Water and traditional asset classes

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Abstract: The present study analyses the role that water exchange traded index funds (ETFs) play in the performance of portfolios that follow the main US and European stock, bond and volatility benchmarks during the period 2007 to 2020. Data from the most representative water-related ETFs at the worldwide level has been selected: Invesco Water Resources (PHO), Invesco S&P Global Water Index (CGW), First Trust ISE Water Index Fund (FIW) and Invesco Global Water (PIO). The empirical analysis has been performed by using cross-correlation analysis and Quantile Regression methodology in a comparative way with Ordinary Least Squares. The results indicate that water-related assets can serve the roles of hedge, diversifier and safe haven for fixed income, equity and volatility-related assets, respectively. Specifically, water assets can be viewed as a strong hedge against movements in European fixed income markets and can act as a diversifier against movements in North American and European stock markets.

Keywords: Diversifier, ETFs, hedge, quantile regression, safe haven, water

JEL Classification: C53, G17

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1. Introduction

Water is one of most coveted and widely used natural resources in the world. Concerns about possible water shortages in the future were among the reasons behind the creation in the early 2000s of two water indices: the Palisades Water Index (ZWI) and the World Water Index (WOWAX). These indices were composed of the world's largest corporations in the water sector. Since then, various water indices have been designed to track the performance of companies worldwide that are creating products that conserve and purify water for homes, businesses and industries (NASDAQ OMX Global Water Index). Others such as the ISE Water Index, the NASDAQ OMX US Water Index and the S&P Global Water Index have been designed to track the performance of US exchange-listed companies that derive a substantial portion of their revenues from the potable water and wastewater industry, and to have a balanced global representation from different segments of the water industry, including water utilities, water infrastructure companies, and water equipment and materials companies.[1]

As stated by the World Bank, water is at the centre of economic and social development; it is vital to maintaining health, growing food, generating energy, managing the environment and creating jobs. According to OECD (2016), globally, one person in ten (663 million) lack access to safe water while one in three (2.4 billion) do not have access to improved sanitation. To deal with this situation, the World Bank launched in 2019 a new Strategic Action Plan on water

[1] There exist more water indices such as the S-Network Global Water index (S-Net), the S&P Global Water Index (S&P) and the MSCI ACWI Water Utilities Index (MSCI ACWI). Reza et al. (2017) studied the interdependence among these indices, including the WOWAX, using the vector autoregression (VAR) framework for the period 2004–2014. Their results indicated that water indices are interdependent and integrated. Nevertheless, they noticed that the level of integration among the indices was still relatively low, and water investors should be mindful when making investment decisions.

that is focused on sustaining water resources, achieving universal access to water supplies and sanitation, and building resilience to water shocks. Although the World Bank Group is the largest single investor in water projects globally and is responsible for a portfolio of about $30 billion through 170 projects (see WBG, 2019), global financing needs for water infrastructure are significant and increasing rapidly. Specifically, global estimates range from $6.7 trillion by 2030 to $22.6 trillion by 2050 (see OECD, 2016), which makes the water industry one of the largest in the world (see Jin et al., 2016).

It is important to underscore that there is a significant body of economic literature that clearly describes the negative consequences of the private financialisation of water, including inflated prices for consumers and denying the human right to water for those who cannot pay, the lack of investment in infrastructure, and enormous environmental damage, among other problems. Specifically, Bayliss (2014) considers that the financialisation of water has been successful in creating assets for the financial sector in wealthy countries, such as water-targeted investment funds or water-focused exchange trade funds, while it has failed to make a dent in the problem of under-resourced infrastructure in developing countries. As a result, the water companies have become financial assets for global private investment instead of operations for the delivery of equitable and affordable basic services. Allen and Pryke (2013) point out that behind the financialisation of water infrastructure for instance is not only the power to mobilise funds at a distance, but also the ability to securitise revenue streams in order to channel funds to investors, as well as refinance existing debts, a model that benefits investors more than customer households. Finally, Bayliss (2017), in a similar way, argues that revenue streams from customer water bills have become securitised for decades into the future not only to raise funds for investment, but also to finance distributions to shareholders, while the high costs of this model are passed on to customers.

Therefore, although it is not clear that the incorporation of water-related assets into the portfolios of investors allows portfolio managers to “do good” and “do well” at the same time, it is worth noting that taking environmental, social and governance (ESG) criteria into account when investing represents a growing portion of overall capital market investment (see Matos, 2020). It appears that the recent pandemic has given a new impetus to investments that consider the Sustainable Development Goals (SDGs), also known as the Global Goals, adopted by all United Nations Member States in 2015. Goal number 6 entitled “Clean water and sanitation” seeks to ensure universal availability and access to water, sanitation and hygiene services. The fact that investors are not only looking for an economic benefit but also for a possible social and responsible one has renewed the interest in investing in companies whose revenues are related to the price of water.

The purpose of this paper is to study the role that water-related assets can play in portfolios that follow the major US and European benchmarks in equity and fixed income markets. To carry out this study, four water exchange traded funds (henceforth ETFs) that track four different US and international water indices have been selected.[2] Specifically, the decision to work with water-related ETFs

[2] An ETF is a type of fund that holds multiple underlying assets, rather than only one like a stock does. The typology and volume traded by ETFs are constantly expanding. According to ETFGI, a leading independent research and consulting firm covering global exchange-traded products, the assets invested in these kinds of financial products listed globally has increased annually until reaching a new record of $7.62 trillion at the end of November 2020. See https://etfgi.com/news/stories/2020/12/etfs-and-etps-listed-globally-hit-new-records-assets-reach-us762-trillion (last accessed on 23 January 2021).

instead of the water indices themselves is based on two reasons. Firstly, water ETFs offer investors the flexibility of buying or selling the water index with a single transaction (Roca et al., 2015) and, secondly, ETF market data vendors provide an intraday indicative value that is disseminated at regular intervals during the trading day and foreign exchange adjustments are made when the ETF holds non-domestic stocks (Lettau and Madhavan, 2018). Furthermore, four ETFs instead of one single ETF have been selected because the whole water market cannot be tracked with only one single asset (Jin et al., 2015).

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. In order to study the response of water-related ETF returns to changes in the major US and European benchmarks in equity and fixed income markets, quantile regression (QR) models have been estimated. In QR, the current change in ETF returns is assumed to depend linearly on the current returns or levels of the selected benchmarks. The purpose of applying a QR model is to study the comovement between the explanatory variables across the quantiles of the dependent variable (water ETF returns) and, at the same time, analysing if the intensity of the dependence increases or decreases when the water market is bearish or bullish. It is expected that such a relationship may vary as the dependent variable varies in its scale. By using a quantile regression approach, a number of coefficients will be produced describing the relationship between these benchmarks and water ETF returns at different points of performance. The main objective of this paper is to determine this relationship, separately for US and European markets, and to test whether such link is heterogonous across various scales of water ETF returns. The rest of the paper proceeds as follows. The subsequent section provides a review of financial literature related to water assets. Section 3 describes the data used to perform the analysis. Section 4 discusses the methodology applied to study whether these assets can be used as a safe haven, a hedge and/or a diversifier. Section 5 presents the results and section 6 offers some conclusions.

2. Review of the literature

The financial literature on the performance of water-related assets and their ability to serve as a hedge or a safe-haven asset is scant. Geman and Kanyinda (2007) were the first to draw attention to the uniqueness of water as a new asset class. Their goal was to illustrate the ways in which one can currently invest in water and to discuss the ineluctable emergence of water markets and water rights. They considered that water should belong to the category of infinitely renewable commodities and argued that the valuation issues and risk-management activities on water led to problems that had already been solved for energy commodities.

Recently, researchers have shown an increasing interest in some topics related to water-related assets. Several papers have analysed the profitability of water-related investments and their diversification benefits in a portfolio context, obtaining conflicting evidence. On the one hand, Gilroy et al. (2013) studied whether the inclusion of water as an asset in a traditional portfolio consisting of stocks and bonds provides diversification benefits and thus leads to more efficient portfolios. By using the ZWI as representative of the price of water, they observed that although the addition of the ZWI leads to a better risk-adjusted return of the portfolio, the improvement of the portfolio's Sharpe ratio was not found to be statistically significant. Further evidence in this line is provided by Alvarez and Rodriguez (2015), who identified and measured the risk-adjusted performance and diversification value of mutual funds dedicated to investments in water-related securities. The authors found that their sample of open-end water-related mutual funds neither outperforms nor underperforms the two chosen benchmarks: the S&P 500 Index and the S&P Global Water Index. On the other hand, Jin et al. (2015) used the same methodology to investigate the performance of WOWAX in a portfolio context. Their results suggested that WOWAX outperforms the traditional asset classes and has the capacity to produce diversification effects in portfolios primarily composed of listed equity and bond assets.

Other studies in the financial literature on water have examined the industry-specific characteristics on water stock returns. Roca et al. (2015) confirmed that some fundamental company variables such as earnings before interest and taxes, accounts payable, labour force, sales and administration expenses and accounts receivable can serve as indicators of profitability of investment in global water company stocks that comprise the WOWAX. In the same line of research, Jin et al. (2016) examined the case of 76 firms that make up the major global water indices and found that water firms with a larger proportion of illiquid assets-in-place are observed to have greater stock returns than those with a smaller proportion of illiquid assets.

Finally, a group of papers has focused on the joint study of return and volatility information of water-related assets. Buckland et al. (2015) showed that the systematic risk of water utilities is time-varying and that the observed variation can be explained in terms of regulatory factors. Their analysis also confirms that there are striking differences between the regulatory risks and patterns of returns for private sector water utilities in the UK and the US. Rompotis (2016) studied the ability of water ETFs to perform better than the broad equity market and concluded that, although risk-adjusted water ETFs returns do not outperform the benchmarks, their performance can be considered satisfactory by a socially responsible investor who seeks competitive rather than above-average returns. Tularam and Reza (2016) investigated the relationship between idiosyncratic risk and return among the four most representative water ETFs. Their findings suggested that water investment has a lower systematic risk and a positive effect on the returns of the water exchange-traded index funds during different regimes. Further evidence on this topic is supported by Reza et al. (2018), who showed that the water indices, water markets and water funds capture the “extremely” high level of stock return volatility in different periods and found that the global water industry is more sensitive to “good” news than to “bad” news.

3. Data and sample

This study uses daily data of water-related ETFs from June 2007 to December 2020 obtained from the website “finance.yahoo.com”. Among the available water ETFs, Table I 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 ETFs on water, these four are widely considered the most representative given their high trading volume and liquidity.

Table I exhibits the four ETFs ranked by total assets under management (AUM) in descending order and shows their symbols and AUM expressed in thousands of US Dollars, as well as their date of inception, the indices that each ETF tracks, and the investment region of the firms that made up the index. In general, all these water funds invest their assets in international water-related companies engaged in activities of the global water industry such as pumps and pipes, filtration, distribution, purification and treatment.[3]

[Please Insert Table I]

Figure I shows the evolution of the prices of the four ETFs analysed from 2007 to 2020. It displays similar patterns and fluctuations. In general terms, all the ETF prices start to increase and peak in the summer of 2008, dropping sharply at the end of 2019. At a glance it reveals an overall upward trend for all the ETFs. After the global economic downturn (2007–2009), all the ETF prices levelled off around $20 until 2011. Since then, they have separated into four trajectories with a similar shape, with the FIW prices being the highest and the PIO prices the lowest. Since 2016, prices have steadily increased until reaching a maximum in 2020. However, looking at Figure I, it could be inferred that several unexpected events affected the water price. Specifically, three price declines are observed from 2016 on. The first one is seen throughout 2018 and is due to tariffs imposed by President Donald Trump on some metals and goods imported from the European Union, Canada, Mexico and China, among others. The second fall in prices took place on 24 December 2018 when the major international stock indexes nosedived

[3] Although water-related ETFs may appear to have low capitalisation, it is important to note that the liquidity of an ETF has to do with the liquidity of the underlying basket of securities of the ETF. This is due to the creation/redemption mechanism of basket shares that characterises ETFs (see Abner, 2016, pp.40-46). As Abner (2016, p.80) indicates: “If your investment horizon is longer than one day, trading volume should not be relevant to you as criteria for portfolio suitability. No matter what size you wish to execute, the liquidity of the underlying assets in the fund will determine the minimum liquidity available in your desired ETF, and not its average daily trading volume.”

following tweets from President Trump criticising the US Federal Reserve. Finally, the last price drop is related to the beginning of the COVID-19 pandemic in March 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 references for equity markets. The first one measures the performance of the large and mid-cap segments of the US and Canada markets, while the second one captures large and mid-cap representation across 15 developed markets 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 companies with a AAA rating. 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 expiry. Data from these six international benchmarks was sourced from Bloomberg.

4. Methodology

The relationship between ETF returns and US and European benchmarks is analysed by means of the Quantile Regression (QR) methodology, introduced by Koenker and Bassett (1978), in a comparative way with Ordinary Least Squares (OLS). OLS models estimate the relationships between the dependent and the independent variables based on the conditional mean of the dependent variable.

However, focusing only on mean effects may lead to the inaccurate estimation of relevant coefficients or the omission of important relationships (see Zhu et al. 2016), particularly when heterogeneity in the sample is significant and/or the relationships between variables differ across various market conditions. Compared to the OLS regression, the QR methodology models specific quantiles of the dependent variable. Therefore, in this context, QR may 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).

QR is an extension of the standard regression, providing a more complete picture of a conditional distribution. It obtains the complex impacts of the independent variables throughout the conditional distribution of ETF returns. Specifically, the quantile regression model can be expressed as follows:

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

where $Q(\tau/x)$ denotes the τ conditional quantile of y (ETF return), x is a vector of independent variables (benchmarks), and $\beta(\tau)$ represents the vector of the estimated coefficients at quantile τ. These coefficients are estimated by minimising the weighted absolute deviations between y and x; then, the regression quantile 0 < $\beta(\tau)$ < 1 solves the following problem:

$$\beta(\tau) = \arg\min \sum_{t=1}^{T} \left(\tau - 1\left(y_t < x_t'\beta(\tau)\right)\right) \, |y_t - x_t'\beta(\tau)| \quad (2)$$

where $y_t < x_t'\beta(\tau)$ is the usual indicator function.

In the OLS regression, the coefficients measure the effects of the independent variables on the conditional mean of the dependent variable, whereas in the QR case, the vector of coefficients $\beta(\tau)$ represents the effects of the independent variables on the τ conditional quantile of the conditional distribution of the dependent variable. Moreover, QR estimators are robust to outliers, heavy tail distributions and heteroskedasticity on the dependent variable (see Koenker and Hallock, 2001). This could be of particular advantage in the ETF returns equations setting since the common features of financial data (negatively skewed and leptokurtic) are characterised by these features (see Baur, 2013).

5. Results

Given that the financial literature on this topic uses different definitions, it is necessary to clarify the concepts of hedge, diversifier and safe-haven assets 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 strong (weak) safe haven as an asset that is negatively correlated (uncorrelated) with another asset or portfolio only in times of market stress or turmoil.

5.1 Preliminary results on ETFs

Panel A of Table II reports descriptive statistics of logarithmic returns of the water-related ETFs used in the analysis. FIW and PIO exhibit the highest and the lowest sample means, respectively, while FIW and PHO show the highest and the lowest sample medians, respectively. However, the test of equality of means and medians cannot reject the null hypothesis of equality. A different behaviour is observed in the volatility of the ETFs. Although the corresponding annualised volatilities are between 22% and 24%, the null is rejected at the 1% level.

[Please Insert Table II]

The range of all the daily maximum and minimum returns is high in comparison with their means. 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 test statistic rejects the existence of a unit root in the ETF returns series, the underlying processes shown in Figure II are quite volatile and heteroskedastic, where the volatility exhibits clustering and mean reversion. All these facts may lead to the inefficiency of estimators when only conditional mean functions are used to analyse causal relationships between variables. However, QR is robust to anomalous values in the dependent variable so that extreme values have a limited impact on the estimates (see Davino et al. 2013).

[Please Insert Figure II]

Following Cade and Noon (2003), the OLS regression estimates in heterogeneous distributions might seriously under- or overestimate effects or even fail to identify effects at all. The presence of several causes for heterogeneity in the ETF returns series and the fact that the ETF returns distributions are significantly different from a normal distribution provide a well-founded motivation to use quantile regression on the ETF returns equations.

Panel B of Table II shows the cross-correlation coefficients among the returns of the water-related ETFs. Given the absence of normality of the series, the degree of association between the ETF variables has been measured by applying the Spearman rank correlation test. This test does not carry any assumption about the distribution of the ETFs. The results obtained confirm the high cross-correlation between all the water-related ETFs. All the coefficients are positively and significantly correlated at the 1% level. The highest degree of relationship (92.6%) is observed between FIW and PHO, which are the US ETFs, followed by the correlation between CGW and PIO (85.7%), the international water-related ETFs.

It is well known that correlation does not imply causation. To know which ETF has the higher information content, a Granger Causality analysis has been performed. Table III presents the Granger Causality Tests for water-related ETF returns. For each equation in the ETF VAR system, the table displays the Wald statistics for the joint significance of each of the other lagged endogenous variables in that equation. Of greatest interest in this table is that FIW and PHO can be treated as the most exogenous variables given that other lagged endogenous variables cannot improve in their explanation at the 1% level. Furthermore, a two-way Granger causation exists between CGW and PIO: PIO Granger causes CGW and vice versa. These results suggest that the water ETFs are influenced by movements from other water ETFs. In this regard, these findings are consistent with those obtained by Reza et al. (2017), who studied the interdependence of global water indices.

Finally, it is worth noting that PIO has the higher information content because it helps in the prediction of CGW, PHO and FIW at the 1%, 5% and 10% levels, respectively. Surprisingly, it seems that PIO, the youngest ETF with the smallest quantity of assets under management, exceeds the returns of the rest of the water-related ETFs.

[Please Insert Table III]

To gain robustness, the existence of cointegration relationships among the ETF prices have been tested by applying the test by Johansen (1995). The existence of at least one cointegration equation is rejected under the assumptions that the level data have linear trends but the cointegrating equations have only intercepts, and that the level data and the cointegrating equations have linear trends. However, the existence of at least one cointegration equation cannot be rejected under the assumptions that the level data have no deterministic trends and the cointegrating equations do not have intercepts, and that the level data have no deterministic trends and the cointegrating equations do have intercepts. Although these last two cases are not very plausible in the present study, the Granger Causality Tests considering one cointegrating relationship have been estimated. Qualitatively similar results have been obtained regarding the exogeneity of the variables FIW and PHO and the two-way Granger causation between CGW and PIO.[4]

5.2 Preliminary results on the main benchmarks

Panel A of Table IV illustrates the descriptive statistics of the main benchmarks. The median daily return of equity indices is higher than that on bond indices. The IBOXXNA exhibits the highest and the lowest daily return of the four equity and bond market indices. Regarding the standard deviation, the IBOXXNA exhibits

[4] These results are not included for the sake of brevity but are available from the authors upon request.

the highest one while the IBOXXEU offers the lowest one. The table also presents the levels of volatility indices for USA and Europe. The mean and the median values for the volatility indices oscillates around 20%; however, it is worth noting that both indices exhibit high ranges that oscillate around 75%. In all the cases, Jarque-Bera tests of benchmarks confirm the non-normality and justify the use of non-parametric cross-correlation coefficients in Panel B. The Augmented Dickey-Fuller test statistics reject the existence of a unit root in both the return series and the original implied volatility indices.

Panel B of Table IV reports the Spearman cross-correlation coefficients between the main benchmarks and each one of the water-related ETFs. All the ETFs exhibit similar results and this preliminary analysis indicates that water 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, therefore, they may 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 viewed as diversifiers (positive correlation).

[Please Insert Table IV]

The Spearman cross-correlation coefficients between the US and EU equity indices is 89% and the correlation coefficients between the European and US volatility benchmarks is 63%. Due to the high correlation between some of the main benchmarks, and in order to avoid possible multicollinearity problems, two versions of equation 1, one for the US benchmarks and another one for the European references have been estimated.

5.3 Quantile regressions

Table V presents the coefficients of the estimates for the US benchmarks of the OLS regression model and QR models for each ETF and for nine quantiles of the ETF returns distribution ranging from 0.1 to 0.9 according to equation 1. MSCINA is the logarithmic return of the MSCI North America Index, IBOXXNA is the logarithmic return of the IBOXX USD Corporates AAA Index, and VIX is the S&P 500 Volatility Index expressed in logarithms. As can be seen in Table V, the explanatory power of all models ranges from 45% to 63%, being higher in the lower quantiles.

The effect of the North American stock market as represented by the MSCI North American Index is positive and significant at the 1% level and similar across quantiles and ETFs, independently of the ETF investment region (international or USA). The Wald test rejects the null 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. Regarding the North American fixed income index, positive dependence across 19 of the 36 quantiles has been found. In the case of FIW, the IBOXXNA Index is negatively correlated only in two lower quantiles, suggesting a weak potential to serve as a strong safe haven in times of falling water-related asset returns. Finally, the effect of US implied volatility on the ETFs is qualitatively similar in all the cases. The estimated coefficient for the intensity of VIX is not homogeneous across different quantiles. The impact is significantly negative (positive) for lower (upper) quantiles. It is interesting to note that the inflexion point is the 50th percentile in which no significant relationship is observed for any ETF. Given that data on US volatility is 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. Therefore, VIX-related assets can serve as a strong safe-haven investment for water-related ETFs.

[Please Insert Table V]

Table VI presents the estimation results for the OLS and QR models following equation 1 for the EU benchmarks. MSCIEU is the logarithmic return of the MSCI Europe Index, IBOXXEU stands for the logarithmic return of the IBOXX EURO Corporates AAA Index, and VSTOXX is the Euro STOXX 50 Volatility Index expressed in logarithms. As can be seen, the explanatory power of all models ranges from 21% to 38% and, according to the findings in Table V, the greatest explanatory power is observed in the lowest quantiles.

Similar patterns across the quantiles for all the ETFs have been observed. The effect of MSCIEU returns on the water ETF returns is positive and significant at the 1% level. Slope tests confirm that the F-tests for the equality of coefficients at low and high quantiles cannot be rejected. Furthermore, Wald tests in all the panels is rejected at the 1% level, suggesting that all the water-related ETFs that have been considered in the present 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 the conventional levels in 35 out of 36 cases. The behaviour of this relationship is uniform for all the ETFs across all the quantiles considered. Furthermore, F-tests confirm a similar intensity of dependence regardless of the European fixed income market scenarios, suggesting water-related ETFs can act as a strong hedge for movements in European fixed income markets. Finally, OLS and the median quantile results show an insignificant relationship between EU implied volatility 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 the conventional levels of significance. The negative relationship between the water returns and the volatility level in bearish markets appears to support the claim that VSTOXX-related assets can act as strong safe havens for all the water-related ETFs analysed.

[Please Insert Table VI]

In summary, Table V and VI show that the impact of international benchmarks on the water ETF returns is heterogeneous across the quantiles of the return distribution and, therefore, quantile estimation does provide more information than OLS. Furthermore, the results from Table V and VI confirm the potential diversification benefits for water-related ETFs in a traditional stock and bond portfolio context and are in line with those obtained for water indexes by Geman and Kanyinda (2007), Gilroy et al. (2013) and Jin et al. (2015).

Finally, we have studied the safe-haven properties of the water ETFs. Following Baur et al. (2021), we have estimated quantile regressions of each benchmark for each water ETF. Thus, we can observe how extreme conditional quantiles of the benchmarks are related to water ETFs. Table VII displays 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. Negative and significant coefficients present in the QR models of IBOXXNA, VIX and VSTOXX indicate that all the water ETFs behave as a strong safe haven for these benchmarks.

[Please Insert Table VII]

5.4 Robustness tests

To estimate the previous quantile regression models, the Huber Sandwich method is applied to compute covariances, and the Kernel method to control the estimation of the scalar sparsity value. To gain robustness, the quantile regressions have been also re-estimated by applying different methods, and the results are qualitatively similar to those presented in the paper. Additionally, the quantile regressions have been estimated by considering a dummy variable that takes the value 1 after 11 March 2020, and zero otherwise.[5] The idea is to study if the effect of COVID-19 has changed the role of the water ETF assets observed in Tables V and VI. This approach considers the period before the WHO pandemic declaration as the base and adds three multiplicative terms between the independent variables and the dummy variable for each regression. All the estimated coefficients of the multiplicative terms are non-significant, except for the coefficients that affect European equity returns, which are positive and

[5] March 2020 is the official date on which the World Health Organisation (WHO) declared the coronavirus outbreak a pandemic.

significant in some quantiles. This implies that the role of water ETFs as a diversifier for EU stock portfolios has slightly increased since the beginning of the pandemic.[6]

6. Conclusions

This study has analysed the ability of water-related ETFs to be viewed as a hedge, a diversifier, and/or a safe-haven investment for six US and European benchmarks. Specifically, in this paper four ETFs (PHO, CGW, FIW and PIO) that offer exposure to a group of companies operating generally in the water industry, including water utilities, water infrastructure companies, and water equipment and materials companies have been considered.

The presence of several causes for heterogeneity in the ETF returns series and the fact that the ETF returns distributions are significantly different from a normal distribution provide sufficient motivation to use quantile regression on the ETF returns equations. Furthermore, the quantile regression method makes it possible to analyse the effects of stocks, bonds and volatility benchmarks on different quantiles of water ETF returns distributions, providing a clearer view of the relationship instead of focusing on the mean of the distribution.

The findings of the study confirm that the sensitivity of water-related ETF returns to changes in international benchmarks is heterogeneous across quantiles and far from the OLS estimates. Furthermore, the evidence herein indicates that water-related ETFs serve the roles of hedge, diversifier and safe-haven investments for fixed income, equity and volatility movements, respectively.

[6] Given that the magnitude and significance of the rest of the coefficients are almost identical to those reported in Table V and Table VI, these results are omitted for brevity. However, they are available upon request from the authors.

These results are of particular interest for portfolio managers. Specifically, water assets can be viewed as a strong hedge against movements in European fixed income markets. Furthermore, water-related ETFs can also act as a diversifier against movements in North American and European stocks markets and as a strong safe-haven investment for North American fixed income indices, VIX- and VSTOXX-related assets. Finally, additional tests confirm that the role of water ETFs as a diversifier for European stock portfolios has slightly increased since the beginning of the pandemic.

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 water ETFs that invest in companies that process and distribute water. These results show the appeal that water-related ETFs can have for investors who want to add water exposure to traditional stock and bond portfolios in US and European markets. As a future line of research, an interesting extension might explore the differential properties of water ETFs in comparison with other Environmentally Responsible ETFs.

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Table I. Water-related ETFs

Symbol	ETF	AUM	Inception	Index tracked	Scope
PHO	Invesco Water Resources ETF	$1,249 M	Dec 6, 2005	NASDAQ OMX US Water Index	US
CGW	Invesco S&P Global Water Index ETF	$799 M	May 14, 2007	S&P Global Water Index	Broad
FIW	First Trust ISE Water Index Fund	$645 M	May 11, 2007	ISE Water Index	US
PIO	Invesco Global Water ETF	$227 M	Jun 13, 2007	NASDAQ OMX Global Water Index	Broad

This table shows the main features of the four water-related ETFs chosen to perform the analysis. The first column indicates the symbols used for each ETF; the second column shows the name; the third column provides the amount of assets under management (AUM) expressed in thousands of US Dollars; the fourth column shows the date of inception; the fifth column indicates the index that each ETF tracks; and the last column reports the investment region of the firms that make up the index. AUM as of 7 December 2020. Source: etfdb.com and prepared by authors.

Table II. 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	11343.58***	22760.1***	10036.36***	22649.36***	
ADF statistic	-62.304***	-63.434***	-62.643***	-40.290***	
Observations	3398	3398	3398	3397	

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

This table shows the main descriptive statistics expressed in percentage (Panel A) and Spearman rank correlations (Panel B) of logarithmic returns of the four water-related ETFs described in Table I. The descriptive statistics are mean, median, standard deviation, maximum, minimum, skewness and kurtosis. The JB statistic stands for the Jarque-Bera statistic, which tests for the null hypothesis of normality for the distribution of the series. The ADF statistic is the Augmented Dickey-Fuller test statistic which tests for the existence of a unit root in the series. 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. The sample period consists of data from 13 June 2007 to 8 December 2020.

Table III. Granger Causality Tests for water-related ETFs

Excluded	PHO	CGW	FIW	PIO
PHO	-	7.667	8.506*	7.481
CGW	7.028	-	6.914	38.060***
FIW	4.276	13.233***	-	5.219
PIO	10.067**	42.335***	7.973*	-
All	19.42***	66.128***	37.616***	66.864***

For each equation in the ETFs VAR system, this table displays the Wald statistics for the joint significance of each of the other lagged endogenous variables in that equation. The first column indicates the excluded variables and the following ones the dependent variable in each equation. The statistic in the last row (All) is the statistic for the joint significance of all other lagged endogenous variables in the equation. Four lags have been considered to estimate the VAR system. The variables considered are the logarithmic returns of the four water-related ETFs described in Table I. The ***, ** and * indicate rejection of the null hypothesis at the 1%, 5% and 10% levels. The sample goes from 13 June 2007 to 8 December 2020.

Table IV. 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	23363***	95472865***	10885***	11717***	3364***	7627***
ADF statistic	-66.286***	-30.536***	-4.676***	-57.623***	-54.062***	-6.018***
Observations	3398	3234	3398	3398	3336	3348

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***

This table shows the descriptive statistics of the US and European benchmarks (Panel A) and Spearman correlations with ETFs (Panel B). US benchmarks: MSCINA is the logarithmic return of MSCI North America Index, IBOXXNA is the logarithmic return of the IBOXX USD Corporates AAA Index and VIX is the S&P 500 Volatility Index expressed in logarithms. European benchmarks: MSCIEU is the logarithmic return of the MSCI Europe Index, IBOXXEU stands for the logarithmic return of the IBOXX EURO Corporates AAA Index and VSTOXX is the Euro STOXX 50 Volatility Index expressed in logarithms. PHO, CGW, FIW and PIO are the logarithmic returns of the four water-related ETFs described in Table I. The JB statistic stands for the Jarque-Bera statistic, which tests for the null hypothesis of normality for the distribution of the series. The ADF statistic is the Augmented Dickey-Fuller test statistic, which tests for the existence of a unit root in the series. The *** indicates rejection of the null hypothesis at the 1% level. The sample period consists of data from 13 June 2007 to 8 December 2020.

Table V. Quantile regressions of the determinants of water-related ETFs: US benchmarks

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 equation 1 for each ETF as dependent variables and for US benchmarks as explanatory variables. PHO, CGW, FIW and PIO are the logarithmic returns of the four water-related ETFs described in Table I. MSCINA, IBOXXNA and VIX are the US benchmarks described in Table IV. 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% level. The sample period consists of data from 13 June 2007 to 8 December 2020. Data source from Bloomberg.

Table VI. Quantile regressions of the determinants of water-related ETFs: EU benchmarks

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***

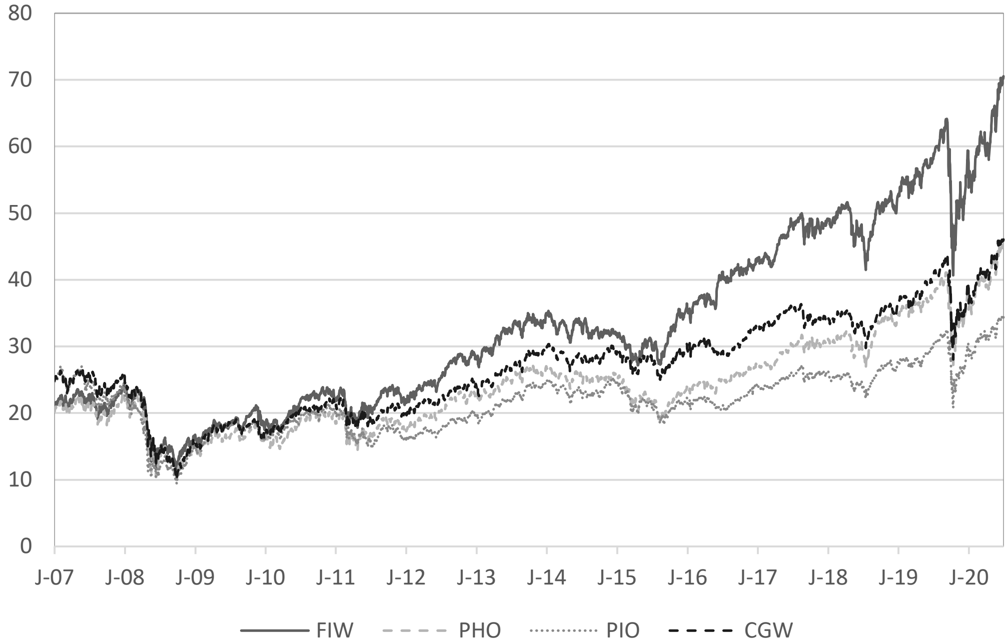
This table shows the coefficients of the OLS regression and the quantile regressions for nine quantiles ranging from 0.10 to 0.90 according to equation 1 for each ETF as dependent variables and for EU benchmarks as explanatory variables. PHO, CGW, FIW and PIO are the logarithmic returns of the four water-related ETFs described in Table I. MSCIEU, IBOXXEU and VSTOXX are the European benchmarks described in Table IV. 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% level. The sample period consists of data from 13 June 2007 to 8 December 2020. Data source from Bloomberg.

Table VII. Quantile regressions and safe-haven properties

	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***

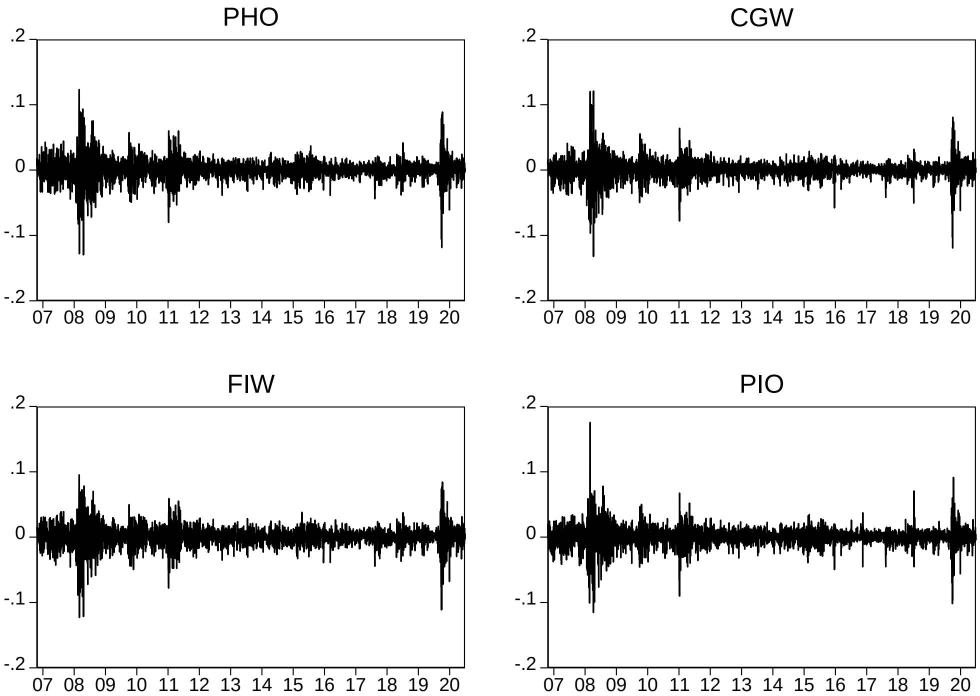
This table shows the coefficients of the quantile regressions for the quantiles 0.1 (MSCINA, IBOXXNA, MSCIEU and IBOXXEU) and 0.9 (VIX and VSTOXX) for each benchmark, as the dependent variable, and for each water ETF, as the explanatory variable. PHO, CGW, FIW and PIO are the logarithmic returns of the four water-related ETFs described in Table I. MSCINA, IBOXXNA, VIX are the US benchmarks described in Table IV. MSCIEU, IBOXXEU and VSTOXX are the European benchmarks described in Table IV. The ***, ** and * indicate rejection of the null hypothesis at the 1%, 5% and 10% level. The sample period consists of data from 13 June 2007 to 8 December 2020. Data source from Bloomberg.

Figure I. Evolution of the price of the 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 Table I. The sample period consists of data from 13 June 2007 to 8 December 2020.

Figure II. Evolution of the returns of the ETFs



This figure shows the daily evolution of the logarithmic returns of the four water-related ETFs. PHO, CGW, FIW and PIO are the four water-related ETFs described in Table I. The sample period consists of data from 13 June 2007 to 8 December 2020.

List of abbreviations

AUM: Assets under Management; CGW: Invesco S&P Global Water Index ETF; CGW: Invesco S&P Global Water Index ETF; ESG: Environmental social and governance considerations; ETFs: Exchange Traded Index Funds; FIW: First Trust ISE Water Index Fund; FIW: First Trust ISE Water Index Fund; IBOXXEU: IBOXX EURO Corporates AAA Index; IBOXXNA: IBOXX USD Corporates AAA Index; MSCIACWI: MSCI ACWI Water Utilities Index; MSCIEU: MSCI Europe Index; MSCINA: MSCI North America Index; OECD: Organisation for Economic Co-operation and Development; OLS: Ordinary Least Squares; PHO: Invesco Water Resources ETF; PHO: Invesco Water Resources ETF; PIO: Invesco Global Water ETF; PIO: Invesco Global Water ETF; QR: Quantile Regression; S&P: S&P Global Water Index; SDGs: Sustainable Development Goals; S-Net: S-Network Global Water index; VAR: Vector autoregression; VIX: S&P 500 Volatility Index; VSTOXX: Euro STOXX 50 Volatility Index; WBG: World Bank Group; WHO: World Health Organisation; WOWAX: World Water Index; ZWI: Palisades Water Index.