

# Ethical Fund Volatility and Inconsistency of Investor Sentiment

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## ***Abstract***

*Purpose – This paper examines the volatility patterns and risk-adjusted performance of ethical funds compared to conventional benchmarks across an entire business cycle, including the global financial crisis. The focus on risk coincides within the context of investor sentiment and the investment community’s relative attachment to ethical funds. Investor sentiment affects the fund flow of ethical funds and shifts the role and function of ethical funds in the eyes of investors.*

*Method – The sample comprises 1,397 regionally based ethical funds from the U.S., European, and Asia-Pacific markets and globally oriented funds. The study examines changes in volatility patterns before, during, and after the 2008 global financial crisis. The authors employ the exponential generalized autoregressive conditional heteroskedastic (EGARCH) model to compute fund volatility and use the wavelet method to assess changes in investor sentiment.*

*Findings – The study finds that ethical equity funds offer significantly lower downside risk than equity benchmarks before and during the global financial crisis. These periods coincide with investor sentiment patterns where investors regard ethical funds as a shelter for risk. After the global financial crisis, a shift occurs in volatility patterns where ethical funds generate greater risk than their respective equity benchmarks. These new volatility patterns coincide with changes in investor sentiment, suggesting that changes in market volatility reflect rational adjustments to investor sentiment.*

*Limitations – The study spans an entire business cycle and includes a global financial crisis. Multiple cycles may provide additional insight into the evolving volatility behavior of ethical funds.*

*Implications – The study provides evidence into the evolving status of ethical funds. The growing acceptance and popularity of such funds coincide with significantly greater cash inflows into the funds, which may continue to impact the volatility behavior of such assets. Furthermore, the growing worldwide attraction and acceptance of ethical funds may*

*generate sufficient cash inflows so that these funds behave the same way as non-ethical funds in the future.*

*Originality – The study fills the ethical fund volatility research gap that focuses mainly on returns. This study proposes a fund volatility cycle that begins as premium assets with limited capital inflows and ends as commonly accepted assets with abundant capital inflow. To the best of the authors’ knowledge, this is the first study to focus on the volatility patterns of ethical funds across a business cycle while incorporating changes in investor sentiment analyzed from a frequency domain perspective. In addition, this study uses a significantly larger sample of ethical funds than most studies of ethical funds, so its analysis spans major international markets to obtain regional variation and differences in systematic risk exposure.*

**Keywords:** ethical funds, volatility, performance, crisis, sentiment

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## Introduction

Investors increasingly engage in financial decisions that align with their social positions. They acquire holdings in mutual funds that perform positive or negative screening to include “ethical” industries and their corresponding companies. Earlier studies of ethical funds often emphasize the return performance measure in comparative analyses with conventional funds. These studies frequently ask whether limiting the investment universe compromises the portfolio’s performance. For example, Trinks and Scholtens (2017) observe that investors incur opportunity costs by applying negative screening in Socially Responsible Investment (SRI) funds. On the other hand, Climent and Soriano (2011) investigate returns of U.S. green funds and find no differences in the latter period of their study. Thus, researchers propose a tradeoff between the benefit of not investing in the industries on the negative list versus the potential benefit of greater returns by not limiting the investment universe.

Studies focusing on the performance of ethical funds relative to conventional funds generate inconsistent findings. Cortez *et al.* (2009) evaluate ethical European funds and do not observe a tradeoff between a limited investment universe and reduced investment performance. Mansor and Bhatti (2011) observe mixed results when examining the fund performance measures of Islamic and conventional funds. These studies focus on funds’ returns and monetary benefits rather than the uncertainty that a fund carries for the entire portfolio.

Other studies produce results suggesting that ethical funds outperform other fund groups. Ooi and Lajbcygier (2013) find evidence of superior performance by SRI fund managers after they incorporate SRI investment constraints to recalibrate risk factors. Nofsinger and Varma (2014) observe that ethical U.S. funds outperform conventional funds during financial crises, primarily through the reduction of downside risk. Brzeszczyński and McIntosh (2014) and Wu *et al.* (2017) find that British ethical funds perform better even during economic crises. Finally, Wu *et al.* (2017) identify a superior recovery among ethical funds during the post-crisis period, though mixed results emerged during earlier expansionary periods. These studies prove that ethical funds do not underperform relative to unrestrictive funds.

Given inconsistent results from studies examining ethical fund performance, Rathner (2013) conducts a meta-analysis of 25 studies to detect trends. The review identifies that an emphasis on U.S. ethical funds increases (decreases) the over-performance (under-performance) of ethical funds relative to conventional peers. Later, Bertrand and Lapointe (2018) find that socially responsible firms comprise an underweighted component in risk-based portfolios. The authors suggest that one plausible explanation may be the lack of understanding of the components of ethical stock risk and volatility performance.

Despite the focus on the return performance of ethical funds, research has not devoted much attention to their volatility, though portfolio construction emphasizes the importance of minimizing portfolio variance while optimizing return performance. Studies such as Behr *et al.* (2013) and Hirshleifer *et al.* (2013) highlight the importance of asset variance during portfolio construction to obtain portfolio optimization. Jordan and Riley (2015) focus on the measurements of fund volatility and affirm that asset volatility, rather than the ability of fund managers, usually generates mutual fund alphas. Additionally, Moreira and Muir (2017) assert that constructing volatility-managed portfolios can enhance Sharpe ratios and produce large alphas to benefit mean-variance investors. In addition to the screening used to construct ethical funds, these studies of conventional funds support the investigation of ethical fund volatility.

Investors in ethical and conventional funds may be partially motivated by similar reasons, yet their behavior may reflect different emphases on sentiment, information, or attitude. Markowitz (1952) epitomizes the classic investment approach, focuses almost exclusively upon financial performance, and views investors as rational and wealth maximizing. Yet investors in ethical funds also emphasize environmental, societal, or governance criteria in their decisions which constrain the investment universe and expose themselves to the non-systematic risk and impact long-term performance. Laurel-Fois (2018) takes an alternative position and argues that screening enables managers of ethical funds to obtain more information than conventional fund managers since they construct their portfolios with ever-increasing selectivity to counter the diversification

challenges created by a smaller investment universe. Ballestero *et al.* (2012) attempt to balance the factors motivating ethical investors with a financial-ethical factor model where investors combine traditional financial goals and incorporate an ethical goal within the same utility framework. Their model extends to the socially responsible rating system of mutual funds, which forms a common basis in ethical investing.

The universe of ethical investors may contain significantly different participants with varying degrees of expertise, emphases on financial performance, and time horizon. Regardless of the diversity among ethical investors, U.S. SIF (2012) observes that ethical funds are establishing a significant presence in public market investments and that from 2001 to 2012, professionally managed assets in the U.S. aligned with an ethical basis grew 61.2% from \$2.32 trillion to \$3.74 trillion. Institutions own a significant portion of securities in developed markets, and given the importance of corporate security ownership, researchers such as Bushee (1998) and Cox and Wicks (2011) examine the attributes of different types of institutional owners. Bushee (1998) categorizes investment institutions as dedicated or transient. The greatest difference between these two groups is their investment time horizon and their accompanying trading patterns, which resonate with management decisions of firms in their holdings. For example, firms with high institutional ownership also have high turnover engage in lower R&D to reverse an earnings decline. Cox and Wicks (2011) identify investor demand for ethical securities as a part of the long-term factor in ownership while short-term market liquidity and portfolio construction needs comprise the other demand requirements. Cox and Wicks (2011) observe that dedicated institutions consider corporate responsibility as important as portfolio theory in security selection. Transient investors place the greatest emphasis on market liquidity and the least on ethical factors. Such differences in trading and holding patterns may impact the volatility of the investors' underlying assets.

Chen and Gaviious (2015) examine the role ethical positions have on three types of investors: 1) the marginal investor trading shares on an exchange; 2) an investor making large transactions outside the exchange, e.g., merger and acquisition; and 3) the institutional investor. The authors observe that marginal investors place greater value on the social component of the investment, whereas the other two groups trading on better information do not believe that firms' ethical positions create greater profit potential. The findings suggest that the price premium of a firm's ethical position is driven by less informed marginal investors' emphasis on positive benefits to society that need not be linked directly with benefits to the firm.

Analysts often rely upon different theoretical frameworks to examine ethical investing. Market performance, with repeated over- and under-pricing, suggests that modern portfolio theory may not adequately explain the collective decisions of investors nor reflect their sentiment. Shefrin and Statman (2000) develop a behavioral portfolio theory (BPT) where investors make positive choices under uncertainty. Investors may construct a multi-layered portfolio with each layer addressing one of their goals, yet with

minimal attention to the covariance between the layers. Investors may incorporate a broader group of factors instead of focusing on risk and return. Bilbao-Terol *et al.* (2016) argue that BPT and mental accounting help explain ethical investing and suggest that each layer in the BPT reflects a form of an individual mental account of the investors. Within each layer, investors establish parameters relevant to a specific ethical goal that may incorporate adherence toward risk and return. Such objectives may not construct portfolios that fit the efficient frontier, but they produce funds that attract a growing market of investors.

Our paper fills the gap in the literature that focuses on volatility from the scope of market divergence and the timing of financial performance. This study examines the risk behavior of ethical funds and compares this pattern to conventional equity benchmarks to determine if higher risk helps explain the return premium found within ethical equity funds and the impact of timing upon risk. We also place this analysis within the context of investor sentiment and the investment community's relative attachment to ethical funds. This study uses the term "ethical funds" loosely to include fund groups focusing on socially responsible or sustainable investing (SRI) or Environmental, Social, or Governance (ESG). We conduct this study across an entire global economic cycle: before, during, and after the 2008 global financial crisis. Additionally, we work with a much larger sample of funds than most studies and focus on funds trading in all major financial markets, so our study provides significant breadth and depth to analyzing ethical funds.

The contribution of this paper goes beyond filling the gap of ethical fund volatility left by the past literature that focuses mainly on fund returns. Our study also expands the discussion of volatility to the fund life and new financial instrument perspective. We propose a fund volatility cycle that initiates from premium assets with limited capital inflow and matures at widely accepted assets with abundant capital inflow. While previous studies take two snapshots during the asset life, namely, initiation and maturity, our study contributes their evolution to this field's research.

We observe that investors of ethical funds incur downside risks significantly lower than conventional benchmarks during the pre-crisis (expansionary) and financial crisis periods. Our tests also uncover regional differences in volatility patterns, so investors of ethical funds do not experience consistent benefits of lower risk geographically. We observe changes in investor sentiment across these periods, suggesting that investors experienced a high level of uncertainty during these periods and appeared to favor ethical funds initially during periods of greater uncertainty. These changes in investor sentiment coincide with the fluctuating performance pattern of ethical funds relative to their conventional benchmarks over the business cycle.

Our study identifies a reversal in the volatility patterns among ethical funds during the post-crisis period, where investors of ethical funds experience greater volatility than those of their conventional benchmarks. The ethical funds also show

greater regional variation in volatility in the post-crisis period than in the other periods in the study. These reversals occur along with an increase in the noise impacting investor sentiment after the financial crisis, indicating that investors no longer regard ethical funds as a shelter from market volatility. These findings concur with other studies. For example, Parida and Wang (2018) observe that funds flowing into ethical funds after the global financial crisis diminish relative to more conventional funds, which would impact volatility patterns. Lower capital inflows and the expansion of asset pools of ethical funds increase fund volatility due to greater asset concentration and limited capital budgets. The post-crisis sentiment decline exacerbates capital flow away from ethical funds to conventional funds, hence the high volatility of the ethical funds.

This paper continues as follows: Section 2 presents the data management for the research, including settings and rationale for the regional markets and sub-periods; Section 3 develops the hypotheses; Section 4 introduces the empirical findings; Section 5 concludes and provides potential areas for exploration with ethical funds; while Appendix A explains the computation of fund volatility with the exponential generalized autoregressive conditional heteroskedastic (EGARCH) model within the context of investor sentiment, the wavelet method, and the rationale of subperiods identification.

## Data and Methodology

This study examines ethical funds obtained from Thomson Reuters Lipper that are domiciled in the U.S., Europe, and Asia-Pacific regions and those having a global focus. The study spans over 3,388 trading days from January 2, 2001, to December 31, 2013. From a universe of 4,807 ethical funds, we eliminate those with short survival periods of less than four years in full records containing daily net asset value. It yields 2,850 funds with at least 1,042 trading days (about 4 years) of net asset value records. We emphasize equity funds and construct a final sample of 1,397 ethical equity funds after removing bond, money market, real estate, commodity, pure hedge and arbitrage, target maturity, and mixed asset funds. Using only equity funds, our volatility conclusions become consistent with the composites and components of our benchmark indices.

We compute the volatility performance from the daily net asset value data of the ethical funds in the sample. Following the conclusion of Hickey *et al.* (2015), which argues that the number of assets in a fund portfolio selection universe is irrelevant to its performance, our study does not apply additional filters on the number of holdings of each mutual fund. Specifically, we estimate two versions of fund volatility for comparative purposes: 1) the EGARCH model proposed by Nelson (1991), with modifications from Ederington and Guan (2005, 2010); and 2) the simple estimated volatility from the standard deviation of daily fund returns. Furthermore, we capture volatility performance of funds from two dimensions: 1) geographical, including regional areas of the U.S., Europe, and Asia-Pacific as well as global; and 2) chronological,

emphasizing three distinct periods: pre-financial crisis (expansionary); global financial crisis, and the post-crisis (recovery).

Our approach of separating regional data is consistent with Cowan (2017), who advocates the leading position of the U.S. equity market that develops the socially responsible fund field and implies the importance and legitimacy of separately measuring U.S.-domiciled ethical funds. Hau and Rey (2008) also identify the importance of regional data at the fund level. Our additional review of broad global indices is echoed by Michelucci (2017), who documents that the Social Impact Investment (SII) market is most highly developed in Anglo-Saxon countries. Yet, organizations embracing SII can play important roles in promoting SII across the global markets.

Cresson (2009) asserts that tradable benchmarks perform well in tracking non-tradable benchmarks. This linkage implies that the study of return and volatility performance of ethical funds needs less consideration on the benchmark tradability. Our study selects the structural breaks consistent with the market environment of ethical funds and the standard business cycle dating promoted by the National Bureau of Economic Research. In addition, we select equity benchmarks to reflect appropriate regional or global orientation for comparison with the ethical funds. Table 1 provides the details of the periods and tradable benchmarks used in this study.

**Table 1. Periods and Geographical Categories of Fund Performance Comparison**

Panel A: Time Periods		Panel B: Geographical Performance Benchmark	
Whole Period	January 2, 2001 - December 31, 2013	Global	Dow Jones Global Total Stock Market Index
Pre-Crisis	January 2, 2001 - November 30, 2007	United States	Standard and Poor's 500 Index
Crisis	December 1, 2007 - June 30, 2009	Europe	STOXX Europe 600 Index
Post-Crisis	July 1, 2009 - December 31, 2013	Asia-Pacific	Dow Jones Asian Titans 50 Index

This table in Panel A reports the dates of the whole sample period and subperiods used in the analysis. Panel B in the table presents the equity benchmarks selected for the global and regional ethical funds

## **Hypothesis Development**

Equity fund managers construct ethical funds using positive and negative screens on the universe of equities and attract different types of investors as previously described. The volatility of these constrained portfolios may behave differently from conventional funds as economic conditions change and generate various responses from investors. Research on the performance of ethical fund returns relative to conventional funds generates inconsistent findings, but little attention has been given to the volatility of these funds. To achieve the objective of this study, we propose two hypotheses.

The first hypothesis focuses upon the relative volatilities between ethical and conventional funds during the sub-periods of this study:

**H1:** *The volatility of ethical funds will exceed the volatility of conventional counterparts in all sub-periods.*

Modern portfolio theory, as presented by Markowitz (1952), proposes that fund managers would expose investors to market risk since risks associated with the volatility of individual securities brought by the non-systematic risk can be eliminated through diversification. Yet ethical fund managers rely upon positive and negative screening processes that may prevent the elimination of idiosyncratic risk. This is because the truncated list of asset candidates may share a new systematic risk exclusively carried by ethical assets.

The second hypothesis focuses on the risk-return performance of ethical funds across the different sub-periods of this study:

**H2:** *The risk-adjusted performance of ethical funds will be comparable to those of their respective conventional benchmarks in all sub-periods.*

Across a complete business cycle, as this study spans 2001 to 2013, investors will react to different market environments based upon their objectives and information. During an expansionary period, one should expect a more stable, robust macroeconomic environment that encourages greater investment. The onset of a global financial crisis would introduce massive upheavals into the macroeconomic system and create a more challenging setting for investors where fund volatility should increase significantly with a correspondingly strong impact upon return pattern. The end of a global financial crisis should witness an uneven reemergence of a more stable macroeconomic environment since different regions experience the crisis with varying intensity and different abilities to absorb and then recover from the global shocks. Thus, the global financial environment may take much time to converge to the new macroeconomic equilibrium in a long recovery period. Our tests will identify the volatility patterns of ethical funds and their respective benchmarks across a business cycle.

## **Results and Discussion**

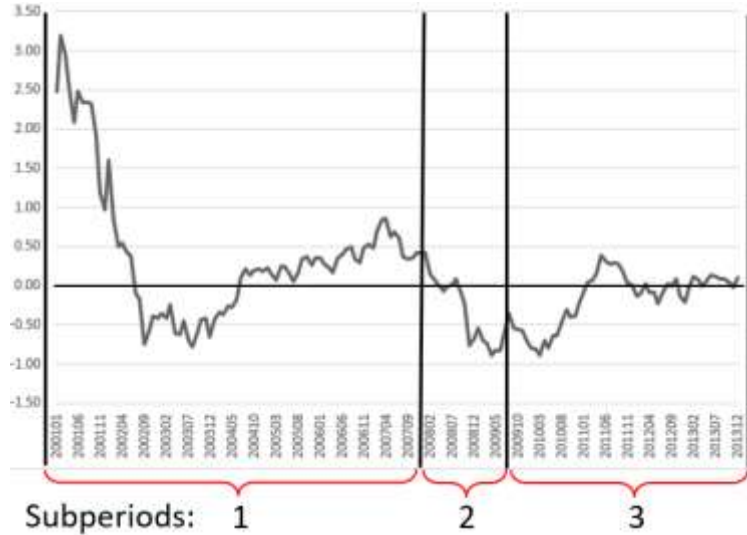
This study examines ethical fund volatility, and the impact that changes in investor sentiment have upon the volatility patterns.

### **Investor Sentiment**

Our analysis of investor sentiment relies upon the Baker and Wurgler (BW) Sentiment Index, which proxies for investor sentiment across the business cycle. We plot the BW Sentiment Index for our sample period in Figure 1, which shows sharp declines



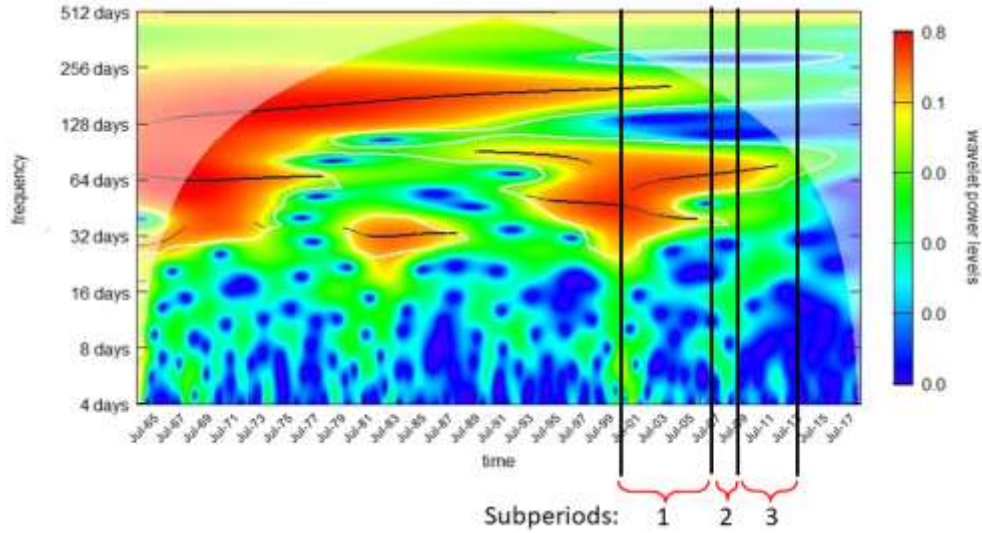
and periods in negative territory, signifying very poor sentiment after the dot com crisis and during the 2008 global financial crisis, while sentiment remains largely anemic during most of the post-crisis period. (The volatility index provides results comparable to the Baker and Wurgler Sentiment Index and is available upon request.).



This Figure presents the Baker and Wurgler Sentiment Index with the three subperiods of this study highlighted.

Figure 1. Baker and Wurgler Sentiment Index

We use the Morlet wavelet analysis of the Baker and Wurgler Investment Sentiment data to construct the power spectrum in Figure 2, with details in Appendix B. The figure presents the power spectrum spanning 1965 to 2018 to provide a context for investor behavior during the business cycle and three subperiods of our study. The long history of investor sentiment presents a persistent and robust turnover at a lower frequency level for about four decades before the 2008 global financial crisis interrupts the pattern. The power spectrum shows that around 2007-2008, the higher frequency turnover of sentiment becomes significant and overlaps with the lower frequency turnover, increasing the induced volatility. The significantly high volatility of investor sentiment during the 2008 financial crisis occurred at the 32-day frequency spectrum, suggesting that investor sentiment segmented the market by inflating the performance fluctuation. From 1965 to 2005, the investor sentiment evolved at a much slower pace, roughly every half year or 252 trading days. However, the investor sentiment turnover frequency spiked before and during the 1987 market crash and during the 1997 crisis in Asia. This pattern suggests that the power spectrum of investor sentiment provides a meaningful instrument for predicting market crises. (We conduct the same analysis with the University of Michigan Consumer Sentiment time series and arrive at similar conclusions. The results are available upon request.)



This Figure presents the Power Spectrum of the Baker and Wurgler Sentiment Index with the three subperiods of this study highlighted

Figure 2. Power Spectrum of the Baker and Wurgler Investor Sentiment

Additionally, Figure 2 depicts a reduction of higher frequency turnover mid-way into the post-crisis period, which indicates an increase in the degree of insignificant return patterns and, thus, greater noise in the market for investors. Figure 2 presents no overlap of frequency between 2001-2002 during the dot-com crisis, suggesting no significant change in investor sentiment during this period. These findings suggest that the relatively small decline in volatility for the ethical funds represents a shift in investor sentiment and does not come from core inadequacies with the ethical funds. Instead, the volatility pattern reflects the reverse of the “flight to safety” that appears to occur at the earlier subperiods, with investors resuming their preference for conventional assets when their sentiment is low because conventional assets offer an unlimited selection spectrum for investors and ease of portfolio diversification. This pattern with investor sentiment coincides with diminished fund inflows for individual ethical funds and the expansion of asset pools of ethical funds, leading to higher fund volatility, as documented by Parida and Wang (2018).

### Fund Volatility

We focus on the volatility of ethical funds domiciled in major geographical regions and compare their behavioral patterns to their respective conventional benchmarks across an economic cycle. Our study finds that the volatility patterns of the ethical funds demonstrate behavior consistent with the calculations of the volatility index, which measures the expected volatility of the stock market, proxied by S&P 500 index options. For example, the mean of volatility index over our entire sample period is 21.28, which suggests that the annualized daily standard deviation of returns of the S&P 500 index is 21.28%, which is  $\sqrt{252}$  times the daily volatility. As a robustness check, this study computes and compares the means of volatility estimated from the EGARCH model to

the simple estimation of volatility, calculated as the standard deviation of the fund's daily returns of net asset value.

Table 2 shows that the values of the volatility of the regionally-based ethical funds during the pre-crisis period are significantly lower than their comparable regional benchmarks. The benefits to downside risk vary among the regional ethical funds. During this expansionary period, EGARCH estimated that volatility values of the U.S. and European domiciled ethical funds are over 4% lower than the respective benchmarks, while those of the Asia-Pacific domiciled ethical funds are over 7% lower than their respective benchmarks. These ethical funds demonstrate an ability to suppress daily fluctuation, regardless of the investment universe, which is a key feature of such funds and may reflect a more conservative nature of assets within the funds. Our findings are consistent with those of Bertrand and Lapointe (2018), who observe that European stocks from an SRI universe offer positive contributions to risk-adjusted performances of portfolios. Similarly, Galema *et al.* (2008) and Lee *et al.* (2010) observe lower risk in their study of SRI portfolios based in the United States.

While the global equity ethical funds generate volatility values lower than regionally-based peers, their estimated volatility values exceeded conventional global benchmarks. The volatility pattern in Table 2 suggests that diversification benefits exist on a worldwide scale since the global benchmark generates volatility significantly lower than the regional benchmarks, and the global equity funds offer downside risk lower than all regional ethical funds. These findings suggest that regional benefits of reduced volatility created by ethical funds may be diminished for broad global investments since greater diversification benefits within the cross-boundary portfolio provide lower volatility than the regional one.

The volatility of global ethical funds, which is lower than the other regional ethical funds, generates over 18% more volatility than their benchmarks (Simple Estimated Mean: 15.29 versus 12.93). Yet it is not the higher volatility of global ethical funds that creates this condition but the lower benchmark volatility. As presented in Table 2, the global equity index generates significantly lower volatility than all other U.S., Europe, or Asia-Pacific equity indices, whose volatility values range from 16.40% to 19.32%. These higher volatility values suggest that the benefit of reduced volatility created by global ethical funds generally impacts global equity investments. Thus, any advantage in volatility reduction may be less pronounced for broad, global investments since the volatility of the cross-boundary portfolio appears naturally lower due to greater benefits of diversification. Nevertheless, the volatility patterns demonstrate that ethical funds can suppress daily fluctuation, despite the constraints placed upon their construction through screening. These findings for the pre-crisis period reject H1 since only the global ethical funds generate greater volatility than their conventional benchmarks.

Table 2. Ethical Fund Volatility: Pre-Crisis Period

	Number of Funds	Ethical Fund Volatility	Index Volatility	Percentage Difference
U.S. Equity Ethical Funds				
EGARCH Fitted Mean Volatility	136	15.65	16.40	-4.56%***
Simple Estimated Mean Volatility	136	15.92	16.93	-5.93%***
Europe Equity Ethical Funds				
EGARCH Fitted Mean Volatility	337	17.23	17.96	-4.04%***
Simple Estimated Mean Volatility	337	17.37	18.50	-6.13%***
Asia-Pacific Equity Ethical Funds				
EGARCH Fitted Mean Volatility	63	17.83	19.32	-7.69%***
Simple Estimated Mean Volatility	63	17.93	19.32	-7.16%***
Global Equity Ethical Funds				
EGARCH Fitted Mean Volatility	319	15.16	12.65	19.80%***
Simple Estimated Mean Volatility	319	15.29	12.93	18.28%***

\*\*\* denotes 0.01 significance level of t-statistics; this table reports the sample sizes and volatilities of the regional and global ethical funds during the Pre-crisis period, January 2, 2001 – November 30, 2007. In addition, we present two volatility measures, EGARCH fitted mean and simple estimated mean, for the ethical funds and their respective equity benchmarks. The table also reports the percentage difference in volatilities and their statistical significance.

The worldwide financial crisis of 2008 tested the effectiveness of many risks management tools within the financial industry. Table 3 shows that the estimated volatility values of all ethical funds increased significantly during the crisis period, relative to that of the expansionary period in Table 2. The increases ranged from 79% in the Asia-Pacific ethical funds (simple estimated mean: 17.93 versus 32.18) to 97% in the U.S. equity ethical funds (EGARCH fitted mean: 15.65 versus 30.88). The regionally based ethical funds in the U.S. and Asia-Pacific and the global fund all had smaller increases in values of volatility than their respective conventional benchmarks. The volatility values of all equity benchmarks increase over 100%, with the U.S. benchmark experiencing the largest spike at 143% (EGARCH fitted mean: 16.40 versus 39.91). The European benchmarks generated the smallest volatility increase with a rate of 83% (simple estimated mean: 18.50 versus 33.79), which was comparable to that of all European ethical funds. These findings highlighting superior risk performance of the regional and global ethical funds offer evidence conflicting with that of Bertrand and Lapointe (2018), focusing on European-based markets. Their paper identifies underweight in ethical firms within risk-based asset allocation strategies. In our paper, the smaller increases in volatility among most of the ethical funds are consistent with the findings of Lee *et al.* (2010) and Laurel-Fois (2018) and may reflect a lower systematic risk for these funds based upon the non-financial screens used in the portfolio construction that reduced their investment universe.

The results in Table 3 show that all ethical funds generate lower values of volatilities and provide consistently lower risk exposure than their respective conventional benchmarks during the global financial crisis. The ethical funds appear to absorb volatility created by the broader equity market within the three regions and a global context. We observe the greatest level of superior volatility performance relative to the benchmark at almost 23% with the U.S.-based equity funds (EGARCH fitted mean:

30.88 versus 39.91). The globally-oriented ethical funds and benchmarks all had lower volatility values than the other regionally based funds, suggesting greater diversification benefits with this broader focus. Yet, in the crisis period, the global equity ethical fund absorbed more market volatility than the global benchmark, with volatility benefits over 2% lower (Simple Estimated mean: 29.29 versus 29.99). Our findings are consistent with Nofsinger and Varma (2014), who observe that socially responsible mutual funds dampen the downside risk during periods of market crisis relative to conventional mutual funds. Thus, our tests show that ethical funds absorbed more volatility created by the broad equity market during the global financial crisis. These funds also provide an acceptable form of market stabilization, regardless of the region, though the greatest benefits were in the Asia-Pacific and U.S.. The test results from the crisis period reject H1 since all ethical funds generate greater volatility than conventional benchmarks.

Table 3. Ethical Fund Volatility: Crisis Period

	Number of Funds	Ethical Fund Volatility	Index Volatility	Percentage Difference
U.S. Equity Ethical Funds				
EGARCH Fitted Mean Volatility	126	30.88	39.91	-22.62%***
Simple Estimated Mean Volatility	126	30.39	38.30	-20.65%***
Europe Equity Ethical Funds				
EGARCH Fitted Mean Volatility	388	32.65	33.69	-3.09%***
Simple Estimated Mean Volatility	388	32.14	33.79	-4.89%***
Asia-Pacific Equity Ethical Funds				
EGARCH Fitted Mean Volatility	88	32.36	38.97	-16.98%***
Simple Estimated Mean Volatility	88	33.18	39.03	-17.55%***
Global Equity Ethical Funds				
EGARCH Fitted Mean Volatility	512	29.67	30.72	-3.42%***
Simple Estimated Mean Volatility	512	29.29	29.99	-2.33%***

\*\*\* denotes 0.01 significance level of t-statistics; this table reports the sample sizes and volatilities of the regional and global ethical funds during the Crisis period, December 1, 2007 – June 30, 2009. In addition, we present two volatility measures, EGARCH fitted mean and simple estimated mean, for the ethical funds and their respective equity benchmarks. The table also reports the percentage difference in volatilities and their statistical significance.

The post-crisis period reveals a reversal in volatility patterns among ethical funds and their conventional benchmarks. Table 4 shows that all ethical funds generated greater volatility than their respective benchmarks during the recovery period, even though they exhibited relatively lower volatility values throughout the financial crisis. The U.S. market generates the smallest difference between the ethical fund and benchmark volatility; the U.S. ethical fund volatility exceeded their conventional benchmark by slightly more than 1% (Simple Estimated Mean: 17.19 versus 16.99). The largest difference occurs in the European region, where its ethical fund volatility exceeds its equity benchmarks by 69.51% (EGARCH fitted mean: 20.06 versus 17014). Our findings align with Leite and Cortez (2015), focusing on French SRI funds during crisis and non-crisis periods. The results show that ethical funds lag their broader-based conventional benchmarks in recovering from the global market turmoil across all geographical regions and with globally focused funds. We also provide results consistent with those of Mansor *et al.* (2019), which document that ethically based Islamic funds outperform conventional

funds in Malaysia and that their performance is more persistent in the pre-crisis periods of the Asian and global financial crises.

Table 4. Ethical Fund Volatility: Post-Crisis Period

	Number of Funds	Ethical Fund Volatility	Index Volatility	Percentage Difference
U.S. Equity Ethical Funds				
EGARCH Fitted Mean Volatility	132	16.99	16.68	1.86%
Simple Estimated Mean Volatility	132	17.19	16.99	1.15%
Europe Equity Ethical Funds				
EGARCH Fitted Mean Volatility	401	29.06	17.14	69.51%*
Simple Estimated Mean Volatility	401	22.59	17.41	29.81%***
Asia-Pacific Equity Ethical Funds				
EGARCH Fitted Mean Volatility	102	19.60	17.48	12.17%***
Simple Estimated Mean Volatility	102	19.76	17.58	12.39%***
Global Equity Ethical Funds				
EGARCH Fitted Mean Volatility	608	17.70	15.19	16.52%***
Simple Estimated Mean Volatility	608	17.89	15.35	16.51%***

\* denotes 0.10 significance level of t-statistics; \*\*\* denotes 0.01 significance level; this table reports the sample sizes and volatilities of the regional and global ethical funds during the Post-crisis period, July 1, 2009 – December 31, 2013. We present two volatility measures, EGARCH fitted mean and simple estimated mean, for the ethical funds and their respective equity benchmarks. The table also reports the percentage difference in volatilities and their statistical significance.

Our findings demonstrate that ethical funds underperform conventional funds in the recovery period after previously offering superior protection of downside risk to investors during the great financial crisis. These observations align with Hirshleifer (2008), who suggests that investors should pay closer attention to corporate behavior during financial crisis, an environment that would benefit ethical funds. These observations also align with Salganik-Shoshan (2017), who suggests that the flow patterns of institutional and retail funds vary across the business cycle. The findings suggest that institutional investors change behavior and do not strongly pursue returns during bad economic periods. In fact, investors of both fund types tend to punish managers with higher market exposure. Yet, Nofsinger and Varma (2014) also find that ethical funds underperform for their investors during non-crisis periods, reflecting their non-systematic risk from limiting the portfolio sample.

In Table 4, the ethical funds consistently generate higher volatility than their respective benchmarks during the post-crisis period. The values of the volatility of the U.S. funds are closest to those of their conventional benchmarks, which may suggest a maturing of these ethical funds within the investment community. The European ethical funds and their benchmarks experienced lower drops in volatility from the crisis period than all other groups of funds in our sample. Additionally, European ethical funds generate the greatest volatility values of all ethical funds and offer the greatest disparity in volatility with their benchmark, reflecting an inability to absorb continued market gyrations from the European debt crisis that emerged when the global financial crisis ended. This underperformance of European ethical funds may reflect the constraints imposed upon their construction through screenings that reflect existing systematic risk. The global index benchmarks produce the lowest volatility measures, which suggests the

benefits of greater diversification are found within a cross-boundary portfolio. Overall, investors in ethical funds experience significantly greater volatility than more fully diversified investors in the post-crisis period. Our findings from the post-crisis period do not reject H1 since no ethical fund generates significantly lower volatility than its conventional benchmarks. Yet our overall results provide sufficient evidence to reject the first hypothesis.

Studies conducted by Bollen (2007), Benson and Humphrey (2008), and Renneboog *et al.* (2008, 2011) find evidence that investors in ethical funds differ in behavior from those of conventional investors, partly because they focus more on the “ethical” component of their investments that may diminish the role of return performance. Renneboog *et al.* (2008, 2011) also observe that ethically based money flows in all market regions demonstrate less sensitivity to past negative returns than conventional fund flows. These findings reveal that investment decisions of ethical-fund investors incorporate nonfinancial attributes, which could distort the typical risk-return relation. Yet a later study by Parida and Wang (2018) provides evidence that investment flows into mutual funds with higher ethical holdings while lagged funds flow with more conventional holdings during the pre-financial crisis period. This pattern reversed during the financial crisis, with ethical funds receiving greater investment flows. The authors argue that these findings reflect a “flight to quality” as investors perceive funds with high ethical ratings to be relatively more trustworthy or of higher quality, especially during a period of negative shocks to overall social trust in financial markets and institutions. Significantly, Parida and Wang (2018) also reveal that flow intensity into ethical funds diminished relatively more conventional funds during the post-financial crisis period. Such a reduction of fund flow to ethical funds would increase the relative volatility of these funds during this recovery period, as substantiated in our study.

Our results align with those of Jiang and Yüksel (2019), who identify changes in fund flows driven by mutual fund investor sentiment, reflecting subjective views of market conditions. Consistent with Frazzini and Lamont (2008) and Chiu and Zhu (2017), the authors observe greater participation of investors of retail equity funds when sentiment is high, with the flows increasing especially to smaller or growth-oriented funds. Additionally, institutional investors demonstrate less sensitivity to sentiment variations in their trading patterns.

The end of the 2008 global financial crisis witnessed a steep decline in volatility among financial securities, reflecting a period of lower risk for investors. Yet, a comparison of volatilities in Tables 3 and 4 reveals that the volatility values of all ethical funds did not decline as sharply as their conventional benchmarks. Thus, all regionally and globally focused ethical funds generated greater volatility than their conventional benchmarks during the recovery period. The U.S. ethical funds experienced the steepest drop in volatility among all ethical funds from its crisis period high with a decline of 45% (EGARCH fitted mean: 30.88 versus 16.99). The smallest decline occurred with European-based ethical funds that fell only 11% (EGARCH fitted mean: 29.06 versus

32.65), though this period includes the European debt crisis. Among the conventional benchmarks covered in this study, we observe that the volatility of the U.S. equity benchmark fell the most at 58% (EGARCH fitted mean: 16.68 versus 39.91), while the smallest decline occurred with the European equity benchmark at 48% (simple estimated mean: 17.41 versus 33.79). Our findings are partially consistent with those of Leite and Cortez (2015), who find that French SRI funds match the performance of their conventional peers during market crises yet underperform in non-crisis periods. Conversely, our overall findings differ from Wu *et al.* (2017), who observe that a British SRI portfolio recovers its values more quickly after economic turmoil than its conventional peer. Our study focuses on the performance of many ethical funds with different regional and global emphases.

The post-crisis period should reflect a market that reverts to more commonly held patterns after the disruptions of the global financial crisis. Yet values of volatility among all ethical funds stabilize at levels consistently greater during the post-crisis period than what occurred prior to the financial crisis. The U.S.-based ethical funds exhibit the smallest increases in volatility from the pre-crisis period with an increase of 3% (estimated median: 16.74 versus 16.18), and these funds exhibit patterns similar to their U.S. equity benchmarks. The European-based ethical funds show higher levels of volatility relative to the pre-crisis period, while their conventional benchmark experiences a decline in volatility relative to their pre-crisis levels. The heightened volatility may reflect the impact of the European debt crisis that impacted the financial markets of this region. The Asia-Pacific and Global ethical funds also show slightly higher volatilities than their pre-crisis period performances. Overall, the benchmarks show mixed results. The U.S. and Global counterparts provided greater volatility in the post-crisis period, while the European and Asia-Pacific benchmarks experienced comparatively lower volatility in the post-crisis period. Yet all ethical funds in the crisis period demonstrate persistence in volatility that none of the equity index benchmarks displays. Our findings of volatility persistence in all ethical funds are comparable to those of Sabbaghi (2011), who finds strong evidence of persistence in volatility in a sample of green exchange-traded funds. We also consider Beaumont *et al.* (2008) who argue that investor sentiment plays a role in explaining the stock returns, and the noise traders who carry high sentiment follow bad market timing. This sentiment rationale may help explain the high volatility of the ethical funds relative to their benchmarks during the post-crisis period.

Our tests on the volatility of ethical funds and their respective benchmarks across an entire business cycle highlight the relative abilities of these ethical funds to absorb downside risk for their investors. While our empirical tests rely on a sample of ethical funds larger than similar studies, the results do not support H1 across the business cycle. This study reveals that values of volatilities of ethical funds are lower than those of their respective conventional benchmarks during the pre-crisis and global financial crisis subperiods. The constraints imposed with positive and negative screening, combined



with a limited asset pool, do not appear to expose investors of ethical funds to unnecessary downside risk. This pattern reverses during the post-crisis period when the volatilities of ethical funds exceed those of their benchmarks. Test results show that ethical funds do not experience significant volatility declines as we observe in their conventional benchmarks during the post-crisis period. The empirical results in the recovery period lead to a rejection of H1, while the overall empirical results emphasize inconsistent findings that have long characterized research into ethical funds.

## Fund Performance

Our previous tests focus on volatility measures to assess the downside risk exposure facing investors of ethical funds from positive and negative screening. We also conduct tests of risk-adjusted returns on the ethical funds and their conventional benchmarks to measure how much risk exposure occurs to generate the returns. This test provides a simple measure of relative risk-adjusted performances of the ethical funds across an entire business cycle. We present the Sharpe ratio as

$$Sharpe = \frac{R_p - R_f}{\sigma_p} \quad (1)$$

where  $R_p$  represents the annualized average daily log portfolio return,  $R_f$  the risk-free rate from the annualized average monthly T-bill rates, and  $\sigma_p$  is the annualized standard deviation of the daily log portfolio returns.

Table 5 shows the Sharpe ratios of the ethical funds and their conventional benchmarks across the three sub-periods and presents the percentage differences between the ratios. Our prior results on volatility suggest that ethical funds may offer investors superior protection from downside risk for the first two sub-periods while also providing a socially responsible investment option according to their sentiments. However, our risk-adjusted results show that three of our ethical funds outperform their respective benchmarks only in the pre-crisis period, while the U.S.-based ethical funds do not generate significantly superior performance. Our tests suggest that only during this expansionary period do the ethical funds outperform their conventional benchmarks. Our findings from the global and regionally oriented ethical funds in the post-crisis concur with the study of British funds by Wu *et al.* (2017). The Asia-Pacific ethical funds provide the only example where ethical funds outperform their benchmarks during the post-crisis period. But our overall findings show that ethical funds underperform their benchmarks during and after the financial crisis. Thus, these funds offer fewer desirable options for investors from a performance perspective.

**Table 5. Sharpe Ratio Comparison: Ethical Funds and Benchmarks**

	Number of Funds	Ethical Fund Sharpe Ratio	Index Sharpe Ratio	Percentage Difference
U.S. Equity Ethical Funds				
Pre-crisis	136	-0.01	-0.05	79.14%
Crisis	126	-0.93	-0.82	-13.75%**
Post-crisis	132	0.83	0.9	-8.41%**
Europe Equity Ethical Funds				
Pre-crisis	337	0.57	-0.12	566.36%**
Crisis	388	-1.24	-1.14	-9.36%**
Post-crisis	401	0.43	0.58	-26.17%**
Asia-Pacific Equity Ethical Funds				
Pre-crisis	63	0.71	0.09	680.3%**
Crisis	88	-0.87	-0.76	-14.82%**
Post-crisis	102	0.44	0.35	25.38%**
Global Equity Ethical Funds				
Pre-crisis	319	0.47	0.23	100.39%**
Crisis	511	-1.09	-1.07	-1.54%
Post-crisis	608	0.46	0.7	-33.97%**

\*\* denotes 0.05 significance level of t-statistics; This table reports the sample sizes and Sharpe ratios of the regional and global ethical funds and their equity benchmarks across all subperiods. The table also reports the percentage difference in Sharpe ratios and their statistical significance.

While the ethical funds have the feasibility of utilizing hedging tools and techniques to suppress volatility, the extra costs of applying the constraints to portfolio construction and then risk management should decrease the net return of the funds by increasing their expense ratios. Before the 2008 global financial crisis, the market sentiment remains positive with lower turnovers. The consistently positive equity returns consolidate investor expectations on the foreseeable returns, increasing the fund’s demand. However, investor sentiment remains largely anemic after the financial crisis since investors do not agree on the end of the global crisis that was complicated by the emergence of the Eurozone debt crisis. As Parida and Wang (2018) observe, investors shifted their capital flows to conventional funds after the global crisis, increasing their volatility of ethical funds. The consequences of the investment constraints and changes of investment sentiment would likely reduce the risk premium or increase volatility, resulting in lower Sharpe ratios for ethical funds.

## Conclusions

This study investigates the volatility of ethical funds in different regional financial markets over a business cycle that includes the 2008 global financial crisis. The volatility patterns across three subperiods may also reflect changes in investor sentiment regarding ethical funds. In the pre-crisis period, the regionally-based ethical funds provided

investors with lower risk options, and this role strengthened during the crisis period when all the ethical funds played the role of portfolio risk hedger. Our results show a shift in volatility patterns and investor sentiment during the post-financial crisis period when ethical funds underperform their conventional alternatives.

The finding that ethical funds outperform their conventional benchmarks only in one subperiod (see Table 5) conforms to the inconsistent findings of studies related to ethical-fund performance. Wu *et al.* (2017) suggest these inconsistencies that span decades may be caused by methodological assumptions. The sample used in this study comprises a much larger group of ethical funds and includes a longer period for the pre-crisis period than similar studies. Yet, Wu *et al.* (2017) observe that the firms' internal organizational factors of these funds may affect the findings, with the most common organizational changes including mergers, acquisitions, divestments, management buyouts, and restructuring. Our findings in Table 5 reject H2, which anticipates ethical funds maintaining comparable risk-return performances throughout the business cycle. The constraints imposed in the construction of the ethical funds do not expose investors to excessive downside risk during the crisis period, nor does the ethical fund volatility increase more than the benchmarks at that time. While the ethical funds experience lower volatility during the recovery period, their volatility does not decline as much as their benchmarks, which coincides with lackluster investor sentiment. Thus, in the post-crisis period, investors of ethical funds experience lower declines in volatility from the prior sub-period and maintain greater risk exposure for investors.

Our conclusions indicate a few caveats for the investment management industry and investors at large. The buy-side pursues quality assets during a market-stress period, and the limited initial interest warrants lower volatility. However, after a new financial instrument or asset is introduced to the market, growing fund inflows increase its volatility and compromise its attractiveness. The findings of our paper pertain to a broader meaning than ethical funds. We reasonably believe that the increasing volatility phenomenon pertains to other newly introduced assets, as Parida and Wang (2018) suggested that funds flowing into ethical funds after the global financial crisis would impact volatility patterns.

Our research contributes to the greater understanding of ethical funds by focusing on the risk side of performance instead of the more common emphasis on returns. We also greatly expand the breadth and depth of analysis with our sample of regionally based and globally focused funds. Our study finds consistent volatility behavior among regionally-based ethical funds relative to their conventional benchmarks. Importantly, this consistent pattern holds across the entire sample period. In addition, we find that the performance in volatility of ethical funds relative to their benchmarks changed after the 2008 global financial crisis. As a result, these funds no longer offer investors superior risk hedging benefits relative to their conventional benchmarks, which corresponds to a shift in investor sentiment.

The second feature should draw attention from researchers and practitioners. The source of the recent volatility inflation needs to be identified from the theoretical perspective, and more detailed ethical fund products need to be developed, tested, and implemented from the practical perspective. As the size of the net asset values of ethical funds in the global equity market grows, a universal tag of an ethical asset does not serve the demand of multi-dimensional return and risk profiles well. One possible trend of the ethical-fund industry is to sub-categorize the funds by sector, industry, dividend profile, and other common attributes of the equities. The specialization of ethical funds also assists the process of identifying the source of excess return and volatility.

Additionally, a meaningful exploration would be the cross-sectional estimation of ethical funds to examine the existence of an ethical premium, which would be a possible new risk factor. If the risk loading of such a factor were stable and significant, then the excessive intercept of the regression would help future studies separately identify the excessive returns created by the skill of the ethical fund managers versus returns associated with positive attributes of ethical assets within the funds.

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## **Appendix A: The EGARCH Model**

Analyzing time series of financial data often presents specific characteristics that modeling must attempt to accommodate, such as leptokurtic distributions (fat tails) and



asymmetric reactions to shocks. This study employs the EGARCH<sup>1</sup> model to estimate fund volatility given the characteristics within the financial data (Bollerslev *et al.*, 1992). In addition, Ederington and Guan (2010) suggest that the EGARCH model fits a wide variety of markets and forecast horizons and tends to have a longer memory than GARCH.<sup>2</sup>

The EGARCH (1,1) model uses the form:

$$\ln(v_{t+1}) = \alpha_0 + \beta \ln(v_t) + \gamma_1 |r_t/\sigma_t| + \gamma_2 (r_t/\sigma_t) \quad (1)$$

where  $r_t$  is the excess log return (i.e.,  $r_t = R_t - E_{t-1}(R_t)$ , where  $R_t = \ln(P_t/P_{t-1})$  and  $P_t$  is the net asset value of a fund at time  $t$ , and  $v_t$  is the expected variance of  $r_t$ .<sup>3</sup> Consistent with Ederington and Guan (2010), this paper defines the integrated volatility  $V_{t+s}$  as the geometric average of volatilities from  $t + 1$  to  $t + s$ , and the logarithmic integrated volatility is

$$\ln(V_{t+s}) = \left(\frac{1}{s}\right) \sum_{k=1}^s \ln(v_{t+k}) = \lambda_{1s} + \lambda_{2s} \sum_{j=0}^J \beta^j |r_{t-j}/\sigma_{t-j}| + \lambda_{3s} \sum_{j=0}^J \beta^j (r_{t-j}/\sigma_{t-j}) \quad (2)$$

The implied  $\lambda$  parameters are

$$\lambda_{1s} = \left(\frac{1}{s}\right) \sum_{k=1}^s [(\alpha + \gamma_1 \sqrt{2/\pi}) \sum_{j=0}^{k-2} \beta^j + \alpha' \beta^{k-1}] \quad (3)$$

$$\lambda_{2s} = \left(\frac{\gamma_1}{s}\right) \sum_{k=1}^s \beta^{k-1} \quad (4)$$

$$\lambda_{3s} = \left(\frac{\gamma_2}{s}\right) \sum_{k=1}^s \beta^{k-1} \quad (5)$$

We calculate volatility at both the mean and the median levels and use the latter as a robustness check of our conclusion. We find no systematic pattern of volatility bias in the different financial markets nor during the three sub-periods. Furthermore, test results show that the mean volatilities are symmetrically distributed around the median volatilities, though our paper presents only mean results.

<sup>1</sup> Like GARCH, EGARCH is used to model financial time series that exhibit time-varying volatility and volatility clustering. The EGARCH is an improved form of GARCH because it better captures the volatility asymmetry in which negative shocks (events, news, and so on) tend to impact volatility more than positive shocks.

<sup>2</sup> Ederington and Guan (2005) observe that the GARCH (1,1) model generally produces greater accuracy than the historical standard deviation and exponentially weighted moving average models. However, their study finds no overwhelming advantage between GARCH and EGARCH.

<sup>3</sup>For example, over the pre-crisis period, the parameters of the EGARCH estimation for the S&P 500 index are:  $\alpha_0 = -0.1372$ ;  $\beta = 0.9854$ ,  $\gamma_1 = 0.0641$ ,  $\gamma_2 = -1.7051$ .

## Appendix B: The Wavelet Method

We examine the impact of investor sentiment on fund volatility behavior and use the wavelet approach to transform the time domain series of sentiment into the time-frequency domain (See Chaudhuri and Lo, 2019.). This process allows us to examine investor sentiment across our sample period and detect significant changes, particularly if a time-varying lead-lag relation exists, as emphasized in Alzahrani *et al.* (2014) and Chaudhuri and Lo (2019), and identify appropriate structural breaks in the data.<sup>4</sup>

The transformation function of the mother Morlet wavelet is

$$\psi(t) = \pi^{-1/4} e^{i\omega t} e^{-t^2/2} \quad (6)$$

where  $\psi(t)$  is the transfer operator, and  $t$  is the time scale of the time series variables.

The angular frequency  $\omega$  is 6, and the measurement period is  $\pi/3$ . This wavelet transforms an asset return  $r_t$  and sentiment  $sent_t$  in the time domain to a set of wavelets with different time  $\tau$  and scale  $s$ :

$$Wave.r(\tau, s) = \sum_t r_t \frac{1}{\sqrt{s}} \psi^* \left( \frac{t-\tau}{s} \right) \quad (7)$$

$$Wave.sent(\tau, s) = \sum_t sent_t \frac{1}{\sqrt{s}} \psi^* \left( \frac{t-\tau}{s} \right) \quad (8)$$

where  $\tau$  is the shift variable and  $s$  is the control variable of frequency. The square of the amplitude is the wavelet energy density of a time series. We adopt the wavelet power spectrum in this study; it demonstrates the density of return and investor sentiment under investigation at multiple frequency levels on the time axis. We calculate the power spectrum as:

$$Power(\tau, s) = \frac{1}{s} \cdot |Wave(\tau, s)|^2 \quad (9)$$

We measure the co-movement between investor sentiment and the asset return in time and frequency domains using the wavelet power spectrum in Eq. (9), which remains between 0 and 1. A higher value reflects a stronger co-movement, with the synergy between the two values strengthening as the value increases. Thus, we can identify those periods where investor sentiment moves together with returns in the time and frequency domains by observing the period and frequency spectrum.

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<sup>4</sup> Appendix C provides details for our designation of these subperiods.

## **Appendix C: Time Periods**

Our study focuses upon the 2008 global financial crisis without isolating the 2001 tech bubble crisis in our review for reasons besides not being supported by the Morlet wavelet analysis. First, according to Bernstein (2014), the dot com bubble centers upon losses in equity investments. Equity speculation occurs primarily in the U.S., where most of the stock market wealth accrues to the top 10%, with more than 30% owned by the top 1% of household income shareholders. Thus, the dot com crisis does not introduce an overwhelming contractionary cycle. The outflow from the high-tech company shares remains a consistent investment preference in the ESG shares within the commonly accepted range of market correction rather than a crisis. We observe such investment behavior with the moderate drop of the Dow Jones Industrial Average. The Dow lost 6.17%, 5.35%, and 16.76% of its value in 2000, 2001, and 2002, while the Nasdaq Composite Index lost 39.28%, 21.05%, and 31.53% during the period of the global financial crisis in our study.

Additionally, the 2008 financial crisis leads to an outflow of capital from the financial markets due to the weakening operating cash inflows of institutional investors. This outflow of capital does not proportionately reduce the performance of assets across various asset classes. Instead, it skews the risk preference and redevelops the priorities of strategic portfolio allocation. Hall (2013) explains that the difference between the 2001 dot com bubble and the 2008 financial crisis resides most clearly in their different impacts on the U.S. financial system. In 2001, the value of business asset valuation fell dramatically, particularly in tech-related industries, but the financial system, while volatile, showed no signs of fundamental stress. A second difference between the dot com and global financial crises revolves around high-frequency trading strategies and algorithm implementations that increasingly impact the equity market's volatility. At the time of the dot com bubble, technological limits greatly reduce the effect of such trades. However, high-frequency trading strategies are pervasive by the time of the 2008 financial crisis. As a result, the volatilities of the two periods, the first being fear-driven and the second being order-driven, are less comparable because of such technical and institutional developments.

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