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European Green Mutual Fund Performance: A Comparative Analysis with their Conventional and Black Peers

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Abstract

We conduct the first comparative analysis of the financial performance of European green, black (fossil energy and natural resource) and conventional mutual funds. Based on a unique dataset of 175 green, 259 black and 976 conventional mutual funds, the investigation contrasts the financial performance of the three dissimilar investment orientations over the 1991-2014 period. Over the full sample period, green mutual funds significantly underperform relative to conventional funds, while no significant risk-adjusted performance differences between green and black mutual funds could be established during the same period. Environmentally friendly investment vehicles display a significant exposure to small cap and growth stocks, while black funds are more exposed to value stocks. Remarkably, the green funds' risk-adjusted return profile progressively improves over time until no difference in the performance of the green and the conventional classes could be discerned. Further evidence suggests that the green funds are beginning to significantly outperform their black peers, especially over the 2012–2014 investment window.

JEL classification: F30, G11, G15, G23, M14

Keywords: Green mutual funds, black mutual funds, conventional mutual funds, socially responsible investments, risk-adjusted returns

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"Investment must be sustainable – delivering value not just financially, but also in social, environmental and developmental terms… Our aim is to generate a critical mass of socially responsible investors, entrepreneurs and businesses prepared to uphold social and environmental principles… Increasingly, investors understand that embracing social, economic and environmental responsibility does not mean sacrificing investment returns."
UN Secretary General, Ban Ki Moon, speaking at the New York Stock Exchange on July 24th 2013

Introduction

The foregoing quote credited to a serving UN Secretary General underscores the growing bullish mood regarding sustainable investing, or socially responsible investing/investment (SRI) as it is more popularly known. Sustainable investing is generally defined as an investment approach that considers environmental, social and responsible corporate governance criteria in order to yield long-term competitive financial utility, as well as favourable societal effect. For decades, following the work on optimal portfolio theory by Markowitz (1952), the overwhelming assumption has been that investing in a restricted universe of stocks implies the concession of the standard risk-reward optimisation. Proponents of this argument therefore assume that SRI is based on convictions, such as religious beliefs, generating additional non-financial compensations and not necessarily optimising financial rewards (see Renneboog et al. 2008). However, with the increasing popularity of SRI products since the 1980s, other evidence suggests that SRI investors are as keen as conventional investors to make money on their investments (see for example, Statman 2000). According to the Global Sustainable Investment Alliance, the global market share in 2014 of SRI relative to total managed assets amounts to 30.2% ($21.4 trillion). More than one in every six dollars under professional management in the United States at the start of 2014 is invested in SRI portfolios – some $6.57 trillion. With over $13 trillion, twice the number of investments in the U.S. and a regional market share of over 58%, Europe has become the undisputed leader in SRI assets under management. This level of investment suggests that SRI portfolios yield financially competitive returns.

In this paper, our analysis of sustainable investment performance focuses on green mutual funds as a sub-set of SRI.[1] A green mutual fund is defined as one that makes investments based on a sole commitment to environmental principles and engagements. A green mutual fund therefore selects companies demonstrating exceptional environmentally friendly conduct and/or low environmental impact. Companies selected by green mutual funds would include those demonstrating exceptional environmentally friendly conduct and low environmental impact, an involvement in natural resource protection, energy efficiency projects, clean technology or alternative and renewable energy, as well as other environmentally friendly pursuits.

We test a central hypothesis that the expected returns on green mutual funds are not different in statistical terms from those of conventional mutual funds. This would imply that the environmental responsibility of the stocks contained in the green funds is not priced. Furthermore, given that environmental investment options have increased steadily over the past two decades, and green investors and fund managers alike are becoming more experienced, we expect to find the performance of green mutual funds improving steadily over time relative to their conventional peers.

The second proposition that we test relates to comparative analysis of the performance of the green and conventional funds against black funds. A black fund is defined as a mutual fund investing in carbon intensive equities of entities involved in the exploitation and depletion of our natural resources and natural capital. This definition also explicitly comprises corporations involved in the extraction, facilitation, transportation, storage, processing, sale and use of natural resources, and thus reaches from upstream drilling companies to downstream utilities. Companies in the value and supply chain of the fossil fuel industry (oil, gas and coal), the mining of minerals, ferrous, non-ferrous, and precious metals, as well as other raw materials would therefore be included in a black mutual fund. Recent events, such as the divestment from coal by the French financial services multinational AXA and the Norwegian Sovereign Wealth Fund, suggest that the awareness of climate change impact has led to attempts by some investors to withdraw from undertakings with significant ties to fossil fuels (see Ansar et al. 2013), or at the very least price in the externalities of fossil fuel consumption. Governments around the world and at the United Nations level have enacted legislations to reduce greenhouse gas (GHG) emissions from fossil fuel sources. As part of the efforts to reduce GHG emissions, market mechanisms have been established to price the hitherto unpriced cost of fossil fuel consumption (see among others Daskalakis et al. 2011). Increasingly, investors are demanding that oil majors address the question that between 60 – 80% of their unexplored assets could become stranded, while multiple stakeholders are campaigning for outright fossil fuel divestment (see Ansar et al. 2013). We propose that the impact of these risk factors will lead to reduced risk-adjusted returns for black funds, such that green and conventional funds will start to outperform black funds over time.

An implicit assumption in our analysis is that the investment driver for SRI investors is similar to that of non-SRI investors – financial utility. This assumption is consistent with the SRI financial performance analysis literature (see for example, Climent and Soriano 2011). Notwithstanding the established approach employed, this paper makes significant contributions to the literature. This paper is the first to conduct a comparative financial performance analysis on European green, conventional and black mutual funds. Based on a unique dataset of 175 green, 259 black and 976 conventional mutual funds, the investigation contrasts the financial performance of the three dissimilar investment orientations over the

1991-2014 period applying a CAPM-based methodology. We find that the green funds' risk-adjusted return profile improves over time until no statistical difference in the performance of the green and conventional classes can be identified. Additionally, we confirm that in recent years green funds significantly outperform their black peers; the underperformance of black funds appears to be linked with increasing environmental risk factors. We also report firm exposure asymmetry between green and black funds such that green mutual funds show a significant exposure to small cap and growth stocks, while black funds are more exposed to defensive traditional value stocks.

The catalyst of investments in green mutual funds could be behavioural, with respect to investors' ethical convictions, or purely economic (Renneboog et al. 2008). Early environmental endeavours such as renewable energy and energy efficiency developments supported by both private and public entities appear to have mostly been driven by non-financial utility, as a result of social and political pressure. For example, some forms of energy generation such as wind and solar were rarely competitive with conventional energy generation. However, over time renewable energy technologies for instance have established themselves both as competitive sources of energy, and as critical components of national energy mixes (see Aguirre and Ibikunle 2014). They have, to a large extent, become economically viable alternatives to established fossil fuel energy sources. In addition to this, the environmental orientation of businesses can translate into advantages such as the exploitation of revenue enhancing and cost reducing low carbon investment opportunities (Ambec and Lanoie 2008; Porter and Linde 1995). Consequently, investment in green portfolios is increasingly justified by qualified economic and financial arguments. In this paper, we avoid focusing on behavioural considerations and non-financial utility driving investment in green funds. Rather, we focus only on the financial performance of the three fund classes enumerated in the preceding paragraph.

While Luther et al. (1992) are the first to examine the performance of ethical UK unit trusts over an index benchmark, the beginning of comparative SRI mutual fund studies is marked by Hamilton et al. (1993), who conduct a simple regression analysis comparing the risk-adjusted return profile of socially responsible investments (SRI) and conventional mutual funds. Since then other studies have followed suit, however overall one notices that most focus on the U.S. mutual fund market, rest upon relatively small sample sizes, and analyse short time spans (Kreander et al. 2005). Furthermore, only very few dissect the different SRI dimensions and thus focus on the broad effect of the environmental, social, and governance (ESG) principles on mutual fund performance (see Renneboog et al. 2008). The blending of multiple ethical notions under the concept of SRI mutual funds (Galema et al. 2008), and the on-going promising development of environmentally conscious investment vehicles, favour a dissection of the various SRI components to allow for isolated studies. The anticipated strengthening of the principles behind green investment vehicles by substantiated self-contained economic advantages gives ground to expect intriguing insights through the adoption of a more differentiated and focused analysis. Specifically, the environmental dimension of mutual funds, which is of particular interest to this study, has only been picked up by White (1995), Climent and Soriano (2011) and Ito et al. (2013), who again majorly focus on the United States. The literature on purely green mutual fund studies is therefore very limited.

Climent and Soriano (2011) find that for the full period from 1987 to 2009, U.S. environmental funds underperform their conventional matched counterparts. This is consistent with White (1995), who finds that environmental mutual funds underperform the general U.S. market (*S&P 500*) and the U.S. SRI *Domini index*. Interestingly however, for the more recent time period from 2001 to 2009, Climent and Soriano (2011) find that no significant differences in the risk-adjusted returns of the green fund portfolio, compared with the more generic SRI and conventional mutual funds, can be determined. The authors suggest that green funds underwent a catch-up phase and do not necessarily now come at a cost to investors. The initial underperformance of green mutual funds can possibly be explained by a constrained investment set, therefore it may be inappropriate to use a broad measure such as the *S&P 500* (White 1995). After adjusting the model to an environmentally friendly benchmark such as the *FTSE KLD Global Climate 100 Index*, Climent and Soriano (2011) could not identify any statistical performance differences between the green and conventional mutual funds. Likewise, one can assume that the environmental investment opportunities, and therefore the green stock universe, will grow over time, allowing investors to achieve returns similar to conventional funds. In consequence, it is reasonable to focus on the results of the more recent sample period for which green, SRI and conventional funds can be considered as equally established investment vehicles.

Ito et al. (2013) apply the single factor CAPM model, and show that the Jensen (1968) alpha is statistically significant for only very few SRI and green funds. The authors also employ an innovative and benchmark-independent technique, simultaneously handling fund risk and return, to identify possible changes in the outcomes. They suggest that, in terms of consistency, their approach is superior to the frequently applied CAPM-based analysis. Applying the dynamic mean-variance model developed by Briec and Kerstens (2009), Ito et al. (2013) find that SRI funds significantly outperform their conventional counterparts in the U.S. and especially the EU, while the green funds demonstrate slightly inconclusive results with equivalent or slightly superior risk-adjusted returns. In comparison to the overall longer term (2000 – 2009), the performance of the environmentally friendly funds decreases in the U.S. over the more recent time period of 2006 – 2009. The authors link this unexpected finding to a liquidity shortage caused by the global financial crisis, posing a greater threat to environmentally related businesses, as investors misevaluate the long-term benefits of responsible investments.

Other studies, such as Derwall et al. (2005:52), classify stocks within self-composed equity portfolios based on "the economic value a company adds relative to the waste it generates when creating that value" (eco-efficiency), thereby isolating the environmental aspect of social responsibility. Derwall et al. (2005) show that the high-ranked portfolio significantly outperforms its low-ranked counterpart, for firms in the U.S. from 1993 to 2003. Thus, no penalty is incurred for holding a green portfolio. While Derwall et al. (2005) acknowledge that direct investigations of historic mutual fund returns yield interesting insights into the practical implications of SRI and green investments, they highlight the limitations of these studies by pointing out distortionary influences such as the fund management's skill, undisclosed holdings, and diverging screening methods. Furthermore, mutual fund studies impede the determination of a SRI/green premium or penalty due to the symbiotic effects of stock holdings occurring in the portfolios of both SRI/green and conventional mutual funds.[2] Derwall et al. (2005) also challenge the origins of the eco-efficiency premium and ask how it fits into the classical finance theory. It is difficult to explain the eco-efficiency premium with the help of the classical risk versus return argument, and this may suggest a mispricing by the market. A lower eco-efficiency ranking rather implies a higher corporate risk, thus incentivising investors to require a higher return.

Ziegler et al. (2007) investigate both the implications of the broader sustainability dimensions and the specific environmental aspect on European stocks between 1996 and 2001 using self-composed equity portfolios. Applying a CAPM-based methodology, Ziegler et al. (2007) find that an industry's average environmental performance has a significantly positive impact on stock performance, while an industry's average social performance has a significantly negative influence on stock performance. The relative social or relative green corporate conduct of a firm within its industry however has no significant effect on financial market performance. According to Ziegler et al. (2007), a buy-and-hold strategy focusing on clean industries with a good average environmental performance generates a superior portfolio value, whereas the same strategy focusing on industries with an exceptional average social performance decimates portfolio value. Selecting stocks according to their relative social or environmental performance within a given industry (also known as best-in class approach) will not yield any positive abnormal returns. However, no negative abnormal returns will be experienced by this approach either. Thus, exposure to corporations with heightened environmental or social commitments does not come at a cost, and can therefore be increased. Subsequently, Ziegler et al. (2011) show that composing a portfolio by taking a long position in European companies with established corporate climate impact disclosures, and shorting those with no disclosure practices, pays off. The same holds for U.S. energy firms.

Interestingly, Ziegler et al. (2007) note that corporations with the highest environmental performance often demonstrate a lower social performance (e.g. banking and insurance). This may explain why SRI mutual fund studies in general yield confounding and still inconclusive results. The disparity in the green and social rankings of companies may suggest that the abovementioned negative financial impacts of socially conscious investments cancel out the positive financial effects of environmentally oriented investments. Furthermore, Galema et al. (2008) suggest that the inconclusiveness of the results may also be due to negative interrelations between the sub-dimensions of SRI mutual funds (e.g. environmental considerations vs. stakeholder relations), which may offset one another. SRI aggregates the different ESG dimensions, which possibly have confounding effects thereby prohibiting an explicit superior/inferior performance of sustainable investments.

Overall, it is still not clear whether environmentally responsible investments allow investors to generate comparable or superior risk-adjusted returns. Clarification on this issue is important given the increased environmental awareness and activism of some investors and stakeholder societies in general. Furthermore, the recent and increasingly vociferous campaign against fossil fuel investment is bound to increase the riskiness of black fund investments, thus necessitating an examination of the risk-adjusted performance of black funds against their conventional and green peers. This paper's main contributions are in these two aforementioned respects. To begin with, this is the first paper to conduct a comparative performance analysis of green mutual funds against their conventional and black peers. Second, the competitiveness of black fund investments in relation to green funds is examined against the backdrop of increased societal and investor environmental awareness over time. In addition, the green fund sample size of 175 is by far the largest to have been examined in any study focused on the comparative performance of green mutual funds and their peers. Potentially, this allows for drawing statistically stronger insights into the analysis of the performance of green mutual funds. To our knowledge only Climent and Soriano (2011) conduct a similar fund level analysis, focusing on environmental mutual funds in the US. Their study contrasts the performance of 7 green, 14 matched SRI and 28 matched conventional investment vehicles. Other studies mainly investigate the broader SRI fund universe. For example, Renneboog et al. (2008) examine the performance of 440 SRI and 16,036 conventional mutual funds.

The remainder of this paper is structured as follows: the following data section describes the mutual fund data set employed in this study; the third section sets out the methodology used; the fourth section presents the results from our empirical analysis; and the fifth section concludes.

Data

In this section, we outline the data collection process of the three mutual fund classes and the market benchmarks used to conduct the empirical analysis. In addition, the data quality control process is presented in some detail. The return data collected for the mutual funds is the Total Return Index, which includes dividends (net income) and other distributions realised over a given period of time by assuming that all cash distributions are reinvested.

Mutual fund dataset

The sample period of the comparative performance analysis covers the time span from January 1991 to June 2014, incorporating 282 months or approximately 23 years of fund data. Table I summarises the main mutual fund selection criteria and quality screens applied to compose the final data set. In order to evaluate the performance of solely green mutual funds and compare them to their black and conventional peers, the three distinct classes are segmented from the overall mutual fund universe. The *Thomson Reuters EIKON* fund screener allows us to narrow down the global fund universe and focus only on the fund classes that are of interest. We target funds domiciled in the European Economic Area (EEA) and Switzerland (CH)[3]. We also include the British administration areas of Gibraltar, Guernsey, Isle of Man and Jersey, given their close connections with the EU. Finally, we include funds from Andorra and Monaco for similar reasons. For comparability with previous US-based studies, we also follow Climent and Soriano (2011) in employing only open-ended mutual funds, labelled as primary funds, and whose asset class is equity.

INSERT TABLE I ABOUT HERE

Green Mutual Funds

EIKON's *theme/strategy* screen allows us to narrow down the universe of interest to ethical funds, but there is no similar option for a purely green fund classification in the database. The ethical filter, however, helps to substantially reduce the fund population to only incorporate the entities of potential relevance for the performance analysis. Yet this broader screen includes all mutual funds which are categorised as ethical investments to some extent and thus focus on at least one aspect of the ESG principles. Hence, green mutual funds are captured by the ethical screen but are mingled with other funds. We therefore manually filter the funds to exclude non-green mutual funds by reviewing the official investor documents and fund holdings received from publicly available mutual fund databases, or the issuers themselves. The majority of the green mutual funds are selected based on the clear descriptions of the investment policies in the official fund documents. In cases where no detailed description/information is available, the funds are excluded in order to ensure the quality of the data.[4] No evaluation of 'how green is green' is undertaken, and the paper does not intend to participate in the discussion questioning the environmentally friendliness of these funds as long as the description provided in the database explicitly shows that the fund invests exclusively in green stocks. Finally, the *EIKON* ethical screen is tested for completeness. In order to ensure that green mutual funds that are not labelled as ethical are, at best, all included in the final sample, the complete European equity mutual fund universe is searched for environmentally related catchwords.[5] Further examination of fund documents is then conducted. The applied screening process results in the identification of 175 active, liquidated and merged green mutual funds domiciled in 21 different countries, with the first one having been issued in 1984. 113 of these funds are 'Live' and the remaining 62 are 'Dead'.

Black Mutual Funds

Analogously to the procedure for green mutual fund selection, the primary equity mutual fund universe is sifted for fossil energy and natural resource funds. The completeness of the sample is further enhanced and assured through a manual search of the entire European equity mutual fund universe for specific fossil energy and natural resource related keywords.[6] In order to ensure that we build a purely black mutual fund sample, the official investor documents and fund holdings are scrutinised. The applied screening process identifies 259 active, liquidated and merged black mutual funds domiciled in 21 different countries, with the first one being issued in 1965. There are 150 'Live' and 109 'Dead' black mutual funds in the sample.

Conventional Mutual Funds

With regard to Carhart (1997), the fund population is set to solely include diversified equity mutual funds. For this reason, the *Lipper Global Classification Scheme* is utilised to exclusively account for funds not being overly restricted by their investment policy. Mutual funds, which apply sectoral and/or specific geographical constraints, are therefore excluded.[7] The first phase of the screening process leads to the reduction of the equity mutual fund universe to roughly 7,000 entities. However, in order to improve the integrity of the data, through the application of the data quality checks described in the next section our final sample is made up of 976 active, liquidated or merged conventional mutual funds, domiciled in 23 countries. The first fund was issued in 1959. Of these funds, 586 are 'Live' and 390 are 'Dead'.

Data Quality Assurance

For all three mutual fund classes, the quality of the data is assured by accounting for several probable sources of distortions. Firstly, consistent with Renneboog et al. (2008), fixed-income, money-market, mixed and balanced funds are excluded. Guaranteed, protected, alternative strategy and absolute return funds are also excluded from the final sample (see Bauer et al. 2005).[8] At this point, it should be noted that the samples enclose only funds listed as 'primary' by the *EIKON* screener and are cleaned manually for same-class or multi-country listings. Following Statman (2000), the youngest or the smallest of the daughter funds are excluded from the samples. Secondly, mutual funds for which no or limited data is available via *Datastream* are excluded from the three fund families of interest. Likewise, mutual funds with less than 12 months of data are eliminated (cf. Bauer et al. 2005; Climent and Soriano 2011). Thirdly, not only active mutual funds but also liquidated and merged mutual funds are included, in order to avoid a survivorship bias in the final sample (see Brown et al. 1992). Following Bauer et al. (2005), all funds closed between 1991 and 2014 are added back to the samples. The respective data is collected from the *Datastream* 'Dead' mutual fund dataset. In addition, the return data of dead funds is included in the samples until they are merged or liquidated. Accordingly, the total return index (RI) data of the dead mutual funds is cleaned for stale price data to solely include return information up to the point at which the fund is liquidated.

Market Benchmarks and Factor Portfolios

The factor portfolios are acquired from the *Kenneth R. French* data library. The data file contains the four factor proxies (MKT, SMB, HML, MOM) and the risk-free rate discussed in the methodology section. Due to the majorly international investment orientation of the mutual funds contained in the three samples, this paper relies on the *Kenneth R. French* global factors to conduct the main analysis. However, half of the conventional mutual funds have a European investment orientation[9] (see Table II). In a second step several robustness investigations, using the European factor portfolios, are performed in order to account for potential distortions. The risk-free rate is the U.S. one-month T-bill rate for both the global and the European factor portfolios. Additionally, due to a possible small company effect experienced by the green mutual funds (see Luther et al. 1992; Gregory et al. 1997), the analysis is extended by using alternative market proxies – a small cap market proxy (*FTSE Global Small Cap Index*) and specialty indices. For instance, the green mutual fund estimations are repeated using the *S&P Global Alternative Energy Index* as market benchmark. Correspondingly, the black mutual fund regressions are computed once more based on the *S&P Global Natural Resources Index.* [10]

Methodology

Previous studies in this literature stream apply either of two approaches in comparing the performances of ethical and conventional funds. The first is a comparison of the means of groups, and the second is a matched-pair analysis approach; in this paper, we present results for the former for two main reasons. Firstly, in the matching procedure a large amount of valuable monthly return data is lost. Even though matched funds are very similar in age and size, the matched-pairs return data does not overlap completely and thus the non-contrasted monthly returns are wasted. Given this loss of vital data, our aim of comparing the evolution of mutual funds returns over time is not best served by using the matched-pair analysis.

Secondly, for the three classes, the end of period (2014) total asset value is not fully available for merged and liquidated funds via the Datastream dead mutual fund file, while the return data is fully retrievable. Including merged or liquidated funds in the matching procedure is therefore not possible (as end-of-period fund size is a matching criteria), and hence, if we apply the matched-pairs analysis, the study will suffer from survivorship bias.[11] Our econometric methodology is based on unbalanced random panel data regressions. The approach stems from the CAPM-based (see Sharpe 1964; Lintner 1965) Jensen (1968) alpha measure, which captures the risk-adjusted average abnormal return in excess of a market benchmark. However, given criticisms that the 1-factor CAPM framework does not sufficiently explain the expected stock returns (see as an example, Fama and French 1992), we also employ the multi-factor framework as proposed by Carhart (1997), which is a further extension of both the original CAPM and the Fama and French (1992) 3-factor model. Over time, the model has become the standard for evaluating mutual fund performance in finance literature. For an introduction to the single CAPM, please refer to Jensen (1968).

If the return, r, on fund i in month t is given as:

$$r_{i,t} = ln(RI_{i,t}) - ln(RI_{i,t-1}), \quad (1)$$

then, the excess return ($r^e_{i,t}$) of fund i in month t is computed by subtracting the risk-free rate from the monthly fund return as in (2):

$$r^e_{i,t} = r_{i,t} - r_{f,t} \quad (2)$$

The excess market return ($r_{m,t} - r_{f,t}$) is also calculated by subtracting the monthly risk-free rate from the respective market return. The market return is calculated on a value-weighted regional (or global) market portfolio.

The Carhart (1997) 4-factor model takes the following form:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,MKT}(r_{m,t} - r_{f,t}) + \beta_{i,SMB} r_{smb,t} + \beta_{i,HML} r_{hml,t} + \beta_{i,MOM} r_{mom,t} + \varepsilon_{i,t} \quad (3)$$

where $\beta_{i,MKT}$ is the coefficient measuring the market-risk exposure of fund *i;* $\beta_{i,SMB}$ corresponds to the coefficient measuring the small firm effect of fund *i*, $r_{smb,t}$ is the return spread between a small cap portfolio and a large cap portfolio at time t; $\beta_{i,HML}$ is the coefficient measuring the value premium of fund *i*, $r_{hml,t}$ is the difference in return between a value stock portfolio (high book-to-market ratio) and a growth stock portfolio (low book-to-market ratio) at time *t;* $\beta_{i,MOM}$ is the coefficient measuring the momentum impact of fund *i*, and $r_{mom,t}$ is the difference in return between a portfolio of past 12 months winners and a portfolio of past 12 months losers at time *t*. Momentum is included in order to account for the effect of differences in investment strategy on performance (see Carhart 1997). The intercept α_i, also called Jensen's (1968) alpha, encapsulates the out- or under-performance of fund *i* relative to the factor portfolios. As an extension to the Carhart (1997) 4-factor model, we control for performance differences between the fund classes by implementing a dummy variable framework. The performance of the individual fund classes is contrasted against each other through the use of dummy variables controlling for the 'green', 'black' or 'conventional' classification of the funds, in order to determine an eventual over- or underperformance by one group; the dummy augmented model is as follows:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,MKT}(r_{m,t} - r_{f,t}) + \beta_{i,SMB} r_{smb,t} + \beta_{i,HML} r_{hml,t} + \beta_{i,MOM} r_{mom,t} + \delta_{i,CLASS} D_x^{class} + \varepsilon_{i,t} \quad (4)$$

where $\delta_{i,class}$ is the coefficient measuring the effect of the affiliation to class *x* on fund *i,* and D_x^{class} is a dummy variable taking the value 1 if the fund belongs to class *x* (green, black or conventional) and 0 otherwise. The CAPM-based regressions are also modelled to include the dummy variables as shown in Equation (5):

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,MKT}(r_{m,t} - r_{f,t}) + \delta_{i,CLASS} D_x^{class} + \varepsilon_{i,t} \quad (5)$$

Finally, in order to avoid the under-estimation of standard errors which could lead to overconfidence, and to account for residual correlation across the different funds, we also employ Beck and Katz's (1995) Panel Corrected Standard Errors (PCSE). This method involves using a panel OLS estimation procedure to determine parameter estimates, but replacing the OLS standard errors with PCSE. This allows for the violation of the assumption that $\varepsilon_{i,t}$ is *iid* (in Equations 3–5); thus $\varepsilon_{i,t}$ can be contemporaneously correlated and heteroscedastic across the instruments, and time series autocorrelation within the regressors is also permitted.

Results and Discussion

Summary statistics

Table II reports the summary statistics pertaining to the green, black and conventional mutual fund samples. With 175 entities, the green sample is the smallest of the three fund types. Furthermore, green funds are the youngest by average fund age (9 years) and are also the smallest by average fund size, with just $73.5M of assets under management, compared to the black (average age: 11 years) and conventional (average age: 12 years) funds with sample sizes (fund average total asset value) of 259 ($134.8M) and 976 ($221.1M) respectively. For the greater part, the green (82%) and black (88%) mutual funds adopt an international investment approach, whereas the geographical scope of the conventional sample is accurately balanced between a generic global and European orientation (50% each).[12]

INSERT TABLE II ABOUT HERE

From 1991 to 2014 the green mutual funds earned an average annualised return of 4.06%, which is lower than the 4.53% and 5.38% return gained on their black and conventional peers respectively. While the black funds (18.56%) are the most risky, the annualised standard deviations suggest that the green mutual funds (17.47%) are more volatile than their conventional counterparts (16.21%). One reason for the relatively less risky nature of the conventional funds is the fact that there is very little or no restriction in the fund equity investment avenues. Thus, managers enjoy the benefits of full portfolio diversification.

CAPM (Single-factor) Regression Results

Global Benchmark

In Table III, we present the CAPM results for each of the three mutual fund samples using the *Kenneth R. French* global factor as market benchmark. The very broad global market proxy is used since a significant proportion of the fund classes have mainly international investment orientations, as shown in Table II.[13] The first observation from the results is that the green and conventional fund classes significantly underperform the market benchmark over the full period of investigation; both risk-adjusted estimates of -7.28% for the green funds and -3.05% for the conventional funds are statistically significant at a 0.01 level. Notably, the result obtained for the black funds (-2.48%) is inconclusive and not statistically significant. The high beta of all three classes is related to the selection of a very broad global market proxy, which slightly overstates the sensitivity of the fund returns to the market risk. We subsequently address this through the application of a narrower market benchmark (see Table IV). Still on the global benchmark, interestingly, with a beta of 1.14, the green mutual funds are the most sensitive to market risk, implying high correlation with the market and heightened risks due to greater volatility (as evidenced by the standard deviation estimates in Table II) and reduced diversification opportunities. Other studies confirm that renewable energy stocks often rank in the high-beta segment (see Henriques and Sadorsky 2008; Bohl et al. 2015). Furthermore, the model best fits the green mutual fund returns ($R^2_{ADJ} = 0.73$). This is surprising as the global market proxy from the *Kenneth R. French* data library is applied, which is initially expected to best explain the diversified conventional mutual fund return variations. The model is least suitable to explain the performance behaviour of the black mutual funds (R^2_{ADJ} = 0.55), which seems realistic as the fossil energy and natural resource industries are influenced by a number of other economic and political factors as well.

In Panel B of Table III, the performances of all three mutual fund portfolios are contrasted against each other using dummy variables, as detailed in Equation (5). The results suggest that neither green nor conventional mutual funds significantly underperform their black peers over the 1991-2014 period. Interestingly, the black mutual funds are unable to significantly outperform their green counterparts over the full period. We anticipated statistically significant superior abnormal risk-adjusted returns of the black class, as the period of investigation includes the early pre-Kyoto time span from 1991 to 1998, an epoch characterised by the fossil energy boom. However, this initial intuition cannot be empirically confirmed. The findings also hint at the conventional funds outperforming their green counterparts, with the estimated coefficient measuring the green funds' underperformance (-3.62%) being statistically significant at the 0.05 level.

Even though the black class is the only class which does not significantly underperform the broad global market index, there is no imperative inversion of the argument requiring the black class to then outperform the green and conventional mutual fund class. While the black mutual funds perform better than the conventional mutual funds compared to a broad global market index, it is the conventional fund class, and not the black class, which significantly outperforms the green class at the 0.05 level of statistical significance. Indications as to the possible reasons may be found in the explanatory power of the global market factor, which is a less appropriate proxy for the abnormal black mutual fund returns (R^2_{ADJ} = 0.55) than for the other two classes (R^2_{ADJ} = 0.73 and 0.65). Additionally, green (β_{MKT} = 1.14) and conventional (β_{MKT} = 1.08) funds are more sensitive to market risk than the black funds (β_{MKT} = 1.02), explaining their inferior performance compared to the global market index. These findings underline the intuition that black mutual fund returns are influenced by various other economic and political factors as well, not captured by the standard equity index.

INSERT TABLE III ABOUT HERE

European Benchmark

Now we re-estimate the CAPM and Equation (5) using the less broad *Stoxx Europe 600 Index* over the 2001-2014 period; the results are presented in Table IV.[14] The main observation in Panel A is that the results obtained in Table III are largely supported, with the overall performance of all fund samples improving slightly. The outperformance of the conventional over the green mutual funds also decreases to -2.67%, and is now only statistically significant at the 0.10 level. Overall, the R^2_{ADJ} increases for all three classes, while the change is most obvious for the conventional funds (0.70). This indicates that the European investment scope of half of the conventional mutual funds significantly affects the estimation outcomes. While the sensitivity to the market exposure has decreased for the three classes compared to the results in Table III, the pecking order remains identical to the previous findings.

INSERT TABLE IV ABOUT HERE

As mentioned by Climent and Soriano (2011), the estimations of the CAPM regression using a broad market proxy may distort the results, as the environmentally friendly screens substantially reduce the investment set available to green mutual funds. Additionally, the development of the low carbon and renewable energy industry was driven by an overall global bullish stock market, rising prices of high technology shares and soaring oil prices from the turn of the millennium until the global financial crisis (see Henriques and Sadorsky 2008; Kumar et al. 2012; Bohl et al. 2015; Sadorsky 2012; Inchauspe et al. 2015; Bohl et al. 2013; Managi and Okimoto 2013). The worsening state of the global economy thereafter lands the industry in substantial difficulties. According to Bohl (2015:194): *"fierce competition and excess supply from Asian manufacturers have taken their toll on the sector's profit margins since the late 2000s. [...] Following the outbreak of the global financial and economic crisis, prices of alternative energy stocks plunged as quickly as they had risen, resulting in an almost hump-shaped performance pattern."* This development has a potentially negative effect on the performance of the green mutual fund class. In order to test for these presumptions, the analysis is repeated using the *S&P Global Alternative Energy Index* and the results are presented in Table V. As the index was only introduced in 2003, the period of investigation has to be reduced. As shown in Table V, the green fund portfolio now tends to demonstrate superior abnormal risk-adjusted returns of 3.58%, although they are not significantly different from the environmental index. Also, there is no evidence of significant performance differences between the mutual fund categories any longer. Interestingly, the index does not substantially increase the estimation of the R^2_{ADJ} for the green fund portfolio (0.75), which contradicts the findings on the U.S. market by Climent and Soriano (2011). However, Bauer et al. (2005) report similar results, noticing that standard indices are more suitable for explaining SRI fund returns. In any case, the usefulness of a green speciality index to compare the financial performance of three distinct mutual fund classes is questionable. All three investment orientations pursue very diverse goals, yet all are assumed to share the same financial performance maximisation ambition, and therefore the only objective reference value for an inter-class comparison is a diverse standard equity index.

INSERT TABLE V ABOUT HERE

Small Cap Effect

With regard to the small company effect established by Luther et al. (1992) and Gregory et al. (1997), the sole purpose of the utilisation of the *FTSE Global Small Cap Index* is to specify whether the green fund portfolio experiences an enhanced tendency towards small capitalisation stocks. The investigation is limited to the 1994-2014 period, and the results are presented in Table VI. Most remarkably, with a value of 0.51, the green mutual fund sample exhibits by far the highest R^2_{ADJ}, while it remains at equally low levels for the black (0.31) and conventional (also 0.31) class. Equivalently, the green mutual funds are the most exposed to the market sensitivity measure β_{MKT}, of the small cap index, showing a value of 0.67.

INSERT TABLE VI ABOUT HERE

Multi-factor Regression Results

Tables VII and VIII summarise the results of the estimation of Equations (3) and (4). Table VII shows the estimation results of using a global market proxy, while Table VIII presents the outcome of applying a European benchmark.

INSERT TABLES VII AND VIII ABOUT HERE

In contrast to the 1-factor model, all mutual fund classes significantly underperform the market benchmark from 1991 to 2014. The main difference to the CAPM results is found in the significantly inferior risk-adjusted returns of the black mutual funds. However, the three additional factors do not notably increase the R^2_{ADJ} of the model for any of the three classes, although, with a value of 0.68 (Table VIII), the European multi-factor model is better able to explain the behaviour of the conventional mutual fund returns. Corresponding to the findings of the CAPM-based computations, the green mutual funds experience the highest exposure to market risk for the global (β_{MKT} = 1.15) as well as European (β_{MKT} = 0.99) proxy. The lower European beta estimations can be attributed to the less comprehensive stock universe used to compute the European market proxy. Contemplating the global factor estimations, it is interesting to note that the green (β_{SMB} = 0.38) as well as black (β_{SMB} = 0.41) mutual funds experience a significantly enhanced exposure to small cap stocks, which corresponds to earlier findings. In general, responsible investment-related screening processes are more inclined to exclude large capitalisation stocks (see Cortez et al., 2012).

Analogous to Bauer et al. (2005), Cortez et al. (2009) and Cortez et al. (2012), the green fund portfolio shows a statistically significant tendency towards growth stocks in both the global and European scenarios; β_{HML} shows values of -0.09 and -0.22 at the 0.1 and 0.01 levels respectively. The results thus confirm earlier studies, suggesting that responsible funds have a tendency towards fast growing and small cap companies as they often invest in environmental and clean tech avant-gardes (cf. Luther et al. 1992; Gregory et al. 1997; Kreander et al. 2005). Moreover, value stocks often bear larger environmental liabilities (Cortez et al. 2012). By contrast, black mutual funds are significantly invested in value stocks with a β_{HML} coefficient of 0.2 for the global benchmark. In line with these findings, Bauer et al. (2005:1762) note that *"the high proportion of growth stocks may lie in the exclusion of traditional value sectors like chemical, energy and basic industries"*. These sectors are particularly ignored by green funds, but actively included in the portfolio holdings of black funds. The stocks of the avoided sectors are often considered as defensive equities, and tend to experience less market risk and, therefore, show lower market betas than aggressive stocks. Naturally, black funds show a higher exposure to high book-to-market defensive equities (for example gas, electric and utility stocks). The fact that green mutual funds exclude defensive traditional value stocks from their portfolios may also help to explain the higher market sensitivity (β_{MKT}), leading to higher return volatility and inferior risk-adjusted returns.

The green trend may also help to explain the growth stock bias experienced by environmentally conscious stocks over the last two decades. This argument is supported by the fact that, between 2002 and 2008, the green funds are heavily exposed to growth stocks.[15] The period was characterised by rising oil prices – which are widely accepted as a driver of the financial performance of renewable energy companies as high fossil energy prices incite the use of cleaner alternatives (see Henriques and Sadorsky 2008) – and heightened social, political and economic climate change action (see Aguirre and Ibikunle 2014). Examples of significant events during the period include the introduction of Phase I of the EU-ETS or the Kyoto Protocol entering into force, thus leading to the introduction of Kyoto market mechanisms such as the Clean Development Mechanism and International Emissions Trading. These events potentially led to an enhanced demand for clean stocks, driving up their market value. Again, this confirms the 'sin stock theory' (see Galema et al. 2008; Hong and Kacperczyk 2009) and the consequences of an excess demand for responsible stocks, and a shortfall in demand for 'sin' stocks, on their pricing and returns. Specifically, Hong and Kacperczyk (2009) show higher book-to-market ratios and higher excess returns for the *disgraced* stocks.

It is also important to note that the momentum factor has significant implications for the black mutual fund returns ($\beta_{MOM} = 0.11$ in Table VII). This coefficient estimate seems realistic in light of the defensive stock exposure of black funds (amongst others, gas, electric and utility stocks), given that these stocks experience lower variability and are less sensitive to market fluctuations. Hence, their performance is more stable during times of economic hardship and less impacted by major economic cycles. For this reason it is more likely that 'good follows good' for the winner stocks in the black fund portfolio.

As with the CAPM-based regressions, neither the green nor the conventional mutual funds significantly underperform their black counterparts over the 1991-2014 period. Nevertheless, the evidence of an outperformance of the green by the conventional fund portfolio remains statistically significant, with values of -3.34% (Table VII) and -2.51% (Table VIII) at the 0.05 and 0.1 levels respectively. The underperformance of green funds may be explained by the fact that sectors stigmatised as being *pollutive* are ignored, while others characterised as 'clean' are over-weighted (see also Climent and Soriano 2011). Consistent with the classical portfolio theory, the discussed industry concentration and *sectoral avoidance bias* lead to a restricted investment universe bringing along reduced diversification opportunities. The negative implications of the latter on financial performance therefore help to explain the significant performance differences between the conventional and the green fund portfolios. Considering the overall picture based on a longer time series of fund returns, our main proposition that the performance of green funds is not different from other fund types is not supported. We next examine whether the evidence on performance evolution is consistent with our expectations.

Evolution of Fund Performance

Table IX outlines the multi-factor regression outcomes for two reduced sample periods (following Bauer et al. 2005; Renneboog et al. 2008; Climent and Soriano 2011). The full period of investigation (1991–2014) is divided into two shorter sub-periods (1991–2002; 2003–2014). This analysis is of specific interest to the study, as a change in the financial performance of environmentally friendly funds is expected to have occurred as a result of important social, political and economic-related developments affecting investments in green and black funds. The sub-periods used are exogenously determined. The full period is divided in January 2003 in order to account for the European Union's adoption of the first emissions trading directive, later entering into force in 2005, marking a milestone for the environmental lobby. The move led to the creation of linked market mechanisms for pricing carbon emissions across the EEA.[16]

There are several interesting observations in this set of results. The first observation is that the R^2_{ADJ} increases significantly for the second twelve-year period, suggesting that the global factor portfolio data fits the model better over the more recent time span. Nevertheless, it is important to note that the majority of green funds are launched after 2003. Accordingly, the results of the first sub-period need to be treated with caution, as the return data is retrieved from 42 funds only (launched between 1984–2003), while the sample substantially increases thereafter to a total of 175 green mutual funds. The second observation is that green funds significantly underperform the black (δ_{GREEN} = -6.73%) and conventional (δ_{GREEN} = -4.47%) funds over the 1991–2002 period at the 0.10 and 0.05 levels respectively, whereas only the conventional fund portfolio shows a significantly superior financial performance over the more recent time span at the 0.05 level of statistical significance (δ_{GREEN} = -3.45%). Specifically, no significant differences in abnormal risk-adjusted returns between the green and black classes can be reported. In general, the performance differences between the three fund classes are less important between 2003 and 2014, suggesting that the returns of the three fund classes converge over time.

INSERT TABLE IX ABOUT HERE

Thirdly, the growth stock bias of green mutual funds appears to have only developed more recently. The HML coefficient estimate of -0.23 is significant at the 0.01 level of statistical significance, thus implying a significant bias towards low book-to-market stocks from 2003 to 2014. This is consistent with the expectation of a recent growth in renewable energy investment and an increasing set of environmental business opportunities. Black mutual funds experience a significant exposure to value stocks (0.61 at the 0.01 level of statistical significance) from 1991 to 2002, which then transforms into a significant growth stock bias of -0.52 at the 0.01 level of statistical significance for the 2003–2014 period. As the fossil fuels pass their climax, constituent firms of black mutual funds may have to adjust their investment orientation towards emerging specialised small cap high-growth businesses involved in the fossil energy value chains, in order to sustain their returns. This may involve large cap firms acquiring the share capital or, indeed, the direct operations of more nimble and smaller firms with operations in similar sectors of the economy. An example of this approach includes the recent acquisition of a 25% stake in Cuadrilla Resources by Centrica, a major gas exploration and supply corporation.[17] Green mutual funds have a significantly negative momentum exposure of -0.09 during the first period. Green stocks thus belong to the group of loser stocks for that period. Back then, the environmental industry was still in its infancy and it seemed to be more challenging to break the cycle of bad performance. Contrarily, but analogous to the full period analysis, black funds show a significantly positive momentum exposure of 0.12 over the more recent sub-period. The underlying black stocks thus belong to the group of winner stocks for the entire sample period, not least because of the oil price boom from 2003 onwards.

Finally, in order to better test our main propositions, we extend the sub-period analysis to cover six other moving windows on a comparative basis, as shown in Table X. The results in Table X are very interesting indeed, as they document an astounding continuous improvement of the green mutual fund performance compared to the performance of their black, as well as conventional, counterparts. The growth of the fossil energy and natural resource industries was long assumed to be steady and certain, not least because of the burgeoning wealth of the growing populations in the emerging economies, national and international mobility escalations and the on-going globalisation. All supported the exponential development of fossil fuel usage, which was only questioned over the past few years. From 1991 onwards, the risk-adjusted returns of environmentally friendly mutual funds transitioned from showing traces of slight underperformance (-2.69%) to demonstrating evidence of a significant outperformance over their black peers. For the most recent period of 2012-2014, the green fund portfolio outperforms its black counterpart with a value of about 14.36%; the result is statistically significant at the 0.05 level. While green funds prosper during the transition to a cleaner economy, black funds thrived during the fossil energy and natural resource age and capitalised on the success of the latter. Black funds performed well in the past, but the fossil energy era is approaching its end and will be most likely supplanted by the renewable energy age in the future; assuming scientific evidence continues to strongly underscore the need to reduce greenhouse gas emissions. Equally, over the entire sample period, the inferior performance of the green relative to the conventional fund portfolio progressively improves, from significant underperformance of -3.34% at the 0.05 level, to no remaining evidence of statistically significant performance differences between 2012 and 2014. The initial substantially inferior returns can be ascribed to the more restricted stock universe, which ought to have expanded over the years, bringing with it an enlarged investment set and diversification benefits.

INSERT TABLE X ABOUT HERE

The green mutual fund performance slowly but steadily improves up to 2007. The following four years were characterised by the global financial crisis (2007-2009) and the Eurozone crisis (2009-2011), the effects of which began to deflate by the end of 2012. The crisis situation caused a liquidity problem as suggested by Ito et al. (2013) which, combined with declining stringency of environmental regulations and a reduced emphasis on climate change issues due to weakened economic activity, resulted in limited financing activities for environmentally oriented ventures. However, in partial agreement to Nofsinger and Varma (2014), who find evidence that socially responsible mutual funds show superior financial performance during the years of crisis compared to their conventional counterparts, our results suggest that over the 2007 - 2014 period the green mutual funds gain in strength, as shown by the diminution of the significant underperformance compared to conventional mutual funds from the 0.05 level (2003-2014) to the 0.1 level of statistical significance. From the beginning of the economic recovery in 2011 onwards the green mutual funds then considerably improve to finally outperform their black counterparts at the 0.05 level, and to substantially reduce their inferior performance compared to the conventional class to an insignificant level, with only a coefficient difference estimate of -0.62%. With regard to the black versus conventional fund portfolio comparison, the black mutual funds' performance continuously deteriorates to significantly underperform the conventional class at the 0.01 level over the most recent years. Strikingly, the black mutual funds' excess returns continuously decrease over the full 1991-2014 period and, much recently, show significantly inferior behaviour to both the green (-12.69%, at 0.05 level) and the conventional (-13.23%, at 0.01 level) mutual fund classes.

Thus both of our main hypotheses are supported by the results detailing the evolution of the comparative performances of the three fund classes. We contend that the increasing awareness of the riskiness of investment in black funds will lead to the demand for higher returns by investors. Similarly, as the need for inducing emission-constrained economies becomes more apparent, investment opportunities in this sector will increase across new and existing industries, and along with it the understanding of green investing. These in turn will lead to improvements in the performance of green funds, such that the risk associated with the reduced investment universe will shrink. The signs are indeed mounting that the required development towards a greener economy will leave its traces on the private sector, companies' asset valuations and business models. Firms active in carbon intensive industries therefore face augmented obstacles in the present and the future in the form of regulatory, political, economic, financial and social pressures. The above results constitute the most significant evidence yet from financial market data of a change of tendency in energy-related ventures, conceivably stimulated by the gradual transition from a fossil energy era to an emission-constrained and greener one.

Perhaps the most important implication of the results is that the risk-adjusted returns yielded by conventional mutual funds are not statistically different from those obtained by investing in green mutual funds instead. Given the results in this paper, green mutual funds could be viewed as a financially rational and standard investment vehicle. Thus we provide the first body of evidence to support the predictions of Climent and Soriano (2011: 285) that:

"*…as fund managers and investors gain experience with green-orientated investment and investment opportunities increase, we may find returns approaching those obtained on conventional funds.*"

Conclusion

This paper comparatively examines the performances of black, conventional and green European mutual funds over time. Although our approach conforms, by and large, to the recent trend in the general SRI literature area (see Capelle-Blancard and Monjon 2012), the results obtained are of greater significance because our focus is on the financial performance of a sub-set of SRI funds, which is currently under-researched – green mutual funds.

Furthermore, we provide the first financial markets-based evidence of what appears to be a changeover in European green and black mutual fund performance to the advantage of the former. While it is possible that this evolution in mutual fund performances is driven by an underlying transition from a fossil fuel age into an emission-constrained one, this study does not provide a definitive proof of such transition. We find that the green, as well as the black and conventional, mutual funds show significant negative risk-adjusted abnormal returns when contrasted with a broad global market benchmark. This is consistent with expectations, as mutual funds in general experience a reduced investment universe, and specifically green and black mutual funds are subject to investment restrictions, which negatively impact their financial performance. Interestingly, the black fund class is the only one not to reveal significant negative single-factor alpha estimates when compared to the broad equity indices. Standing out from the competition, black mutual funds likely benefited from the fossil energy and natural resource age, and the associated supportive ambient conditions, which have shaped the world economy over the past century.

Remarkably, when it comes to the inter-fund class comparison, the black fund portfolio is unable to significantly outperform its conventional and green counterparts. Yet, when we contrast the green mutual funds with the conventional investment vehicles, the latter show a significantly superior performance. This is related to the variance in the explanatory power of the global market index for the different fund types. These findings underscore the intuition that black mutual fund returns are influenced by various other economic and political factors too, not properly captured by the standard equity index. These may include socio-political unrest in major oil producing countries that are not well mainstreamed into the global economy. The findings also strengthen the assumption that a restricted investment set limits the green funds' diversification endeavours and negatively impacts the financial performance of the class. Over the full period of investigation, green mutual funds experience a significant small company effect. Small cap and growth stocks face less environmental risks and presumably the funds' holdings are tilted towards innovative environmental pioneers (see Cortez et al. 2012; Kreander et al. 2005). Likewise, the green fund portfolio is highly exposed to growth stocks. Among other explanations, the environmentally oriented stock prices most likely soared due to an excess demand triggered by the environmental trend ultimately resulting in disproportionate market values. A subsequent adjustment to founded stock price levels would have negatively impacted the green funds' performance. Conversely, black funds show a tendency towards high book-to-market defensive value stocks.

The looming end of the fossil fuel and natural resource age and the impending renewable energy era suggest that, possibly, the performance of green and black mutual funds has substantially changed over the period of investigation. Our findings reveal that the performance of black mutual funds diminishes over time and, most recently, evidence indicates a significant underperformance of the black funds when compared to their green and conventional peers. Correspondingly, green mutual fund performance progressively improves such that no significant performance differences between the conventional and the green class could be established. While, over the 1991–2014 period, a statistically significant advantage could be obtained by investing in conventional mutual funds, lately investors are not penalised for investing in green portfolios instead. Equally, investors do not pay a premium for choosing green over black mutual funds. The results imply that, in practice, investment specialists can enhance their exposure to environmentally friendly investments without sustaining a loss in risk-adjusted returns.

In reference to discussions in previous studies on how to explain a superior financial performance of green investment vehicles, the question arises: is this a mispricing story? In the early days of investment in SRI stocks, financial markets likely overestimated the risks faced by clean stocks, and underestimated the environmental risk confronted by carbon-intensive stocks. This is a classic case of information asymmetry in financial markets. Such an occurrence is usually due to the lack of transparency in the market as well as the dearth of information. In this case, it is more likely that the unavailability of adequate information about green investments, and ignorance about the externalities caused by carbon intensive investments, combined to give rise to the mispricing of both green and black stocks. Together with an undervaluation of the environmentally related revenues and profitable opportunities, green stocks are potentially mispriced during the early years of their emergence.

Our efforts to compile comprehensive and representative fund samples notwithstanding, the significance of our findings is limited by the data and only valid for our particular period of investigation and chosen geographic region. Moreover, uneven fund class distributions over time call for caution when interpreting the results, especially at the beginning of our period of investigation. Hereafter, it is important to expand the study to different time periods and distinct geographic areas with focalised in-depth investigations of more recent time frames, including market downturns. Linking the performance differences between green and black mutual funds to explanatory factors – fossil fuel prices, environmental regulations and policies, technological innovations, investors' environmental awareness and investment objectives – would add to the understanding of fund class behaviour. Examining the funds' portfolio holdings would also provide invaluable insights into the inner workings of the three fund classes.

Despite the limitations of this study, the findings of this paper demand attention. The findings indicate that we possibly see a mispricing story by the market during the early years. Green funds underperform the conventional funds largely during the first fifteen years of their existence. Roughly, over the last five years or thereabouts, the green funds appear to post equivalent performances when compared to the conventional funds, and also significantly outperform the black funds during the same period. Hence, the investors' awareness of a reduced risk exposure of the green funds compared to their black peers is eventually enhanced over time, leading to the elimination of possible mispricing of green and black stocks. This should lead to a general downward adjustment of the required rate of return for green stocks and an upward adjustment for black stocks, with investors requiring a compensation for the heightened risk. Indeed, de Haan et al. (2012) show that investors receive a premium for holding a portfolio of dubious environmental reputation. The compensation for the higher level of recognised risk that investors assume when they purchase black stocks should be reflected in the cost of capital for individual firm projects. This in turn could shrink the investment universe for carbon-intensive firms, leading to the ushering in of an emission-constrained global economy. For example, as the cost of capital for oil exploration activities begins to rise relative to profits, firms are likely to become more prudent when making investment decisions. They may choose to pursue mainly proven oil reserves rather than prospecting for new ones. Consequently the volume of oil exploration projects may reduce and, with less products in circulation, prices will rise, thus leading to an increased search for alternatives: green energy.

Notes

[1] This approach has already been well established in the literature (see as examples, Climent and Soriano 2011; Ito et al. 2013; Ziegler et al. 2007).

[2] Please note that the congruence of the portfolio holdings of the three distinct mutual fund classes has not been tested due to limited information on portfolio stock contents. However, while it is possible that the diversified conventional mutual funds include stocks contained in both the green and black mutual funds, it is highly unlikely that the congruence will be significant enough to bias our results. This is because each conventional mutual fund usually contains about 100 – 150 stocks on average and the inclusion of one or two black and green stocks each will be enough to capture the gains of diversification. The diversification benefits in the funds should ensure that no one sector dominates returns. Furthermore, given the commonality in the two non-conventional mutual fund classes, fund returns are unlikely to be significantly boosted in the long-term by including several stocks from the same industry in one conventional mutual fund.

[3] The EEA includes EU countries and also Iceland, Liechtenstein and Norway. Membership of this economic bloc allows the non-EU countries access to the EU's single market. However, Switzerland is neither a EU nor an EEA member but is also part of the single market based on other subsisting treaties.

[4] The official fund documents such as the 'Key Investor Information Document' (KIID), the prospectus, the sales brochure or the annual/half-year reports are scanned to identify the true investment objective of each and every single ethical mutual fund. In addition, in the case that uncertainty persists, the concerned fund's portfolio composition and top holdings are revised so as to increase the level of confidence of the fund class allocation. The documents are received from the publicly available Morningstar or Fundsquare mutual fund database. In the case that the official mutual fund investor documents have only been available in a language other than English, French or German, the translation of the relevant text passage has been performed with the help of Google Translate, and the subsequent green inclusion/abandon decision trusts the tool to yield the correct translation of the generic meaning of the information. We also obtain information from the issuers themselves. The mutual fund emitters' declarations are believed to be accurate.

[5] The fund names of all primary European equity mutual funds are browsed for keywords such as 'renewable', 'green', 'eco', 'efficiency', 'water', 'solar', 'wind', 'biomass', 'environment' and 'climate' as well as their respective synonyms and counterparts in other European languages.

[6] The Lipper Global Classification Schemes screen is used to sift for funds classified under the following categories: 'Commodity Energy', 'Equity Sector Natural Resource', 'Equity Sector Utilities', 'Commodity Industrial Metals' and last but not least 'Commodity Precious Metals'.

[7] The sample is defined to solely comprise mutual funds with a diversified investment strategy through the application of the Lipper filters 'Equity Europe', 'Equity Eurozone' and 'Equity Global'.

[8] This exclusion controls for short selling and other alternative trading strategies. Short selling restrictions were implemented in Europe, if at all, for very limited periods and would have the highest impact only on these excluded funds. As summarised by Beber and Pagano (2013), for the period of the global financial crisis, most short selling constraints were lifted

within several months following their imposition. Furthermore, it is generally accepted that the majority of open-ended mutual funds engage in long only investment strategies.

[9] The European benchmark is employed for robustness. We aim to account for potential distortions, and also confirm the appropriateness of use and the results of the global benchmark.

[10] In the same spirit, the single factor computations are repeated employing the S&P Global Natural Resources Index; the results are not presented but are available on request. While the force of expression of all previous indices on the black mutual fund returns is relatively low, the natural resources benchmark notably improves the black class's R^2_{ADJ}. Nonetheless, it should be noted that the amelioration might be ascribed to the considerably reduced time span for which index data is available (2009–2014). In line with prior estimations, no performance differences between the black fund portfolio and the applied market proxy can be identified. An inter-class interpretation of the regression outcomes is avoided due to the aforementioned line of reasoning.

[11] Nevertheless, we also conduct an analysis based on the matched-pair approach using a reduced sample of funds, with no qualitative difference in the inferences drawn. This is not surprising because the sample size of each of the investigated three mutual fund classes allows for correction of possible distorting fund characteristics such as fund size, age, management, and investment policy. If they exist, the biases are expected to average out. Thus, as suggested by the matched-sample robustness analysis, the significance of the study outcomes is not affected. The results from this additional analysis are not presented but are available on request.

[12] Further analysis, conducted to examine whether regional orientation of funds is a factor influencing performance, suggests that the orientation is not a significant factor for our samples. This is not surprising given the high degree of commonality among global financial markets.

[13] We also conduct narrower estimations using mutual funds with only global investment focus for both the 1-factor and multi-factor models. The results obtained are qualitatively similar. This is not surprising since most of the funds have a global investment focus.

[14] We also conduct narrower estimations using only mutual funds with a European investment focus for both the 1-factor and multi-factor models. Although the statistical significance of coefficients obtained from the estimations is generally reduced on account of smaller sample sizes, the overall inferences drawn from the results are qualitatively unchanged. Furthermore, using the Kenneth R. French data library European market portfolio does not yield qualitatively different results; however, the R^2_{ADJ} values are slightly lower.

[15] β_{HML}: -0.51*** (-4.33) - Please note that these results are not shown in any of the tables included in this paper.

[16] We also conduct a Chow-type parameter stability test by obtaining the residual sum of squares for the panel regressions; the results suggest that there are no breakpoints at all the periods tested.

[17] See *"Centrica buys into Cuadrilla's Lancashire fracking licence"* in the June 13, 2013 edition of Financial Times.

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TABLE I

Fund sample selection criteria and quality screens

	Criteria	Green MF	Black MF	Conventional MF
A	Open-ended MF	√	√	√
B	Primary funds	√	√	√
C	Equity	√	√	√
D	Debt, mixed and balanced funds	*X*	*x*	*x*
E	Guaranteed, protected, alternative strategies and absolute return funds	*X*	*x*	*x*
F	Same class, double country listing	*X*	*x*	*x*
G	Domicile	Europe, EEA + CH	Europe, EEA + CH	Europe, EEA + CH
H	Geographical scope	Europe/Global	Europe/Global	Europe/Global
I	Screens	Green	Black	Diversified
J	Asset status	A, L, M	A, L, M	A, L, M
	Total # of funds	175	259	976
	# of countries	21	21	23

This table illustrates the sample selection criteria and quality screens applied to mutual fund sample selection. "√" illustrates that the final sample of the associated fund class adheres to the respective criteria. "*x*" illustrates that the final sample of the associated fund class excludes funds possessing the respective criteria. In Row J, A, L and M correspond to Active, Liquidated and Merged respectively. EEA and CH refer to the European Economic Area and Switzerland respectively.

TABLE II

Summary statistics of mutual fund classes

MF class	Mean return (%)	Standard deviation (%)	# of MFs	Average size	Average fund age (years)	Geographical investment scope of the MF (%)
Green (1)	4.06	17.47	175	$73.5 M	9	Domestic: 9 (5%) Europe: 20 (11%) Global: 143 (82%) Other: 3 (2%)
Black (2)	4.53	18.56	259	$134.8M	11	Domestic: 3 (1%) Europe: 17 (6%) Global: 227 (88%) Other: 12 (5%)
Conventional (3)	5.38	16.21	976	$221.1 M	12	Domestic: / Europe: 489 (50%) Global: 487 (50%)

The Table provides summary statistics on all three fund classes. The size and geographical scope are represented as of 01/06/2014. The *geographical investment scope of the MF (%)* reports the domestic, regional or global investment focus within each class in percentages (%). The average fund returns are calculated for each month based on an equally weighted portfolio of all funds and then averaged out over the whole sample period. The *mean return (%)* is inclusive of any distributions. Both the *mean return* as well as the corresponding *standard deviation* are annualised. All figures are denominated in US$. Sample period: 31.01.1991-30.06.2014. 'Other' in column 7 refers to narrower geographical investment scopes such as "Asia-Pacific", "Emerging Markets", "Nordic", "Scandinavian" etc.

TABLE III

Empirical results for 1-factor (CAPM) Regressions using the *Kenneth R. French data library*-sourced global market factor

Panel A	α	β_{MKT}	R^2_{ADJ}
Green (1)	-7.28*** (-3.64)	1.14*** (46.09)	0.73
Black (2)	-2.48 (-1.08)	1.02*** (27.76)	0.55
Conventional (3)	-3.05*** (-3.93)	1.08*** (75.47)	0.65
Panel B	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	-2.89 (-1.37)	/	0.76 (0.35)
Conventional vs. (1) & (2)	-3.62** (-2.55)	-0.75 (-0.35)	/

This Table reports the results of the CAPM-based random effects panel least squares seemingly unrelated regressions (SUR), using a global market factor. Panel A presents the estimation results for the single-factor CAPM equation, while Panel B presents the results for Equation (5) with dummies applied as appropriate for each estimation. The global MKT factor portfolio collected from the *Kenneth R. French data library* is used as market proxy to measure the risk-adjusted returns of the green, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied market proxy. β_{MKT} measures the effect of the MKT factor. In Panel B, the over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variable and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.01.1991-30.06.2014.

TABLE IV

Empirical results for 1-factor (CAPM) Regressions using the Stoxx Europe 600

Panel A	α	β_{MKT}	R^2_{ADJ}
Green (1)	-4.85** (-2.31)	0.94*** (42.81)	0.74
Black (2)	-0.83 (-0.30)	0.85*** (25.31)	0.59
Conventional (3)	-2.44*** (-3.99)	0.91*** (104.67)	0.70
Panel B	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	-2.88 (-1.22)	/	-0.22 (-0.09)
Conventional vs. (1) & (2)	-2.67* (-1.71)	0.22 (0.09)	/

This Table reports the results of the CAPM-based random effects panel least squares seemingly unrelated regressions (SUR), using a regional European market factor. Panel A presents the estimation results for the single-factor CAPM equation, while Panel B presents the results for Equation (5) with dummies applied as appropriate for each estimation. The Stoxx Europe 600 Index is used as market proxy to measure the risk-adjusted returns of the green, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied market proxy. β_{MKT} measures the effect of the MKT factor. In Panel B, the over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variable and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 28.02.2001-30.06.2014.

TABLE V

Empirical results for 1-factor (CAPM) Regressions using the S&P Global Alternative Energy

Panel A	α	β_{MKT}	R^2_{ADJ}
Green (1)	3.58 (1.41)	0.76*** (38.24)	0.75
Black (2)	3.14 (1.11)	0.71*** (22.96)	0.61
Conventional (3)	2.09 (0.87)	0.64*** (25.58)	0.61
Panel B	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	1.14 (0.42)	/	0.22 (0.07)
Conventional vs. (1) & (2)	0.92 (0.48)	-0.22 (-0.07)	/

This Table reports the results of the CAPM-based random effects panel least squares seemingly unrelated regressions (SUR), using a specialty index as the market factor. Panel A presents the estimation results for the single-factor CAPM equation, while Panel B presents the results for Equation (5) with dummies applied as appropriate for each estimation. The *S&P Global Alternative Energy Index* is used as market proxy to measure the risk-adjusted returns of the green, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied market proxy. β_{MKT} measures the effect of the MKT factor. In Panel B, the over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variable and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.12.2003-30.06.2014.

TABLE VI

Empirical results for 1-factor (CAPM) Regressions using the FTSE Global Small Cap Index

Mutual Fund Classes	α	β_{MKT}	R^2_{ADJ}
Green (1)	-5.98**	0.67***	0.51
	(-2.41)	(25.25)	
Black (2)	-0.94	0.41***	0.31
	(-0.31)	(13.67)	
Conventional (3)	-2.55	0.42***	0.31
	(-1.03)	(17.05)	

This Table reports the results of the CAPM-based random effects panel least squares seemingly unrelated regressions (SUR), using a global small cap index as the market factor. The FTSE Global Small Cap Index is used as market proxy to measure the risk-adjusted returns of the green, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied market proxy, and β_{MKT} measures the effect of the MKT factor.
All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.01.1994-30.06.2014.

TABLE VII

Empirical results for Multi-factor Regressions using the *Kenneth R. French data library*-sourced global factors

Panel A	α	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	R^2_{ADJ}
Green (1)	-7.46***	1.15***	0.38***	-0.09*	0.03	0.74
	(-4.15)	(47.97)	(6.46)	(-1.76)	(1.17)	
Black (2)	-4.00**	1.05***	0.41***	0.2***	0.11***	0.57
	(-1.97)	(27.77)	(4.91)	(2.83)	(2.66)	
Conventional (3)	-3.40***	1.08***	0.08**	0.03	0.02	0.65
	(-4.24)	(72.26)	(2.50)	(1.13)	(1.08)	

Panel B	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	-2.69	/	0.67
	(-1.30)		(0.32)
Conventional vs. (1) & (2)	-3.34**	-0.67	/
	(-2.43)	(-0.32)	

This table reports the results of the Carhart (1997) four-factor model-based random effects panel least squares seemingly unrelated regressions (SUR), using global factors. Panel A presents the estimation results for Equation (3), while Panel B presents the results for Equation (4) with dummies applied as appropriate for each estimation. 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, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied proxies. β_{MKT}, β_{SMB}, β_{HML} and β_{MOM} measure the effects of the MKT, SMB, HML and MOM factors, where SMB corresponds to the return spread between a small cap portfolio and a large cap portfolio, HML is the difference in return between a value stock portfolio and a growth stock portfolio, and MOM is the difference between a portfolio of the past 12 months' winners and a portfolio of the past 12 months' losers. In Panel B, the over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variables and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.01.1991-30.06.2014.

TABLE VIII

Empirical results for Multi-factor Regressions using the *Kenneth R. French data library*-sourced European factors

Panel A	α	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	R^2_{ADJ}
Green (1)	-5.54***	0.99***	0.37***	-0.22***	0.01	0.75
	(-3.43)	(52.18)	(8.12)	(-5.02)	(0.64)	
Black (2)	-3.59*	0.91***	0.39***	-0.05	0.10***	0.59
	(-1.84)	(29.28)	(5.46)	(-0.77)	(2.75)	
Conventional (3)	-2.37***	0.93***	0.06***	-0.12***	0.00	0.68
	(-4.60)	(113.46)	(3.08)	(-6.84)	(0.02)	

Panel B	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	-2.00	/	0.52
	(-0.98)		(0.24)
Conventional vs. (1) & (2)	-2.51*	-0.51	/
	(-1.88)	(-0.24)	

This table reports the results of the Carhart (1997) four-factor model-based random effects panel least squares seemingly unrelated regressions (SUR), using European factors. Panel A presents the estimation results for Equation (3), while Panel B presents the results for Equation (4) with dummies applied as appropriate for each estimation. The European factor portfolios collected from the *Kenneth R. French data library* are used as factors to measure the risk-adjusted returns of the green, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied proxies. β_{MKT}, β_{SMB}, β_{HML} and β_{MOM} measure the effects of the MKT, SMB, HML and MOM factors, where SMB corresponds to the return spread between a small cap portfolio and a large cap portfolio, HML is the difference in return between a value stock portfolio and a growth stock portfolio, and MOM is the difference between a portfolio of the past 12 months' winners and a portfolio of the past 12 months' losers. In Panel B, the over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variables and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.01.1991-30.06.2014.

TABLE IX

Empirical sub-period analysis results for Multi-factor regressions using the *Kenneth R. French data library*-sourced global factors

Panel A	α	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	R^2_{ADJ}
JAN 1991 – DEC 2002						
Green (1)	-9.63***	0.91***	0.36***	-0.05	-0.09**	0.57
	(-2.75)	(21.06)	(5.50)	(-0.78)	(-2.38)	
Black (2)	-7.14***	0.92***	0.48***	0.61***	0.01	0.36
	(-2.61)	(15.39)	(5.62)	(7.75)	(0.25)	
Conventional (3)	-2.54	0.96***	0.17***	0.00	0.00	0.50
	(-1.48)	(26.52)	(3.13)	(0.00)	(0.00)	

Panel B	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	-6.73*	/	-2.36
	(-1.69)		(-0.60)
Conventional vs. (1) & (2)	-4.47**	2.41	/
	(-2.07)	(0.60)	

Panel C	α	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	R^2_{ADJ}
JAN 2003 – DEC 2014						
Green (1)	-7.41***	1.20***	0.36***	-0.23***	0.05	0.76
	(-3.95)	(42.42)	(4.26)	(-2.69)	(1.33)	
Black (2)	-3.86	1.19***	0.34***	-0.52***	0.12**	0.65

	(-1.63)	(26.27)	(2.67)	(-3.83)	(2.10)	
Conventional (3)	-3.49***	1.13***	-0.05	-0.08	0.00	0.72
	(-3.70)	(60.04)	(-0.97)	(-1.47)	(0.21)	

Panel D	δ_{GREEN}	δ_{BLACK}	δ_{CONV}
Black vs. (1) & (3)	-1.96	/	1.54
	(-0.74)		(0.56)
Conventional vs. (1) & (2)	-3.45**	-1.52	/
	(-2.14)	(-0.56)	

This table reports the results of the Carhart (1997) four-factor model-based random effects panel least squares seemingly unrelated regressions (SUR), using global factors. Panels A and C present the estimation results for Equation (3), while Panels B and D present the results for Equation (4) with dummies applied as appropriate for each estimation. 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, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied proxies. β_{MKT}, β_{SMB}, β_{HML} and β_{MOM} measure the effects of the MKT, SMB, HML and MOM factors, where SMB corresponds to the return spread between a small cap portfolio and a large cap portfolio, HML is the difference in return between a value stock portfolio and a growth stock portfolio, and MOM is the difference between a portfolio of the past 12 months' winners and a portfolio of the past 12 months' losers. In Panels B and D, the over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variables and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.01.1991-30.06.2014.

TABLE X

Empirical comparative analysis results for Multi-factor regressions using the *Kenneth R. French data library*-sourced global factors

Panel A	δ_{GREEN} 91-14	δ_{GREEN} 95-14	δ_{GREEN} 99-14	δ_{GREEN} 03-14	δ_{GREEN} 07-14	δ_{GREEN} 11-14	δ_{GREEN} 12-14
Black vs. (1) & (3)	-2.69	-2.64	-3.39	-1.96	-0.29	7.82	14.36**
	(-1.30)	(-1.26)	(-1.47)	(-0.74)	(-0.08)	(1.51)	(2.37)
Conventional vs. (1) & (2)	-3.34**	-3.31**	-3.28**	-3.45**	-3.79*	-4.27	-0.62
	(-2.43)	(-2.37)	(-2.18)	(-2.14)	(-1.88)	(-1.63)	(-0.25)

Panel B	δ_{BLACK} 91-14	δ_{BLACK} 95-14	δ_{BLACK} 99-14	δ_{BLACK} 03-14	δ_{BLACK} 07-14	δ_{BLACK} 11-14	δ_{BLACK} 12-14
Green vs. (2) & (3)	2.75	2.70	3.50	2.00	0.29	-7.30	-12.69**
	(1.30)	(1.26)	(1.47)	(0.74)	(0.08)	(-1.51)	(-2.37)
Conventional vs. (1) & (2)	-0.67	-0.69	0.11	-1.52	-3.51	-11.29**	-13.23***
	(-0.32)	(-0.32)	(0.05)	(-0.56)	(-0.93)	(-2.42)	(-2.58)

This Table reports the results of the extended Carhart (1997) four-factor model-based (Equation 4) random effects panel least squares seemingly unrelated regressions (SUR). 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, black and conventional mutual funds. α measures the risk-adjusted abnormal return relative to the applied proxies. β_{MKT}, β_{SMB}, β_{HML} and β_{MOM} measure the effects of the MKT, SMB, HML and MOM factors, where SMB corresponds to the return spread between a small cap portfolio and a large cap portfolio, HML is the difference in return between a value stock portfolio and a growth stock portfolio, and MOM is the difference between a portfolio of the past 12 months' winners and a portfolio of the past 12 months' losers. The over- and underperformance hypotheses on the 'comparative classes' (green, black and conventional) are determined by regressing the excess mutual fund returns of all three fund classes jointly against the independent variables and thereby including two dummy variables, each one accounting for one of the three classes. This way a potential over- or underperformance of two of the three classes compared to the remaining third class can be identified. All α measures and the fund class δs in the table are annualised and in percentage terms. The t-statistics are depicted in parentheses and derived from panel corrected standard errors (PCSE). *, ** and *** correspond to statistical significance at 10%, 5% and 1% levels respectively. Sample period is 31.01.1991-30.06.2014.