listed US companies and show that these companies display stable excess returns over companies with conventional business concepts. They find positive and statistically significant excess returns, a so called “green equity premium” but their selection of stocks considers also e.g. stocks out of the Claymore-LGA Green ETF, which is based on the best-in-class approach. So, the selection made is thus based on less stringent criteria.

Our paper analyses the performance of sustainable stocks. We make a comparative analysis as to whether SRI investors need to sacrifice returns if they consider green stocks instead of conventional stocks. For this purpose, only stocks that are members of the Natur-Aktien-Index (NAI) or the Global-Challenge-Index (GCX) will be considered for the sustainable portfolio because of the strict selection process of each index. In addition, we create a reference portfolio, using a matching approach, regarding countries, sectors and market capitalisation (Kreander et al., 2005; Schröder, 2004). Our results indicate that green (sustainable) portfolios do not perform substantially worse. Taken together, the null hypothesis of equal Sharpe ratios; concentrating only on the positive ones (in three periods) of both portfolios, could only be rejected for one of the periods in favour of the green portfolio and one time in favour of the conventional one. In two periods both portfolios even performed worse than the benchmark. Focussing on the 3-year periods, we cannot find substantially different performance. Slightly contrary to this, the null hypothesis can be rejected in two cases for the 5-years-period to the disadvantage of the green portfolio – analyzing this broader timeframe, the conventional one performs betters.

The remaining part of the paper is structured as follows. In section 2 we review the literature about sustainable development and SRI, the competitiveness of SRI investments, and the three different

main performance indicators. Section 3 gives an overview of the applied methodology and summarizes the data. Section 4 presents the results and section 5 concludes.

2. Related literature

2.1 Sustainable development

Sustainable development means to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, 41). It is rather plurivalent than clearly defined. In other words, sustainability can be described as the maintenance of natural or physical capital. Natural capital refers to natural resources like raw material or biodiversity whereas physical capital consists of infrastructure like roads, railways or buildings. In this context, sustainability means the maintenance of the level of consumption among the generations, which is also known as intertemporal fairness or the Hartwick Rule (Lewis and Tietenberg, 2012).[1] One example for this is the evolution of the energy sector. The exit of fossil fuels is necessary to reduce air pollution and the dependency on depleting resources.[2] But the transition to a low-carbon society requires large investments in green sectors (Zuckermann et al., 2016; IEA, 2012). The allocation of external capital by bank lending, market debt and market equity plays a decisive role in turning the economy more sustainable. However, banks still shun investments in low-carbon activities despite carbon pricing and continue financing fossil fuel energy capacity (Campiglio, 2015).

Sustainable development is strongly related to green growth. Green growth means "making growth resource-efficient, cleaner and more resilient without slowing it [down]" (Fay et al., 2012, 1). There exist three different ways to accomplish green growth (Jacobs, 2012). The first argument relates to the theories of Keynes. In the case of a recession, the government has the possibility to increase spending to balance the demand deficit. If a government puts a green focus on its spending, it might have a positive impact on green growth due to growing investments. The second argument relates to market failure by undervaluation of natural capital that could be removed by adjustments of standard growth theories. The third argument underlines the importance of innovation for growth. Hence, especially the Keynesian argument and the key role of innovations emphasize the importance of SRI and the role of the government. Financial markets and investors have major opportunities to influence the behaviour of companies and SR investors might increase the procurement cost of capital, which could force companies to make their business concepts more sustainable (Michelson et al., 2004; Heinkel et

[1] The concept of sustainable development can be divided further into three different concepts, depending on the type of capital under consideration. *Weak Sustainability* assumes that substitutionability among the different types of capital and is related to the maintenance of the sum of capital respectively to the stock of capital, for e.g., the exploitation of oil in Norway and the establishment of a fund that let further generations participate in the revenues of the current oil extraction. *Strong Sustainability* has stricter conditions. Applying the criterion means a non-decline of natural capital and a focus on preservation. Even stronger is the definition of "*Environmental Sustainability*" (Lewis and Tietenberg, 2012). Following this concept, not only the aggregate sum of natural capital needs to be maintained but also the physical flow of different natural resources such as animal stocks or the preservation of biodiversity.

[2] In the presence of climate change, many countries established ambitious energy policies. For instance, at the UN Framework Convention on Climate Change, it was decided that the effects of global warming have to be limited to less than 2°C by 2100, which implies a substantial decrease in the emission of Greenhouse Gases (GHG). The energy sector, in specific, faces substantial challenges. It is assumed that the energy demand will increase more than 30 per cent until 2040.

al., 2001). A feasible way to foster SRI is via public pension funds such as those in the Scandinavian countries (Bentsson, 2008).[3]

2.2 Socially responsible investment (SRI) – Definition and history

First of all, it can be said that there has been no exact definition of SRI for a long time but rather different points of view (Cooper and Schlegelmilch, 1993). As there are no specific features what define SRI exactly, there is a large scope for creating assets, which try to meet the different requirements. In general, a widely used definition of the European SRI study (2016) is that "Sustainable and Responsible Investment is a long-term oriented investment approach, which integrates ESG-factors[4] in the research, analysis and selection process of securities within an investment portfolio".

The classic theory would assume that SRI would only be chosen if it yields as well as conventional investments (Gutsche and Ziegler, 2016; Bauer and Smeets, 2015). Investors would have to pay a moral fee if they want to include ethical considerations into their process of portfolio decisions (Belghitar et al., 2014). In general, consumer's value and even pay for special ethical features of products (Auger et al., 2003). Based on this result, Nilsson (2009) argues that these findings may also be true for financial investment decisions. Cheah et al., (2011), for e.g., identify an ethical penalty in the case that SRI performs substantially worse than comparable non- SRI. To sum up, it is rational that a significant number of investors look for financial returns as well as non-financial utility (Pérez-Gladish et al., 2012).

SRI should at least consider one nonfinancial criterion, namely ethical, ecological or society-related (Benijts, 2010; van Liedekerke et al., 2007; Barnett and Salomon, 2003; Lewis and Mackenzie, 2000). The richness of different sustainable investment strategies such as *exclusions*, *Best-in-Class*, *Impact Investing*, *Norms-based screening*, *ESG integration* or *sustainability themed investments* makes it difficult to point out how many assets are sustainable. Every approach places certain demands, which can vary significantly. For instance, different approaches set different standards and not every approach is consistent to the investors' values (EuroSif, 2016; Bacher and Bacher, 2015). Other problems concerning SRI are the weighting of ecologic, social and economic criteria or the considerations of companies that have small sales shares in undesired sectors such as armament or nuclear energy. According to Knoll (2002), SRI are based on two cornerstones. Firstly, ethical investments must not have a negative impact on portfolio performance. Secondly, ethical investments should improve the behaviour of companies because of the rising cost of capital for companies that have an undesired business concept. Following Knoll (2002), this duality implicates a contradiction and both targets can only be fulfilled with restrictions. SRI can be described as "the integration of personal values, social considerations and economic factors into the investment decision" (Michelson et al. 2004, 1).

However, SRI not only salve the investor's conscience, but it also contribute to the development of green technologies and finance sustainable companies. The transition to a low-carbon society requires large amounts of capital, which can only be met by different groups of investors such as retail investors as well as institutional investors like governments. It is also worthwhile noticing that non-financial

[3] According to studies of the OECD (2014, 2015), sovereign wealth funds in China, Norway, the United Arabian Emirates, Saudi Arabia and Singapore and public pension funds in Denmark, Sweden, Finland, the US, Japan, Korea and Canada are significant actors in financial markets. Moreover, sustainable investments are also prevalent in the Islamic world (Abdelsalam et al., 2014; Jamali and Ullah, 2010).

[4] ESG means: Environmental, social and governance

drivers may influence the decision for SRI and investors may gain non-financial utility from their investments (Gutsche et al., 2016; Masini and Menichetti, 2013; Pérez-Gladish et al., 2012). Following traditional finance theory, investment decisions are mainly determined by risk and return (MacGregor et al., 1999), which are supposed to be positively correlated in financial investments, especially in stock markets (Lundblad, 2007; Ghysels et al., 2005). Complete with the factor liquidity, the magical triangle of financial decisions consists of the factors risk, return and liquidity that refer to all different types of investments (Deutsche Bank Research 2010). Remarkably, the preferences returns, risk and liquidity also apply to SR investors (Dorfleitner and Utz, 2014). Peylo (2014) emphasized the integration of ethical[5] issues into the process of financial investment decisions. That goes along with the non-prioritisation of financial returns but implies the achievement of the highest financial return within the restricted investment universe. The traditional economic theory limits investment decisions to the dimensions of return and risk. The concept of SRI widens this concept by adding ethical preferences[6].

Since the mid-1980s, investors became increasingly aware of environmental issues as a result of e.g. the Chernobyl disaster and the Exxon Valdez accident, which implied the leakage of 11 million gallons of crude oil. In addition, a palmful of corporate scandals attracted the attention of a growing number of investors (Renneboog et al. 2008a). Until the 1980s retail investors led the market in SRI (Rita et al., 2013). In the following decades, institutional investors were the most dominant players. Nonetheless, in the last few years retail investors have become more active again. Retail investors hold 22 per cent of the total SRI market in 2015 (EuroSif 2016). Moreover, many evaluations of rating agencies are based on voluntary disclosures. The lack of transparency can also undermine the trust in labels such as the transparency logo of EuroSif or the Austrian Ecolabel (Gutsche and Zwergel, 2016). Hence, the resulting heterogeneity among SRI products regarding the implementation of sustainable strategies causes an enormous complexity in the field of SRI and may lead to confusion among SR investors (Valor et al., 2007; McLachlan and Gardner, 2004).

According to EuroSif (2016), the European market of SRI has grown tremendously in the past 10 years. In 2015, the market size of investments which used exclusions or negative screenings were about 10 billion Euro and increased sixfold since 2007. Among the EU-countries, weapon production and trade, tobacco and nuclear energy have been the top exclusion criteria. Apart from these exclusions, three other SRI strategies have been prominent. The assets under management which employed a Norms-based screening were about 5 billion Euro and quintupled since 2009. Also, ESG Integration respectively Engagement and Voting, have grown significantly and affected an aggregated wealth of approximately 7 billion Euro. The US market of SRI developed quite similarly. These strategies aim to influence the behaviour of companies directly. According to USSif (2016), nearly 9 billion US Dollars,

[5] The terms "SRI" and „ethical investments" can be taken as synonyms. Ethical investments are commonly used in the United Kingdom whereas SRI is a common term in the United States (Michelson et al. 2004)

[6] Ethical investment itself has, without doubt, a long tradition. The idea of ethical investing is far from being fashionable or modern and goes back to Christian, Jewish or Islamic traditions (Renneboog et al., 2008a). For instance, the Christian Church stood against usury. In the 9th century, the church took drastic measures against usurers. After the Second Lateran Council in 1139, usury was entirely prohibited in Christian Countries (Lewison, 1999). In the beginning of the 18th century, a number of religious groups such as Quakers and Methodists established ethical standards of investing. They shunned investments in unethical businesses like tobacco, gambling, alcohol or firearms. In the course of time, the concept of ethical investment included more aspects apart from environmental concerns or the protection of employees (Wen, 2009; Kreander et al., 2003). The Mennonite´s MMA Praxis funds or the Lutheran Brotherhood Fund Family are still prominent examples of ethical church investments (Schepers, 2003). As a response, the Pioneer Fund was founded in 1928 and is considered as the first mutual fund that implemented religious screenings regarding its assets (Renneboog et al., 2008a).

which accounts for one-fifth of all investments, can be considered as SRI. Only ESG incorporating mutual funds have more than 2.5 billion US Dollars under management. Other actors in the financial system play an important role in financing SRI, too. In the past decades, governments have already spent large amounts of money to develop new technologies. In addition, capital from the private sector is required to foster this development (Edwards and Murphy, 2003). Due to their immense capital resources, institutional investors are of fundamental importance (Gillan and Starks, 2003). In particular, with regard to the environment of low interest rates and low economic growth rates, it can be argued that SRI offer alternative capital investments for institutional investors with long-term investment horizons such as pension funds, insurance companies or sovereign wealth funds and institutional investors have begun to increase their investments in green projects in the last decade (Kaminker and Stewart, 2012).

2.3 Competitiveness of SRI investments

In the case of SRI, it is often stated that investors are deterred from investing in SRI because SRI are expected to perform systematically worse than conventional investments and have higher management fees (Gutsche and Zwergel, 2016; Riedl and Smeets, 2016; Benson and Humphrey, 2008). The degree of diversification of an SRI portfolio itself seems to be limited because of the restricted investment universe (van Liedekerke et al., 2007).

There is already a vast range of literature focussing mostly on SRI mutual funds and only rarely on green stocks (Chang et al. 2012, Cummings 2000, Mallin et al. 1995).[7] Recent literature indicates that SRI seem to perform predominatly equal (Climent and Soriano 2011; Bello 2005; Kreander et al. 2005), sometimes even better (Cummings 2000; Mallin et al. 1995) or at least not worse (Bauer et al. 2005,2007; van Liedekerke et al. 2007) than their conventional counterparts.[8] Climent and Soriano (2011) use a CAPM-based methodology and show that US environmental mutual funds show a lower performance between 1987 and 2009 but similar risk-adjusted returns between 2001 and 2009 in comparison to conventional mutual funds. SR mutual funds go through a catching up phase before delivering competitive returns (Bauer et al. 2005, 2007). Bauer et al. (2005) use a Carhart multi-factor model for the evaluation of over hundred ethical mutual funds in comparison to their conventional counterparts in Germany, the UK and US and cannot find hints of a generally worse performance. Moreover, these findings are consistent with those for Spain (Fernandez-Izquierdo and Matallin-Saez, 2008), the Netherlands, the UK and Sweden (Kreander et al., 2005), Belgium (van Liedekerke et al., 2007), Australia (Humphrey and Lee, 2011; Bauer et al., 2006), Europe and a group of 17 countries in Asia and Europe (Renneboog et al., 2008a). Similar results were found in China (Zhang, 2014), in the North American market (Muñoz et al., 2014; Bello, 2005; Statman, 2000), Canada (Bauer et al., 2007),

[7] Reasons are e.g. that mutual funds are easy to buy; bank advisors supply information and investors do not have to adjust their portfolio due to the funds management. Moreover, investors can easily cover different markets, regions, countries or sectors with relatively small amounts of capital (Redman et al., 2000). However, investors must pay front-end loads and management fees that reduce the financial performance of mutual funds significantly. Furthermore, on a net return level, mutual funds underperform the respective market index due to transaction costs, expense ratios and lower average returns of the nonstock holdings (Wermers, 2000; Gruber 1996).

[8] It is worthwhile noticing that many SRI funds and actively managed conventional funds seem to underperform their benchmark portfolios (Renneboog et al. 2008b, Kempf and Osthoff 2007). Only a minority of mutual funds can compete with their respective indices. The aspect of diversification of mutual funds seems to be overestimated. As Statman (1987) has shown, modern portfolio theory assumes that a well-diversified portfolio should include at least 30 different, randomly picked stocks. Early studies (Archer and Evans 1968) conclude that lesser diverse stocks are necessary to diversify the portfolio decently.

for the Australian and the British market (Cummings, 2000; Mallin et al., 1995). Nevertheless, conventional investments show a better performance in the US market (Chang et al., 2012; Chang and Witte, 2010).

Hence, SRI investors could also consider direct investments like Exchange Trade Funds (ETFs) or even stocks. ETFs often replicate indices, are relatively cost-effective due to the lack of management fees and have various other advantages. Nevertheless, the market for sustainable ETFs is still in its infancy. There are comparative returns but a higher risk in comparison to the benchmark (Schröder, 2007). Also Belghitar et al. (2014) find comparable returns for sustainable indices but with more uneven distribution of the return distribution for FTSE4Good Series. A possible explanation might be that companies generally exhibit a comparatively larger level of volatility if they display large expenditures for R&D and are significantly financed by debt capital (Comin and Philippon, 2005). This might be the case for some companies of the green sector. So, SRI investors could also have stock investments in mind when considering SRI.

Thus, the question of this paper is whether investments in green SRI stocks perform as well as conventional investments. If they do not, it might be the case that SRI investors have a willingness-to-pay (Gutsche and Ziegler, 2016; Apostolakis et al., 2016), are less return orientated (Wins and Zwergel 2016) or are less focused on the maximisation of wealth (Rivoli, 1995). However, pursuing investment objectives apart from risk and return debilitates the neoclassical view of the stakeholder's utility functions (Rivoli, 1995).

3. Performance measures and methodology

3.1 Performance indicators

A vast variety of performance measurements of investments exist and the most prominent traditional performance indicators are Jensen´s Alpha, the Treynor Ratio and the Sharpe ratio. For instance, Kemp and Osthoff (2007), Bauer et al. (2005, 2006) or Hamilton et al. (1993) use Jensen´s Alpha to examine the performance of SR mutual funds. Furthermore, Chang and Witte (2010) use the Sharpe ratio for the comparison of US conventional and SR mutual funds and Schröder (2007) for the performance analysis of SR indices. Moreover, Sharpe ratio and Jensen´s Alpha have been used to analyse the SRI mutual funds market in Australia (Humphrey and Lee, 2005) and in the US (Sauer 1997, Bello 2005). All three have been taken to compare the performance of Australian SR mutual funds (Cummings, 2000) or European SR mutual funds (Kreander et al., 2005) with their conventional counterparts. In general, all three methods provide adequate measurements for portfolio performance (Cogneau and Hübner, 2009). The Sharpe ratio is a useful tool for analysing the performance of stocks (Capaul et al., 1993).

The choice of the appropriate risk-adjusted performance measure depends on different factors. Portfolio diversification and dismantling of the absolute risk into a systematic (market risk) und unsystematic (diversifiable risk) part is of fundamental importance to the adequate choice. When it comes to SRI, diversification effects on the portfolio's volatility are not entirely clear. If the diversification possibilities of SR and conventional portfolios are not significantly different and the portfolio can be considered as well diversified, the unsystematic risk would be negligible. Then, using Jensen´s Alpha or Treynor Ratio seems to be advisable. Considering the assumption that SR portfolio shows a lower degree of diversification suggests the application of the Sharpe ratio (Sauer, 1997).

Hereby, the unsystematic risk will be considered. Taking into the account the total risk appears to be recommendable in the case of stock picking. Hereby, individual assets are taken to construct a portfolio, which will increase the unsystematic risk. It should be noted that the Sharpe ratio provides an individual view on the selected stocks. The Sharpe ratio is not appropriate for the aggregation of portfolios due to covariance effects of the portfolio members (Cogneau and Hübner, 2009).

The Sharpe ratio is one of the most common risk-adjusted performance measures and is impressive for its simple quantification and interpretability (Lo, 2002; Kourtis, 2016). It is also called "Reward to Variability-Ratio" and can be described as "the excess return to variability measure" (Mallin et al., 1995). Relating the excess return of an investment to the standard deviation of an asset computes the Sharpe ratio. The Sharpe ratio is an absolute measurement that allows a ranking of the considered assets (Cogneau and Hübner, 2009). A high Sharpe ratio does not mean that an asset has a high return or low volatility. In fact, an asset with a lower volatility needs relatively lower returns to get a comparative Sharpe ratio. On the contrary, a volatile asset needs larger returns to receive an attractive Sharpe ratio. Hence, the Sharpe ratio might be seen as a monetary compensation for the taken risk. Unfortunately, the interpretation of the Sharpe ratio turns out to be complicated when the returns are negative (Kidd, 2011). In this special case, Israelsen´s modified Sharpe ratio can be taken into account, where the denominator is exponentiated with the excess return divided by its absolute value. However, using this modification, the values of the Sharpe ratio gets a wider range and its interpretation is still limited (Cogneau and Hübner, 2009). Additionally, interpreting is subject to constraints. Following Hodges et al. (1997), the investment horizon influences the accuracy of the risk-adjusted performance measurement. They found empirical evidence that the expected return does not rise as fast as the standard deviation. This causes an incline of the Sharpe ratio in the beginning but a decline that correlates with the length of the investment horizon.

Every measurement has its strengths and drawbacks. If the normal standard deviation is taken into account, it makes no distinction between the systematic and unsystematic risk. On the one hand, this non-differentiation might be seen as a drawback (Kreander et al., 2005). On the other hand, the total or absolute risk will be considered. This can be useful while regarding SRI's due to its questionable effect on portfolio diversification. Some studies concluded that restrictions of the investment universe may result in lower level of diversification (Sauer 1997). Other studies deny the existence of a higher risk of SRI portfolios (Kempf and Osthoff, 2007; van Liedekerke et al., 2007; Koedijk et al., 2004).

Despite the described weaknesses, the Sharpe ratio is still one of the most used risk measurements. Its merits lies in simple quantification and interpretation possibilities, the ranking criterion and the consideration of the absolute risk. It is considered as one of the best understood measurements (Lo 2002) and has valid statistical tests (Jobson and Korkie, 1981).

3.2 Methodology

We use the Sharpe ratio for our analysis, which is convincing for its simple quantification, the observation of the absolute risk and the ranking criterion. It points out the risk-return relation of the stocks of the sustainable and the conventional portfolio. It should be kept in mind that risk-adjusted performance measures only allow an ex-post examination of stock returns. Hence, a forecast regarding the future trend in stock prices is only applicable to very a limited extent.
The Sharpe ratio is computed as follows:

$$SR = (r_{pf} - r_f) / \sigma_{pf} \text{ (3)}, \quad [1]$$

where r_{pf} is the return of portfolio, r_f denotes the risk-free interest rate and σ_{pf} describes the standard deviation of the portfolio.

The individual return of each stock, a risk-free interest rate and the standard deviation of each portfolio are necessary to compute the Sharpe ratio. The periods of observation are three and five years. According to Hodges et al. (1997), the accuracy of the Sharpe ratio declines with the length of the investment because the expected return does not rise as fast as the standard deviation. Thus, no longer investment periods will be analysed. Both portfolios contain 20 different stocks. The green portfolio contains 20 stocks from 11 different countries (Denmark, France, Germany, Great Britain, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the US) and various sectors like Banking, IT, Machinery, Organic Food, Pharmaceuticals, Photovoltaics, Water Treatment, Wind Energy. We take these different sectors and countries into account to reach a certain degree of diversification and to cover different topics of sustainability. The reference portfolio also consists of 20 stocks. The stocks of these companies come from 10 different countries (Australia, Canada, Germany, Great Britain, Italy, Japan, Spain, Switzerland, Sweden, US) and rather represent conventional sectors such as car producers, chemicals, gas and oil production, mining or pharmaceuticals.

The excess return, which is the annual individual performance plus the dividend yield of every stock less the risk-free interest rate, will be calculated as a continuous yield. The computation of returns in previous research is based on a constant capital investment because of better comparison possibilities among different investments. Hence, the reinvestment of the distribution like dividends and payouts of mutual funds and stocks is common (Liedekerke et al., 2007; Kreander et al., 2005; Bauer et al., 2005; Schröder, 2004). The tax situation of individual investors might be very different and will not be regarded. Furthermore, the risk-free interest rate has been calculated as discrete and geometric average return.

The portfolio standard deviation cannot be computed by the geometrical average of every share within the portfolio. The consideration of a higher number of stocks usually tend to reduce the risk of the portfolio, which is called the diversification effect. Hence, the portfolio standard deviation is the square root of the portfolio variance of a 2-asset portfolio that is computed as follows:

$$(w(1)^2 * \sigma(1)^2 + w(2)^2 * \sigma(2)^2) + (2*w(1)\sigma(1)w(2)\sigma(2)q(1,2)) \quad [2]$$

where w is the weighting and s the standard deviation of every share and q is the correlation coefficient. The numbers denote the individual share. q(1,2) can be also described as the covariance of two assets. The portfolio variance can be computed in the same way if a portfolio contains more than two assets. First, the sum of the percentage squared weighting multiplied with the squared standard deviation of every stock is taken. Second, the covariance of every asset and the each remaining stock will be doubled and multiplied with the weightings. Third, both term will be aggregated. Hence, the Sharpe ratio is computed on the basis of the excess return of the portfolio divided by its standard deviation.

We test the null hypothesis of equal Sharpe ratios as follows:

$$H0: SR(g) - SR(c) = 0 \quad [3]$$

For the comparison of the Sharpe Ratios in the following analysis only Memmel's corrected version of the classic approach of Jobson and Korkie (1981) is used. This equation has been taken in various studies to compare the Sharpe ratio of two different investment strategies (Walkshäusl and Lobe, 2012,2016; Bai et al., 2013; DeMiguel et al., 2009).

The test statistic is described by:

$$ZJK = (\mu_g\sigma_c - \mu_c\sigma_g) / \sqrt{2/n\,(\sigma_g^2\sigma_c^2(1-\rho_{gc}) - 0{,}5\sigma_{gc}\,\rho\,\mu_g\mu_c + 0{,}25(\mu_g^2\sigma_c^2 + \mu_c^2\sigma_g^2))} \quad [4]$$

where n is the number of monthly observations, μ is the excess return, σ is the standard deviation, σ_{gc} is the covariance of both returns and ρ_{gc} is Pearson´s correlation coefficient. The index g describes the green (sustainable stocks) and c denotes the conventional stocks. Z follows asymptotically a normal standard distribution.

This test is the best-known traditional test for performance comparison (Auer and Schumacher, 2013; Walkshäusl and Lobe, 2012). This standard approach is restricted to the assumptions that excess returns are normally distributed and serially uncorrelated (Auer and Schumacher, 2013). In addition, this test is not useful when tails are heavier than the normal distribution (Walkshäusl and Lobe, 2012).[9]

4 Data, results and discussion

4.1 Data

We develop two portfolios, each consisting of 20 firms covering the time period in between 2002-2016. One portfolio consists of sustainable stocks and the other one is based on 20 conventional stocks. All of the sustainable stocks of our analysis are listed in the Global Challenge Index (GCX)[10] and the Natur-Aktien-Index (NAI)[11] to make sure that the companies meet the strict requirements concerning sustainable standards[12]. For the reference portfolio, only companies listed in the MSCI MidCap or MSCI

[9] The bootstrap test proposed by Ledoit and Wolf (2008) could have been a reasonable second test. This test suggests the use of robust inference methods and considers the non-normally distribution and times-series characteristic of asset returns. Hence, it seems to be more advanced test procedure but it is more complex from the perspective of computation. According to Auer and Schumacher (2013), this test procedure is still relatively new and has only been used rarely for the performance comparison.

[10] The Global Challenge Index (GCX) was established by the Börse Hannover and includes 50 different stocks from different countries. This index is obliged to a strict selection process and bases its decisions on positive and negative criteria. The selection process complies with large global challenges and is based on the Millennium Development Goals that have been established by the United Nations (UN). The seven main areas of activity are mitigating causes and consequences of climate change, securing the supply of drinking water, a sustainable management of forests, preservation of biodiversity, dealing with population development, fighting poverty and establishment of government structures. (see: http://www.boersenag.de/GCX/Einzelwerte and http://gcindex.boersenag.de/de/pdf/GCX_Factbook_D_17-05.pdf)

[11] The Natur-Aktien-Index (NAI) is calculated by the providers of boerse-stuttgart AG and Solactive AG and contains 30 different stocks. The selection process is stricter than that of the GCX. It is based on positive and negative criteria and considers only companies that contribute to a sustainable ecological and social style of economics. (see: http://www.nai-index.de/ and https://www.solactive.com/wp-content/uploads/2013/09/NAI-per centE2percent80per cent93-Der-Natur-Aktien-Index_DE000A1A4ZT2.pdf

[12] In the recent years, a couple of rating agencies and banks have established their own sustainability indices. These indices serve as tools for the creation of financial products; they are used to track the performance of sustainable

SmallCap are considered.[13] We use a matching approach[14] to construct the two reference portfolios, which equal in aspects such as branch, sector, country, region, market capitalisation (list of the included companies: Table 4 and 5, Appendix). The market capitalisation ranks between 205mn Euro and 33.400 mn Euro and the entire market capitalisation of both the portfolios mounts up to 180 bn Euro.

The respective stock prices and dividend payments are collected from different websites.[15] The stock prices are mostly given in daily quotation and have been merged to monthly returns to obtain the respective standard deviations. Previous studies use an annualized, discrete geometric average returns of 1-month interbank offered rate as the risk-free interest rate for the computation of the Sharpe ratio or other ratios (Bauer et al., 2007, 2005; Kreander et al., 2005; Schröder 2007, 2004). Hence, we take the EONIA to obtain the risk-free interest rate (e.g., Giese, 2012; Hallerbach, 2012).[16]

4.2 Results and discussion

4.2.1 Analysis of 3-year-periods

In our empirical analysis, we compare the Sharpe ratio of a green portfolio to the Sharpe ratio of a corresponding conventional benchmark. Table 1 shows the results of excess returns, standard deviation and Sharpe ratio of both portfolios over the three-year periods under study.

Our results indicate that the excess return of the sustainable portfolios is better in one of the five periods under investigation. Second, the standard deviation of the green portfolio is slightly lower in three of five observed periods. The Sharpe ratio is computed by the division of the excess return of each portfolio by its standard deviation. Both portfolios show a negative Sharpe ratio in period 1 (2002-2004) and period 3 (2008-2010). In these periods both indices even perform worse than the benchmark and the possibilities of interpretation are limited. The explanatory power of negative Sharpe ratios is limited, given that a higher risk would lead to a "better", thus less-negative Sharpe ratio.
Compared with each other, the conventional portfolio displays a higher Sharpe ratio in two of three (considering the negative ones: four of five) observed periods. Remarkably high is the Sharpe ratio of the green portfolio in period 2: 2005 -2007 (2.3227) and the Sharpe ratio of the conventional portfolio in period 5: 2014 -2016 (1.7435). Our results indicate, that the performance of the green and the conventional portfolio is similar.

portfolios; companies can take it as a reference to evaluate their level of meeting ESG criteria and these indices can be used to identify environmentally and socially sustainable companies. Just to name a few, green indices are e.g. the Dow Jones Sustainability Indices (DJSI) and the FTSE4Good Index Series.

[13] Members of the different MSCI indices can be found on https://www.msci.com/constituents.

[14] This matching approach was used in previous studies (see e.g., Kreander et al. 2005, Schröder 2004).

[15] http://www.boerse.de/ or http://www.ariva.de/ or http://www.finanzen.net/

[16] Excess returns and Sharpe ratios are calculated using the 1-month EONIA interbank offered rate as risk-free interest rate. The risk-free interest rate is calculated as a discrete and geometric average return. Stock returns are calculated as logarithmic differences to the month before and are denominated in Euro.

		Green portfolio			Conventional portfolio			Test statistics
		Excess Return μ_g	Standard deviation σ_g	Sharpe ratio SR_g	Excess Return μ_c	Standard deviation σ_c	Sharpe ratio SR_c	**ZJK**
2002-2004	1	-0.0792	0.1736	-0.4562	-0.0428	0.2214	-0.1933	-3,6778
2005-2007	2	0.2226	0.0958	2.3227	0.0764	0.2988	0.0256	5,9593
2008-2010	3	-0.074	0.313	-0.2363	-0.0319	0.496	-0.0643	-1,4212
2011-2013	4	0.0639	0.5807	0.1101	0.0448	0.1964	0.2228	-1,2801
2014-2016	5	0.1021	0.1345	0.7587	0.1696	0.0973	1.7435	-2,7697

Table 1: Excess returns, standard deviation and Sharpe ratios of the portfolios in 3-year-periods

Generally said, the subprime crisis and the following financial crisis caused some challenges for the world economy with various impacts. For instance, interest rates decreased significantly (Blanchard 2008, Buiter 2008). Moreover, stock market prices have never shown before such an extent of volatility as after the financial crisis (Schwert 2011, Blanchard 2008). Comin and Philippon (2005) have investigated a larger volatility of stock prices of firms, which have higher expenditures in R&D activities and operate with larger shares of debt capital. This might also be the case for some green companies, which are not yet fully established on that the market and need debt capital for the development of new technologies that accounts for R&D. Especially when it comes to a recession, investors tend to dispose of assets that may imply a comparatively high risk for the investors' portfolio. There are several reasons why the volatility of some green companies might be increased. Brown (2001) e.g. argue that large research expenditures might negatively influence a company's market capitalization because companies are not able to take the full economic benefit of the results of their R&D expenditures. The financial situation obviously influences the market capitalisation of a company (Comin and Philippon 2005).

The problems of financing large-scale projects might be further exacerbated by the financial crisis, which has made financing of large-scale projects more difficult (Scannella 2012). This might be especially the case for some companies that are members of the portfolio, which deal with energy projects and are dependent on external capital (Ghosh and Nanda 2010, Goldman et al. 2005). Our results in Table 1 reflect these difficult economic circumstances. Stock markets display historically high levels of volatility after the breakout of the financial crisis in late 2008 (Schwert, 2011). In particular, the green portfolio displays high levels of volatility.[17] One further explanation for the increased volatility of the green portfolio is the cluster risk. At least three companies out of the green portfolio (Pennon Group, REC Silicon and SunPower) belong to the solar industry, which faces tough market conditions for several reasons. Chinese companies create a serious over-supply with the result of a tremendous price drop for solar panels, falling sales, job reductions and lastly sinking stock market prices for European and US firms (Platzer, 2015; Quitzow, 2015). In addition, the recent enormous

[17] Besides the already mentioned impact of the financial crisis, one further possible explanation might be that companies generally exhibit a comparatively larger level of volatility if they display large expenditures for R&D and are significantly financed by debt capital (Comin and Philippon, 2005). This might be the case for some companies out of the green portfolio.

extraction of shale gas has lowered the costs of generating electricity from gas and reduced the demand for solar panels (Platzer, 2015). Consequently, these three companies perform mostly below average in comparison to the other members of the green portfolio in recently observed periods (2011-2013, 2014-2016, 2012-2016).

4.2.2 Analysis of 5-year-periods

Limiting our analysis to two periods (2007-2011 and 2012-2016) shows that the conventional portfolio has higher Sharpe ratios in both periods, while the Sharpe ratio of the green portfolio is even negative in one period. Hereby, the results indicate that the conventional portfolio performs better than the green portfolio. Nevertheless, in between 2012-2016 the green portfolio performs still better than the benchmark. Comparing both Sharpe ratios indicates a slightly better performance of the conventional portfolio.

		Green portfolio			**Conventional portfolio**			**Test-statistics**
		Excess Return μ_g	Standard deviation σ_g	Sharpe ratio SR_g	Excess Return μ_c	Standard deviation σ_c	Sharpe ratio SR_c	**ZJK**
2007-2011		-0,0661	0,4079	-0,162	0,0114	0,349	0,0327	-1,9037
2012-2016		0,1535	0,362	0,4241	0,1523	0,0715	2,1305	-7,5613

Table 2: Excess returns, standard deviation and Sharpe ratios of the portfolios in 5-year-periods

4.2.3 Robustness-check: Jobson-Korkie-Test

The explanatory power of the Sharpe ratios is limited (Table 1). The robustness checks for the performance comparison of the Sharpe ratios will provide more explanatory power. For this, we use the Jobson-Korkie-Test. The last row (Table 1, 2) displays the test-statistics (ZJK) for the comparison of the Sharpe ratios, which we calculate on the basis of calculated excess returns and portfolio standard deviation. Analyzing the data of the 3-year-periods and focussing on the test-statistics of the positive Sharpe ratios (Table 1) indicates that the green portfolio performed significantly better in period 2, while the conventional portfolio performed significantly better in period 5. In Period 3 and 4 it is not possible to reject the null-hypotheses of equal Sharpe ratios. Thus, it seems that both portfolio perform in a similar way.

Nevertheless, this picture changes if we focus on the 5-year periods (Table 2). Here, the conventional portfolio performs significantly better than the green-portfolio, rejecting the hypotheses of equal Sharpe ratios. While in 2007-2011 the null-hypotheses can just be rejected on a 10%-level, in 2012-2016, the null-hypotheses can be rejected on a 1%-level.

5. Conclusion

Up to now, previous work mostly focus on the performance of SR mutual funds or SR indices. So far, the relationship between sustainable business models and financial performance is not fully understood. Our analysis contributes to recent research in various ways. We have conducted a comparison of the risk-adjusted performance of a green and a conventional portfolio. Using Sharpe Ratios as at test of equality for two investments is a usual and important tool in the financial performance analysis. We used a matching-approach to obtain two comparable portfolios. The Sharpe

Ratio has been taken as a performance measure due to the fact that it considers the total risk in comparison to other performance measures such as Treynor Ratio or Jensen´s Alpha, which only take the β-factor into account.

For the composition of the green portfolio, we apply strict selection criteria and no larger statistically significant difference in the risk-adjusted performance is observable. Above all, the investment results seem to depend on the investment strategy. The selection of individual shares or ETFs may lower the costs of the portfolio in comparison to the purchase of mutual funds and might lead to a better performance. The Sharpe Ratio has been computed for 3- and 5-years periods. Taken together, the null hypothesis of equal Sharpe ratios; concentrating only on the positive ones (in three periods) of both portfolios, could only be rejected for one of the periods in favour of the green portfolio and one time in favour of the conventional one. In two periods both portfolios even performed worse than the benchmark. Focussing on the 3-year periods, we cannot find substantially different performance.
Slightly contrary to this, the null hypothesis can be rejected in two cases for the 5-years-period to the disadvantage of the green portfolio - the conventional one performs betters. Analyzing the period 2012 – 2016 indicates, that despite the fact that the green portfolio has performed slightly better than the conventional one, the result is ascribable to an increased level of volatility according to the Sharpe Ratio formula.

Our analysis leads to the conclusion that green or sustainable portfolios do not have to perform substantially worse and that sustainable firms do not display a worse risk-adjusted performance. We do not find excess return of green firms in comparison to conventional firms. These findings coincide with a majority of studies on mutual green funds or green indices, which have shown an at least equal performance (Zhang, 2014; Climent and Soriano, 2011; Humphrey and Lee, 2011; Junkus and Berry, 2010; Fernandez-Izquierdo and Matallin-Saez, 2008; Renneboog et al., 2008a,b; van Liedekerke et al., 2007; Kreander et al. 2005).

The subprime crisis and the following financial crisis caused some challenges for the world economy with various impacts. For instance, interest rates decreased significantly (Blanchard 2008, Buiter 2008). Moreover, stock market prices have never shown before such an extent of volatility as after the financial crisis (Schwert 2011, Blanchard 2008). The problems of financing large-scale projects might be further exacerbated by the financial crisis, which has made financing of large-scale projects more difficult (Scannella 2012). This might be especially the case for some companies that are members of the portfolio, which deal with energy projects and are dependent on external capital (Ghosh and Nanda 2010, Goldman et al. 2005). Our results reflect these difficult economic circumstances.

Our analysis exhibits some strengths. For instance, the analysis period covers 15 years. The matching-approach (Kreander et al., 2005; Schröder, 2004) has been used to construct comparable portfolios. Importance was attached to the balance of both portfolios. Both portfolios contain stocks from different sectors and from different countries. A rather strict selection process of companies has been applied to obtain a green portfolio. All members of this portfolio had to have member at least of one of the two indices (NAI and GCX), which are supposed to apply very strict criteria regarding sustainability. Many different risk-adjusted measurements have been developed. Still, the Sharpe ratio is one of the most used and best understood tool to examine the performance of stocks and portfolios.

Additionally, a widely accepted robustness check has been applied to compare the performance of both portfolios and verify the (non-) significance of the results.

Yet, some limitations remain. The random sample is rather small. Both portfolio just contain 20 different stocks, what involves a certain cluster risk. For instance, the green portfolio includes some technology and green energy firms, which are supposed to have certain degree of correlation. This also applies to the conventional portfolio that contains some forms out of the oil-, gas- and mining sector. Another point of criticism concerns the robustness checks. We use the Jobson-Korkie-Test for the performance comparison of both portfolios. This test procedure assumes a normal distribution of returns and neglect the times-series characteristics of stock exchange quotations, what seems to be at least questionable.[18]

Taken the results of the analysis together, the consideration of sustainable criteria does not influence the investment result negatively and could be applied by investors without the need to sacrifice returns. Investors rather should focus on appropriate and low-cost investment vehicles. The findings that SRI do not have to imply financial losses for investors as well as the view that tremendous investments in various sectors are required to deal with challenges of climate change emphasise the importance of SRI as a reasonable investment as well as important to modernise considerable parts of the economy. It is reasonable to encourage private and institutional investors to take SRI into a greater consideration. Different subjects remain for further research. From the empirical point of view, a more sophisticated knowledge about performance measures could be helpful to obtain more detailed results.

[18] The bootstrap test developed by Ledoit and Wolf (2008) could refine the test procedure. A better understanding and a further development of this test could provide results that are more sophisticated.

Appendix

Ethic criteria	Ecologic criteria	Social criteria
Alcohol	Fossil-fueled power-plants	Labor law (contraventions)
A number of financial institutions	Genetic engineering	Discrimination
Drugs	Nuclear energy	Armament
Birth control	Non-sustainable fishing and forestry	Bad working conditions
Gambling	Dangerous substances (pesticides, PVC)	Contraventions of human rights
Child labor	Climate-damaging activities (Car industry, road construction, aviation, oil, gas)	Countries with bad governance
Corruption		
Pornography		
Prostitution		
tobacco		
Animal experiments		

Table 3: Overview of often used negative selection criteria (own illustration after Seitz 2010, p.27)

Name	ISIN	Country	Sector	Market capitalisation in million €[19]
Aixtron	DE000A0WMPJ6	GER	Technology	409
Ansaldo	IT0003977540	IT	Technology	2.310
Boiron	FR0000061129	FR	Pharmaceutics	1.670
East Japan Railways	JP3783600004	JP	Railway Company	33.400
Energy Recovery	US29270J1007	US	Water Treatment	448
Gamesa	ES0143416115	SP	Windenergy	5.720
Hain Celestial	US4052171000	US	Organic Food	3.600
Kingfisher	GB0033195214	GB	Commerce	8.840
Kurita	JP3270000007	JP	Water treatment	2.640
Nordex	DE000A0D6554	GER	Wind Energy	1.900
Ormat	US6866881021	US	Geothermal Energy	2.680
Pennon Group	GB00B18V8630	GB	Utilities	4.090
REC Silicon	NO0010112675	NO	Renewable Energies	351
Ricoh	JP3973400009	JP	IT	5.970
Shimano	JP3358000002	JP	Technology/Bike accessories	13.200
SKF	SE0000108227	SE	Machinery	8.370
SunPower	US8676524064	US	Photovoltaics	1,240
Triodos Groenfonds	NL0000440204	NL	Banking	502
Vestas	DK0010268606	DK	Wind Power	15.700
Vossloh	DE0007667107	GER	Railway Technology	813

Table 4: List of sustainable companies (own illustration after data from boerse.de, finanzen.net, ariva.de)

[19] 23.02.2017

Name	ISIN	Country	Sector	Market Capitalisation in million €[20]
Anglo American	GB00B1XZS820	GB	Mining	21.000
Array BioPharma	US04269X1054	US	Pharma	1.710
Ascopiave	IT0004093263	IT	Energy Supply	660
Deutz	DE0006305006	GER	Machinery	685
Elanders	SE0000119299	SE	Infomedia/Print	369
Sandy Springs		US8003631038	Finance	842
Fraport	DE0005773303	GER	Traffic/Airports	5.360
Fuji Heavy Industries	JP3814800003	JP	Machinery	27.600
Harley Davidson	US4128221086	USA	Motorbikes	9.680
Lonza Group	CH0013841017	CH	Chemicals	8.990
Major Drilling	CA5609091031	CA	Oil/Gas	435
Mitsubishi	JP3899800001	JP	Vehicle manufacturer	5830
Momenta	US60877T1007	US	Pharma	998
Oclaro	US67555N2062	US	Technology	1.540
Altagas	CA0213611001	CA	Oil/Gas	3.300
Petrofac	GB00B0H2K534	GB	Oil/Gas	3.500
Qantas Airways	AU000000QAN2	AUS	Airline	5.490
Symrise	DE000SYM9999	GER	Healthcare	7.060
Yamaha Motor	JP3942800008	JP	Cars/Motorbikes	7.560
Zardoya	ES0184933812	SP	Machinery	2.940

Table 5: List of reference stocks (own illustration after data from boerse.de, finanzen.net, ariva.de)

EONIA	
2016	-0,35 %
2015	-0,1071 %
2014	-0,030 %
2013	0,0895 %
2012	0,2293 %
2011	0,869 %
2010	0,4362 %
2009	0,7164 %
2008	3,8636 %
2007	3,8641 %
2006	2,835 %
2005	2,0881 %
2004	2,064 %
2003	2,3226 %
2002	3,0091 %

Table 6: Risk-free interest rate (own illustration after **http://de.global-rates.com/zinssatze/eonia/eonia.aspx**, computed as discrete and geometric average)

[20] 23.02.2017

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