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Water and traditional asset classes

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ABSTRACT

Data from the most representative water exchange-traded index funds (ETFs) at the worldwide level has been selected to analyze their role in the performance of portfolios that follow the main US and European stock, bond and volatility benchmarks. The empirical analysis has been performed using cross- correlation analysis and Quantile Regression methodology. Our results indicate that water assets can play the roles of diversifier, hedge and safe haven for equity, fixed income and volatility indices, respectively.

Introduction

Water is one of most coveted and widely used natural resources in the world. Concern about possible future water scarcity was one of the reasons for the creation, in the early 2000s, of two water indices: the Palisades Water Index (ZWI) and the World Water Index (WOWAX). These stock market indices were composed of the world's largest corporations in the water sector. Since then, various stock market indices have been designed to track the performance of companies operating in the water sector in general, including both water utilities and infrastructure companies and water equipment and materials companies around the world (NASDAQ OMX Global Water Index) or in the US water sector (ISE Water Index, NASDAQ OMX US Water Index and S&P Global Water Index).

As the United Nations states, water is at the core of sustainable development and is critical for socioeconomic development, energy and food production, healthy ecosystems and for human survival itself.[1] Globally, one in ten people lack access to safe water while one in three do not have access to improved sanitation (see OECD, 2016), and half the world's population is already experiencing severe water scarcity at least one month a year (see United Nations, 2019). To address this situation, the World Bank launched a new Strategic Action Plan on water in 2019. Although the World Bank Group is the largest single investor in water projects (see World Bank, 2019), global financing needs for water infrastructure are significant and growing rapidly.[2]

Given that water is a critical resource for growth and considering the potential imbalance between its supply and demand, investing in water assets could be an appealing way to gain broad exposure to economic activity. Hence the interest in the ability of water-related

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[1] See https://www.un.org/en/global-issues/water (last accessed on 29 August 2022).

[2] The OECD projects that global water demand will increase by 55% between 2000 and 2050, fuelled by manufacturing, electricity generation, and domestic uses. Other pressures relate to declining water quality, especially outside the OECD, driven by nutrient flows from agriculture and poorly treated wastewater (see OECD, 2016).

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assets to serve as diversifiers, hedges or safe-haven assets. However, the financial literature on this topic is sparce. Geman and Kanyinda (2007) were the first to draw attention to the uniqueness of water as a new asset class. Since then, several papers have analysed the profitability of water-related investments and their diversification benefits in a portfolio context, with conflicting evidence. On the one hand, Gilroy et al. (2013) observed that the inclusion of water as an asset in a traditional portfolio consisting of stocks and bonds did not lead to better risk-adjusted returns. Further evidence in this line is provided by Alvarez and Rodriguez (2015), who found that their sample of open- end water-related mutual funds neither outperforms nor underperforms the benchmarks they had considered. On the other hand, Rompotis (2016) concluded that, although risk-adjusted returns of water ETFs do not outperform the equity benchmarks, their performance can be regarded as satisfactory for a socially responsible investor. Finally, Jin et al. (2015) and Samitas et al. (2022) conclude that the WOWAX index and the Pictet Water fund, respectively, have the ability to produce diversification effects in traditional portfolios.[3]

The purpose of this paper is to study the role that water-related exchange-traded funds (henceforth ETFs) can play in portfolios that follow the major US and European benchmarks in equity and fixed income markets. To the best of our knowledge, no previous study has analysed the attractiveness of water-related ETFs for investors by assessing their hedging and diversifying properties and the role of such assets as a safe haven against movements of the main international benchmarks.

Data

This study uses daily data from 13 June 2007 to 8 December 2020. Data on water-related ETFs were obtained from Yahoo (https://finance.yahoo.com/) while data for international benchmarks were obtained from Bloomberg (https://data.bloomberg.com/).

Among the available water ETFs, Table 1 presents the four ETFs selected: Invesco Water Resources (PHO), Invesco S&P Global Water Index (CGW), First Trust ISE Water Index Fund (FIW) and Invesco Global Water (PIO). Although there are more tradable water-related ETFs, these four are widely considered the most representative given their high trading volume and liquidity.[4]

Fig. 1 shows the evolution of the prices of the four ETFs. It displays similar patterns and fluctuations. Generally, all the ETF prices start to rise and peak in the summer of 2008, before falling sharply at the end of 2019. At a glance, it reveals an overall upward trend for all ETFs. After the global economic downturn (2007–2009), all ETF prices leveled off around $20 until 2011. Since then, they have separated into four similarly shaped trajectories, with FIW prices being the highest and PIO prices the lowest. Since 2016, prices have risen steadily to reach a peak in 2020.

For the second group of variables, six benchmarks widely followed by financial investors have been selected. These references are the MSCI North America Index (MSCINA) and the MSCI Europe Index (MSCIEU), as benchmarks for equity markets. The former measures the performance of the large and mid-cap segments of the US and Canada markets, while the latter captures large and mid-cap representation across 15 developed market countries in Europe. The IBOXX USD Corporates AAA Index (IBOXXNA) and the IBOXX EURO Corporates AAA Index (IBOXXEU) have been selected as references for the fixed income markets. Both indices are designed to reflect the performance of bonds denominated in USD and euros issued by AAA-rated companies. Finally, regarding volatility benchmarks, the Euro STOXX 50 Volatility Index (VSTOXX) and the S&P 500 Volatility Index (VIX) have been chosen. The VIX (VSTOXX) measures the implied volatility in the USA market (Eurozone) and is based on the S&P 500 (Euro STOXX 50) Index Options with a rolling 30-day maturity.

Methodology

The relationship between ETF returns and US and European benchmarks is analysed using the Quantile Regression (QR) methodology introduced by Koenker and Bassett (1978). Ordinary Least Squares (OLS) models estimate the relationships between the dependent and independent variables based on the conditional mean of the dependent variable. However, focusing exclusively on changes in the means may underestimate, overestimate, or fail to distinguish real nonzero changes, particularly when heterogeneity in the sample is significant (see Cade et al., 1999) and/or the relationships between variables differ across various market conditions (see Baur 2013). The use of QR estimates in linear models with unequal variances will allow us to detect effects associated with variables that might have been dismissed as statistically indistinguishable from zero based on estimates of measures of central tendency (see Terrell et al., 1996). Compared to OLS regression, QR methodology estimates multiple rates of change (slopes) from the minimum to maximum response, providing a more complete picture of the relationships between variables (see Cade and Noon, 2003).

Therefore, in our context, QR can provide information on the effects of the main benchmarks on ETF returns in specific market conditions, such as bullish (upper quantiles), bearish (lower quantiles) or normal (intermediate quantiles). Moreover, QR estimators are robust to outliers, heavy tail distributions and heteroskedasticity of the dependent variable (see Koenker and Hallock, 2001).

QR is an extension of the standard regression, providing a more complete picture of a conditional distribution. It obtains the impacts of the independent variables throughout the conditional distribution of ETF returns. Specifically, the quantile regression

[3] Reza et al. (2021) provide a comprehensive review of research on private investment in the water sector that analyses and synthesises the existing literature, summarising 55 studies published from 1997 to 2020. They conclude that the investment options available in the water- sector and the inclusion of water as an asset class for long-term investment have steadily increased. Furthermore, they indicate that the water market appears to have reached a stage of maturity and economic resilience, making water investment options a mature asset class that can lead to decent pecuniary returns.

[4] Table 1 of the supplementary material presents the main characteristics of the four water-related ETFs.

Table 1
Descriptive statistics and correlations of the main water-related ETFs.

Panel A	PHO	CGW	FIW	PIO	Equality Tests
Mean	0.024	0.018	0.036	0.010	0.910
Median	0.055	0.080	0.095	0.084	0.828
Std. Dev.	1.611	1.430	1.546	1.501	0.000
Maximum	12.318	12.088	9.525	17.546	
Minimum	-12.954	-13.205	-12.281	-11.511	
Skewness	-0.401	-0.644	-0.682	-0.275	
Kurtosis	11.915	15.613	11.308	15.638	
JB statistic	11,343.58***	22,760.1***	10,036.36***	22,649.36***	
ADF statistic	-62.304***	-63.434***	-62.643***	-40.290***	
Observations	3,398	3,398	3,398	3,397	

Panel B	PHO	CGW	FIW
CGW	0.824***		
FIW	0.926***	0.831***	
PIO	0.801***	0.857***	0.773***

The column labelled Equality Tests presents the p-values of the Anova F-test, the Kruskal-Wallis test and the Levene test for the equality of means, medians, and variances between the series, respectively. The *** indicates the rejection of the null hypothesis at the 1% level.

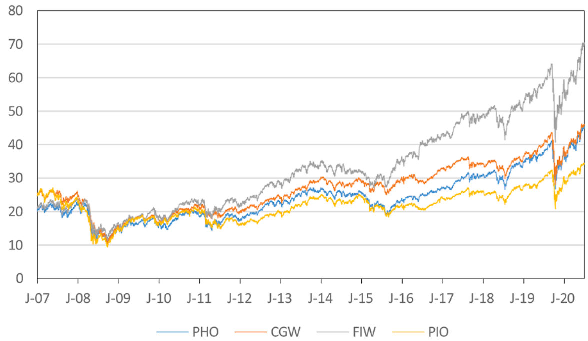

Fig. 1. Evolution of the price of the water-related ETFs
This figure shows the daily evolution of the prices of the water-related ETFs in US dollars. PHO, CGW, FIW and PIO are the four water-related ETFs described in the supplementary material. The sample period consists of data from 13 June 2007 to 8 December 2020.

model can be expressed as follows:

$$Q(\tau/x) = \{b / F_y(b/x \geq \tau)\} = \sum_k \beta_x(\tau) x_k = x_t{}' \beta(\tau) \tag{1}$$

where Q(τ/x) denotes the τ conditional quantile of y (ETF return), x is a vector of independent variables (benchmarks), and β(τ) represents the vector of the estimated coefficients at quantile τ.

Results

Given that the financial literature on this topic uses different definitions, it is necessary to clarify the concepts of hedge and diversifier employed in this study Following Baur and McDermott (2010), a weak (strong) hedge is an asset that is uncorrelated (negatively correlated) on average with another asset. A diversifier asset, according to Baur and Lucey (2010), is an asset that is positively, but not perfectly, correlated on average with another asset. Finally, Baur and McDermott (2010) define a weak (strong) safe haven as an asset that is uncorrelated (negatively correlated) with another asset or portfolio only in times of market stress or turmoil.

Preliminary results on ETFs

Panel A of Table 1 presents the descriptive statistics of the logarithmic returns of the water-related ETFs. All the series are negatively skewed and leptokurtic. The Jarque-Bera (JB) test statistic for normality clearly confirms the rejection of the null hypothesis for all series at the 1% level of significance. Furthermore, although the Augmented Dickey-Fuller (ADF) test statistic rejects the existence of a unit root in the ETF returns series, the underlying processes reported in Fig. 1 of the supplementary material available online, are quite volatile and heteroskedastic, where the volatility exhibits clustering and reversion to the mean. All these facts may lead to the inefficiency of estimators when only conditional mean functions are used to analyze the relationships between variables.

However, as mentioned, QR is robust to anomalous values in the dependent variable, so outliers have a limited impact on the estimates.

Given the non-normality of the series, the degree of association between the ETF variables has been measured by applying the Spearman rank correlation test. Panel B of Table 1 shows the results that confirm the high cross-correlation between all the water-related ETFs at the 1% level.

Preliminary results on the main benchmarks

Panel A of Table 2 illustrates the descriptive statistics of the US and European benchmarks. In all cases, Jarque-Bera tests confirm non-normality. Furthermore, the ADF test statistics reject the existence of a unit root in the equity and fixed income return series and in the original implied volatility indices.[5]

Panel B of Table 2 presents the Spearman cross-correlation coefficients between the main benchmarks and each of the water-related ETFs. All the ETFs exhibit similar results, and this preliminary analysis indicates that water-related ETFs and stock indices are positively correlated and, in consequence, water assets could serve as diversifier assets for portfolios that follow North American and European MSCI indices. Furthermore, the ETFs and volatility indices are negatively correlated and could therefore act as strong hedges for European and US volatility benchmarks. Finally, it is interesting to note the changing role of water ETFs when they are combined with AAA corporate investments in the US or in Europe. In the first case they seem to act as strong hedges (negative correlation), while in the second case they could be considered as diversifiers (positive correlation).

The cross-correlation coefficients between the US and EU equity indices and between the US and European volatility benchmarks are 89% and 63%, respectively. Due to these high correlations, and to avoid potential multicollinearity problems, two versions of Eq. 1 have been estimated, one for the US benchmarks and another for the European references:

$$\mathrm{ETF}_{it} = \beta_0 + \beta_1\ \mathrm{MSCINA}_{it} + \beta_2\ \mathrm{IBOXXNA}_{it} + \beta_3\ \mathrm{VIX}_{it} + \mathrm{u}_{it} \tag{2}$$

$$\mathrm{ETF}_{it} = \beta_0 + \beta_1\ \mathrm{MSCIEU}_{it} + \beta_2\ \mathrm{IBOXXEU}_{it} + \beta_3 \mathrm{VSTOXX}_{it} + \mathrm{u}_{it} \tag{3}$$

Quantile regressions

Table 3 presents the coefficients of the estimates and their statistical significance for the US benchmarks from the OLS regression model and the QR models for each ETF and for nine quantiles of the distribution of ETF returns ranging from 0.1 to 0.9 according to Eq. 2. As can be seen in Table 3, the explanatory power of all the QR models ranges from 45% to 63%, with the highest in the lower quantiles.

The effect of the North American stock market, represented by the MSCI North American Index, is positive and significant at the 1% level and similar across all quantiles and ETFs, irrespective of the ETF investment region (international or USA). The Wald test rejects the null hypothesis that the coefficient of the MSCINA is equal to 1 in all the ETFs, except for the PIO in several quantiles, indicating that the correlation with the MSCI North American Index is positively, but not perfectly, correlated in the PHO, CGW and FIW. Therefore, these ETFs can be viewed as diversifiers for North American stock index portfolios.

The effects of the North American fixed income index and of US implied volatility on the ETFs are qualitatively similar in all the cases. The estimated coefficients for the intensity of these benchmarks on ETF returns are not homogeneous across different quantiles and therefore water-related ETFs can be considered neither as diversifiers nor as hedges for these references. Note that in the case of VIX the impact is significantly negative (positive) for the lower (upper) quantiles. Given that US volatility data are in levels, this result implies a positive relationship between US volatility and ETF returns in times of bullish markets, which turns negative when the water market is bearish.

Table 4 presents the estimation results for the OLS and QR models according to Eq. 3. The explanatory power of all the QR models ranges from 21% to 38% and the greatest explanatory power is also observed in the lowest quantiles. The effect of MSCIEU returns on the water ETF returns is positive and significant at the 1% level. Furthermore, Wald tests in all the panels is rejected at the 1% level, suggesting that all the water-related ETFs considered in this study can serve as diversifiers for EU stock portfolios.

With respect to the effect of the European fixed income index on ETFs, the relationship is negative and significant at conventional levels in 35 out of 36 cases. The behavior of this relationship is uniform for all ETFs across all quantiles considered. Furthermore, F-tests confirm a similar intensity of dependence regardless of the European fixed income market scenarios, suggesting that water-related ETFs can act as a strong hedge for movements in European fixed income markets. Finally, the median quantile results show an insignificant relationship between VSTOXX and ETFs. However, the findings for the rest of the quantiles are similar to those obtained for the VIX volatility, indicating a significant and positive (negative) effect for upper (lower) quantiles at conventional levels of significance.[6]

Finally, we have studied the safe-haven properties of water-related ETFs. Following Baur et al. (2021), we have estimated quantile regressions of each benchmark for each water ETF. Thus, it can be seen how extreme conditional quantiles of the benchmarks are

[5] If we compare both panels, we observe that all water assets outperform fixed income benchmarks and only FIW has a higher performance than stock indices.

[6] The quantile regressions have been also re-estimated by applying different methods and the results are qualitatively similar to those presented in the paper.

Table 2
Descriptive statistics of the main benchmarks and correlations with ETFs.

Panel A	MSCINA	IBOXXNA	VIX	MSCIEU	IBOXXEU	VSTOXX
Mean	0.026	0.005	20.195	-0.004	0.001	23.649
Median	0.071	0.020	17.290	0.041	0.017	21.800
Std. Dev.	1.321	2.534	9.845	1.458	0.588	9.636
Maximum	10.428	81.305	82.690	10.906	4.883	87.513
Minimum	-12.811	-81.088	9.140	-13.190	-3.289	10.678
Skewness	-0.651	0.064	2.342	-0.354	0.192	1.999
Kurtosis	15.780	844.735	10.412	12.070	7.905	9.221
JB statistic	23,363***	95,472,865***	10,885***	11,717***	3,364***	7,627***
ADF statistic	-66.286***	-30.536***	-4.676***	-57.623***	-54.062***	-6.018***
Observations	3,398	3,234	3,398	3,398	3,336	3,348

Panel B	MSCINA	IBOXXNA	VIX	MSCIEU	IBOXXEU	VSTOXX
PHO	0.906***	-0.038**	-0.124***	0.611***	0.111***	-0.081***
CGW	0.887***	-0.034*	-0.127***	0.656***	0.199***	-0.087***
FIW	0.895***	-0.032*	-0.126***	0.614***	0.116***	-0.081***
PIO	0.844***	-0.033*	-0.131***	0.665***	0.204***	-0.094***

The *** indicates rejection of the null hypothesis at the 1% level.

related to water ETFs. Table 5 shows the coefficient estimates and their statistical significance for the lowest conditional market return quantile (0.1) in the case of the stock and fixed income indices, and for the highest quantile (0.9) in the case of volatility indices. We have chosen these specific quantiles in order to capture extreme turbulent movements. The negative and significant coefficients present in the QR models of IBOXXNA, VIX and VSTOXX indicate that all water-related ETFs behave as a strong safe haven for these benchmarks.[7]

Conclusion

This study has analysed the ability of four water-related ETFs (PHO, CGW, FIW and PIO) to be considered as hedges, diversifiers and/or safe-haven investments for six US and European stock, bond and volatility benchmarks.

Our findings show that the sensitivity of water-related ETF returns to changes in international benchmarks is non-homogeneous across quantiles. The data presented here indicate that water-related ETFs can act as diversifiers in North American and European stock markets and can be considered as strong hedges for European fixed income markets. Furthermore, our results confirm the role of water-related ETFs as safe-haven investments for assets related to the North American fixed income index and for US and European volatility indices.

This study contributes to the literature on water-related assets by focusing on water ETFs and expanding the knowledge on the diversification and hedging properties of ETFs that invest in companies that process and distribute water. Furthermore, these findings should be of interest to portfolio managers who want to add water exposure to traditional stock and bond portfolios in US and European markets. The main limitation of this study is the small research sample. A study with a larger number of water-related ETFs would allow us to explore the differential properties of these ETFs compared to other environmentally responsible ETFs.

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CRediT authorship contribution statement

Ana Carmen Díaz-Mendoza: Methodology, Software, Data curation, Writing- Original draft preparation, Visualisation, Investigation, Supervision, Validation, Writing- Reviewing and Editing, Funding acquisition. **Ángel Pardo:** Conceptualisation, Methodology, Software, Writing- Original draft preparation, Visualisation, Investigation, Supervision, Validation, Writing- Reviewing and Editing, Project administration, Funding acquisition. Both authors have read and approved the final manuscript.

[7] Throughout the paper, some reasons have been suggested that, jointly or separately, may be responsible for the empirical results obtained. Specifically, these findings can be explained by different reasons: (i) we have considered water-related ETFs that have been designed to track the performance of companies operating in the water sector in the US, but also water-related ETFs for companies operating worldwide; (ii) investing in water assets is an attractive way to gain broad exposure to economic activity in different countries; and (iii) the relationships between water-related ETFs and traditional assets may differ in bullish or bearish markets.

Table 3
Quantile regressions of the determinants of water-related ETFs: US benchmarks
$ETF_{it} = \beta_0 + \beta_1 MSCINA_{it} + \beta_2 IBOXXNA_{it} + \beta_3 VIX_{it} + u_{it}$ (2).

Panel A: PHO	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCINA	1.1035***	1.1039***	1.1201***	1.1082***	1.1048***	1.0986***	1.1001***	1.1049***	1.1152***	1.0956***
IBOXXNA	0.0001	0.0114***	-0.0013	0.0037	0.0064***	0.0015	0.0027**	0.0027**	0.0013	-0.0009
VIX	0.0003	-0.0062***	-0.0043***	-0.0026***	-0.0009**	0.0003	0.0013***	0.0029***	0.0045***	0.0074***
Intercept	-0.0009	0.0104***	0.0076***	0.0043***	0.0012	-0.0008	-0.0024*	-0.0053***	-0.0082***	-0.0139***
R^2/Pseudo R^2	82.02	63.51	58.95	56.28	54.71	53.91	53.59	53.97	54.91	57.48
Wald test	25.107***	25.698***	31.530***	9.115***	32.880***	29.660***	46.871***	52.794***	46.883***	26.269***

Panel B: CGW	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCINA	0.9535***	0.9566***	0.9413***	0.9453***	0.9618***	0.9457***	0.9517***	0.9392***	0.9397***	0.9424***
IBOXXNA	0.0022	0.0096***	0.0049***	0.0061***	0.0074***	0.0041*	0.0031	0.0018	0.0006	0.0004
VIX	-0.0001	-0.0064***	-0.0042***	-0.0025***	-0.0013***	0.0006	0.0017***	0.0028***	0.0045***	0.0064***
Intercept	0.0002	0.0113***	0.0077***	0.0045***	0.0025**	-0.0016	-0.0037***	-0.0053***	-0.0084***	-0.0116***
R^2/Pseudo R^2	77.72	58.88	54.76	52.11	50.37	49.64	49.56	49.96	51.17	54.56
Wald test	6.276**	7.008***	10.967***	18.199***	6.420***	15.032***	12.764***	18.418***	18.571***	6.031**

Panel C: FIW	*OLS*	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCINA	1.0474***	1.0688***	1.0724***	1.0765***	1.0675***	1.0588***	1.0568***	1.0592***	1.0672***	1.0566***
IBOXXNA	0.0036**	-0.0055***	-0.0031*	0.0083***	0.0068***	0.0057**	0.0044*	0.0033***	0.0045***	-0.0000
VIX	0.0001	-0.0050***	-0.0036***	-0.0022***	-0.0011***	-0.0003	0.0010**	0.0025***	0.0037***	0.0059***
Intercept	-0.0001	0.0071***	0.0056***	0.0034**	0.0020**	0.0008	-0.0013	-0.0043***	-0.0059***	-0.0095***
R^2/Pseudo R^2	80.08	60.90	57.44	55.10	53.54	52.49	51.95	52.16	52.89	54.84
Wald test	7.720***	19.550***	30.899***	19.788***	28.211***	14.862***	13.467***	11.296***	14.578***	6.162**

Panel D: PIO	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCINA	0.9411***	0.9662***	0.9822***	0.9833***	0.9846***	0.9873***	0.9735***	0.9527***	0.9537***	0.9214***
IBOXXNA	0.0016	0.0041	0.0035*	0.0050**	0.0057***	0.0045*	0.0034	0.0021	0.0017	-0.0019
VIX	-0.0003	-0.0078***	-0.0041***	-0.0027***	-0.0015***	-0.0001	0.0011**	0.0030***	0.0050***	0.0068***
Intercept	0.0007	0.0142***	0.0067***	0.0045***	0.0027**	0.0002	-0.0018	-0.0055***	-0.0094***	-0.0119***
R^2/Pseudo R^2	71.16	54.61	50.43	47.96	46.51	45.57	45.07	45.05	45.87	47.46
Wald test	4.244**	2.207	0.517	0.839	0.791	0.749	2.846*	5.453**	5.818**	11.141***

This table shows the coefficients of the OLS regression and the quantile regressions for nine quantiles ranging from 0.10 to 0.90 according to Eq. 2 for each ETF as dependent variables and for US benchmarks as explanatory. R^2 and Pseudo R^2 are expressed in percentage for the OLS model and the QR model, respectively. The Wald test stands for the p-value of the F-statistic that is used to test if the coefficient of the benchmark for equities is equal to 1. The ***, ** and * indicate rejection of the null hypothesis at the 1%, 5% and 10% levels.

Table 4
Quantile regressions of the determinants of water-related ETFs: EU benchmarks
$ETF_{it} = \beta_0 + \beta_1 MSCIEU_{it} + \beta_2 IBOXXEU_{it} + \beta_3 VSTOXX_{it} + u_{it}$ (3).

Panel A: PHO	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCIEU	0.7448***	0.7631***	0.7302***	0.7147***	0.7221***	0.7197***	0.7247***	0.7073***	0.6874***	0.6700***
IBOXXEU	-0.4102***	-0.3445***	-0.3330***	-0.3390***	-0.3657***	-0.3607***	-0.3659***	-0.3222***	-0.3313***	-0.3880***
VSTOXX	0.0001	-0.0152***	-0.0100***	-0.0064***	-0.0029***	0.0000	0.0027***	0.0051***	0.0094***	0.0150***
Intercept	0.0001	0.0340***	0.0231***	0.0152***	0.0070***	0.0002	-0.0057**	-0.0106***	-0.0205***	-0.0332***
R^2/Pseudo R^2	40.08	34.47	27.93	24.77	23	22.01	21.53	22.13	23.61	27.68
Wald test	73.32***	36.30***	89.06***	130.63***	160.31***	180.89***	136.87***	112.09***	101.22***	142.77***

Panel B: CGW	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCIEU	0.6743***	0.6855***	0.6584***	0.6604***	0.6484***	0.6419***	0.6397***	0.6302***	0.6149***	0.6172***
IBOXXEU	-0.1579***	-0.1331***	-0.0612	-0.0778**	-0.0856***	-0.0737**	-0.0708**	-0.0798**	-0.0906**	-0.0939**
VSTOXX	0.0000	-0.0131***	-0.0088***	-0.0045***	-0.0023***	-0.0006	0.0021***	0.0045***	0.0076***	0.0121***
Intercept	0.0002	0.0301***	0.0208***	0.0107***	0.0057***	0.0023	-0.0042**	-0.0094***	-0.0167***	-0.0270***
R^2/Pseudo R^2	44.97	38.31	32.35	29.41	28.04	27.23	26.83	27.19	28.85	33.09
Wald test	177.82***	351.21***	249.09***	312.70***	573.47***	376.22***	258.12***	412.98***	315.66***	206.75***

Panel C: FIW	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCIEU	0.7143***	0.7709***	0.7372***	0.6961***	0.7006***	0.6694***	0.6693***	0.6610***	0.6485***	0.6746***
IBOXXEU	-0.3778***	-0.3036***	-0.3157***	-0.3124***	-0.3180***	-0.3334***	-0.3266***	-0.3458***	-0.3367***	-0.4024***
VSTOXX	0.0000	-0.0135***	-0.0085***	-0.0057***	-0.0024***	-0.0003	0.0026***	0.0047***	0.0086***	0.0135***
Intercept	0.0004	0.0289***	0.0186***	0.0132***	0.0059***	0.0015	-0.0050***	-0.0095***	-0.0183***	-0.0288***
R^2/Pseudo R^2	40.26	32.83	27.21	24.14	22.56	21.58	21.23	21.8	22.85	26.74
Wald test	93.77***	70.15***	121.19***	149.43***	256.52***	310.78***	251.17***	166.01***	154.02***	188.55***

Panel D: PIO	OLS	.1	.2	.3	.4	.5	.6	.7	.8	.9
MSCIEU	0.7145***	0.7114***	0.7090***	0.6856***	0.6655***	0.6739***	0.6620***	0.6688***	0.6636***	0.7011***
IBOXXEU	-0.1709***	-0.1267**	-0.0902***	-0.1020**	-0.1015**	-0.0896**	-0.0559	-0.1046***	-0.1171**	-0.1661***
VSTOXX	-0.0002	-0.0144***	-0.0089***	-0.0054***	-0.0027***	-0.0003	0.0020***	0.0040***	0.0076***	0.0125***
Intercept	0.0007	0.0332***	0.0206***	0.0129***	0.0069***	0.0013	-0.0038**	-0.0081***	-0.0164***	-0.0276***
R^2/Pseudo R^2	45.75	36.86	32.02	29.34	28.05	27.19	26.89	27.41	28.64	31.95
Wald test	116.94***	123.70***	198.79***	225.31***	260.06***	242.32***	287.40***	287.93***	234.11***	191.19***

This table shows the coefficients of the OLS regression and the quantile regressions for nine quantiles ranging from 0.10 to 0.90 according to Eq. 3 for each ETF as dependent variables and for EU benchmarks as explanatory variables. R^2 and Pseudo R^2 are expressed in percentage for the OLS model and the QR model, respectively. The Wald test stands for the p-value of the F-statistic that is used to test if the coefficient of the benchmark for equities is equal to 1. The ***, ** and * indicate rejection of the null hypothesis at the 1%, 5% and 10% levels.

Table 5
Quantile regressions and safe-haven properties of water-related ETFs.

	MSCINA	IBOXXNA	VIX	MSCIEU	IBOXXEU	VSTOXX
PHO	0.7499***	-0.0358***	-3.4213***	0.5935***	0.0570***	-2.3148***
CGW	0.8629***	-0.0261***	-3.9364***	0.7761***	0.0864***	-2.7000***
FIW	0.7696***	-0.0351***	-3.3676***	0.6009***	0.0585***	-2.2849***
PIO	0.7665***	-0.0296***	-3.0077***	0.6816***	0.0869***	-2.4325***

This table shows the coefficients of the quantile regressions for the quantiles 0.1 (MSCINA, IBOXXNA, MSCIEU and IBOXXEU) and 0.9 (VIX and VSTOXX) for each benchmark, as the dependent variable, and for each water-related ETF, as the explanatory variable. The ***, ** and * indicate rejection of the null hypothesis at the 1%, 5% and 10% levels.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Data availability

Data will be made available on request.

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Supplementary materials

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