Water as an Alternative Asset

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Abstract

As correlations of asset returns increased and diversification effects vanished during the financial crisis, the search for new and potentially uncorrelated asset classes gains importance. As a result, several asset classes have been analyzed by academics in order to determine their diversification properties. In this article we take a closer look at water as an asset and its potential diversification benefits. Water as an alternative asset improves a traditional stock and bond portfolio. Though the enhancement of a portfolio's Sharpe ratio due to the inclusion of water as an additional asset is of economic significance, we do not find evidence of statistical significance.

Key Words: Alternative Assets, Diversification, Water

JEL classification codes: G11, Q25

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1 Introduction

During the financial crisis, potential diversification benefits of different asset classes ceased to exist as correlations of returns increased (see for example Szado (2009)). Hence, the search for new and uncorrelated asset classes gains importance. As the global population is expanding, water supply becomes one of the most important issues. Facing increasing demand for this scarce resource, the global water business seems to offer investment opportunities. For example, the World Bank's portfolio of sewerage investments increased from US$ 227 million in 2003 to US$ 1.2 billion by 2009 (World Bank (2010)). This figure is outnumbered by hydropower projects (from US$ 3.7 billion in 2003 to US$ 8.5 billion in 2009). However, water investments have not been studied in a portfolio context so far. The question arises whether investors can benefit from this development by considering water as an asset. More precisely, we examine whether water provides an attractive risk-return trade off. Furthermore, we study 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.

As our analysis shows, water as an asset has a higher expected return than stocks and bonds. Moreover, the inclusion of water as an additional asset leads to an improvement of the efficient frontier, a higher Sharpe ratio[1] and a lower value at risk (VaR). Thus, it seems worthwhile for investors to consider the diversification effects of water in a portfolio context.

The paper is structured as follows: Section 2 provides a review of the literature on diversification properties of several asset classes. Section 3 describes our data and methodology while the results are presented in section 4. Section 5 concludes.

[1] See Sharpe (1964) and especially Sharpe (1966).

2 Literature Review

One of the asset classes that has been considered among academics as an alternative to traditional assets such as stocks and bonds is real estate. Rubens, Louton & Yobaccio (1998) find improvements of the Sharpe ratio of portfolios that contain real estate investments, though not statistically significant. Georgiev, Gupta & Kunkel (2003) conclude that direct investments in real estate offer diversification benefits whereas real estate investment trusts (REITs) do not. Using a 4-quadrant model (public vs. private, equity vs. debt), Hudson-Wilson, Fabozzi & Gordon (2003) and Hudson-Wilson, Gordon, Fabozzi, Anson & Giliberto (2005) show that the inclusion of real estate as an asset class is able to enhance the Sharpe ratio of investment portfolios. Another asset class similar to real estate is farmland as considered by Painter & Eves (2008). Their analysis reveals beneficial diversification effects as farmland shows only very low or negative correlations with other asset classes such as U.S. and global stocks. At the same time, farmland provides attractive returns at reasonable risk. Consequently, Painter & Eves (2008) conclude that the inclusion of farmland significantly improves portfolio performance.

Taking a look at derivatives as an asset class in a portfolio context, Van Lennep, Oetomo, Stevenson & De Vries (2004) consider the diversification benefits of weather derivatives. Their study shows that including weather derivatives in the construction of portfolios improves the efficient frontier of portfolios consisting of traditional asset classes. More precisely, Van Lennep, Oetomo, Stevenson & De Vries (2004) find that the inclusion of weather derivatives significantly improves the Sharpe ratio while at the same time only marginally increasing the portfolio's standard deviation.

Daigler & Rossi (2006) consider volatility as an asset class. Using the new VIX, i.e, the CBOE Volatility Index, they are able to show positive diversification properties due to the negative correlation between the VIX and the S&P 500.

Szado (2009) takes a closer look at VIX futures and options. As volatility has negative expected excess returns, the focus of the analysis is not the inclusion of VIX exposure as part of a long-term portfolio diversification strategy but rather to assess whether VIX exposure possesses beneficial diversification properties in times of crisis. The study reveals that allocating funds to VIX futures increases returns while simultaneously reducing standard deviation. For at the money VIX calls Szado (2009) finds mixed results as they tend to reduce portfolio losses but have varying effects concerning the standard deviation of returns. The addition of out of the money VIX calls significantly increases portfolio returns as well as portfolio volatility.

Beach (2006) investigates emerging market equities and finds beneficial diversification properties as the inclusion of emerging market equities in an international portfolio offers higher returns and a higher Sharpe ratio. Chiang, Wisen & Zhou (2007) analyze emerging market bonds as an asset class and find significant diversification benefits and an improvement of the investment opportunity set for investors.

Pesando (1993) analyzes the market for modern prints and finds that the return of modern paintings is below the returns of U.S. Treasury Bills whereas the risk by far exceeds that of Treasury Bills. However, due to the negative correlation between modern prints and T-Bills, the minimum-variance portfolio is composed of 6% invested in modern paintings. Using the capital asset pricing model (CAPM)[2] and the S&P 500 as a proxy for the market portfolio, Pesando (1993) estimates the β-coefficient of modern paintings to be 0.32. Pesando & Shum (2007) update the analysis by Pesando (1993) and come to similar conclusions. All in all, the authors conclude that modern paintings only play a limited role for portfolio diversification. The analysis of Campbell (2008) concurs with these findings as the

[2] See Sharpe (1964).

low correlation of art (i.e., paintings) with other asset classes offers diversification benefits. However, due to the risk and return associated with investing in art, the amount allocated to art is relatively small.

Another asset class that has been of interest in academic research are precious metals. Hillier, Draper & Faff (2006) find low correlations of precious metals with stock returns and that portfolios that include precious metals show a significantly better performance. Ratner & Klein (2008) take a closer look at gold as an alternative asset class. They find that the long-term return of gold as a stand-alone investment generates lower returns than a buy-and-hold strategy of the U.S. stock market. Although the correlation of gold with other asset classes is statistically low, Ratner & Klein (2008) do only find limited diversification potential from adding gold to an internationally diversified stock portfolio. Dempster & Artigas (2010) however find that in addition to low correlations with traditional asset classes such as U.S. stocks and bonds, gold offers higher risk-adjusted returns than other precious metals and commodities. They conclude from their analysis that gold possesses diversification potential. This view is underlined by Conover, Jensen, Johnson & Mercer (2009) who find that investments in precious metals improve portfolio performance by increasing returns and reducing the portfolio's standard deviation. Furthermore, they find that investment in equities of precious metals companies yields higher diversification benefits than direct investment in precious metals as a commodity. In addition to that, precious metals equities have only a low correlation with the U.S. stock market.

Grelck, Prigge, Tegtmeier & Topalov (2009) consider potential diversification properties of shipping investments. They find low correlations of shipping indices to global stocks and bonds. Furthermore, the inclusion of investments in shipping increases the Sharpe ratio of a traditional portfolio consisting of stocks and bonds.

Author(s)	Asset Class	Findings
Beach (2006)	Emerging market equities	Diversification properties for emerging market equities, higher returns and Sharpe ratio, no significant risk reduction
Campbell (2008)	Art (paintings)	Limited diversification properties of art (paintings)
Chiang et al. (2007)	Emerging market bonds	Diversification properties for emerging market bonds, improvement of investment opportunity set, especially beneficial for portfolios with low variance
Conover et al. (2009)	Precious metals	Diversification properties for equities of precious metals companies, higher return and lower standard deviation of returns
Daigler et al. (2006)	Volatility	Diversification properties for volatility, risk reduction without substantial effect on portfolio return
Dempster et al. (2010)	Gold	Diversification properties for gold, low correlation with other asset classes
Georgiev et al. (2003)	Real estate	Diversification properties for direct real estate investments, no diversification properties for inclusion of REITs
Greclk et al. (2009)	Shipping	Diversification properties for shipping investments, higher returns and Sharpe ratio
Hillier et al. (2006)	Precious metals	Diversification properties of precious metals investments, higher returns per unit of risk, low correlation to U.S. stocks

Author(s)	Asset Class	Findings
Hudson-Wilson et al. (2003) and Hudson Wilson et al. (2005)	Real estate	Diversification properties of real estate investments, higher returns per unit of risk than stocks and bonds, improvement of Sharpe ratio
Painter et al. (2008)	Farmland	Diversification properties for farmland, higher returns, low correlation with other asset classes
Pesando (1993) and Pesando et al. (2006)	Modern paintings	Limited diversification properties of modern paintings, lower returns than U.S. Treasury Bills but much higher risk
Ratner et al. (2008)	Gold	Negative correlation of gold with U.S. equities, however, no significant diversification benefits
Rubens et al. (1998)	Real estate	Low or negative correlation of real estate with U.S. equities and bonds, improvement of Sharpe ratio
Szado (2009)	Volatility	Diversification properties of VIX futures and options, especially in times of crisis
Van Lennep et al. (2004)	Weather derivatives	Diversification properties of weather derivatives, improvement of efficient frontier and Sharpe ratio
Veld et al. (2007)	Stamps	Low correlation of stamps to U.S. and UK stock indices, generation of α for British and American investors

Table 1: Literature Review

Veld & Veld-Merkoulova (2007) analyze diversification benefits of adding stamps to a stock portfolio for British and American investors. Using CAPM-regressions, they find that the addition of stamps offers positive Jensen alpha[3] both, for British and American investors. Table 1 presents a summary of the literature.

3 Data and Methodology

We use total return indices for all asset classes (see Jorion & Goetzmann (1999) and Dimson, Marsh & Staunton (2002)). Our base portfolio consists of a traditional stock and bond portfolio where the MSCI World Index represents a global stock investment and the Barclays Capital Global Aggregate Bond Index is used as a proxy for global investment-grade bond investments. Considering water as an asset class, several funds are available such as the SAM Sustainable Water Fund, the S&P Global Water Index, the NASDAQ OMX Global Water Index, the Pictet Water Fund, and the Palisades Water Index. Geman & Kanyinda (2007) provide an overview.

All indices except the Palisades Global Water Index are heavily dominated by companies located in the United States. The Palisades index is more equally balanced between the three large regions USA (22.95%), euro area countries (28.13%) and Asia (26.39%). Table 2 shows the weights by region for the indices.

As we do not want our results to be influenced by the dominance of a specific region in the index, we use the Palisades Global Water Index that is calculated by Dow Jones Indexes (see Palisades (2011)) to represent water as an investment asset. The index includes companies active in the global water business. More precisely, companies active in wastewater treatment, water infrastructure and distribution, services and technology, water utilities and the provision of tap water are included

[3] See Jensen (1968).

Region	Palisades	SAM	S&P	NASDAQ	Pictet
USA	22.95%	41.70%	40.40%	41.63%	43.30%
United Kingdom	5.80%	10.50%	19.50%	13.96%	10.30%
Eurozone Countries	28.13%	18.50%	15.70%	21.54%	6.20%
Switzerland	4.40%	3.80%	11.40%	8.26%	3.60%
Asia	26.39%	9.40%	10.00%	9.51%	5.30%
Brazil	1.97%	2.60%	3.00%	4.26%	10.70%
Others	10.37%	13.50%		0.80%	20.60%

Palisades: Palisades Global Water Index; SAM: SAM Sustainable Water Fund; S&P: S&P Global Water Index; NASDAQ: NASDAQ OMX Global Water Index; Pictet: Pictet Water Fund

Table 2: Weights by Region

in the index. In order to ensure exposure to companies active in the water business, at least 80% of the index consists of companies that earn at least 50% of their revenues from these activities.

The data spans the period January 1, 2001 - June 30, 2012. We collect daily prices for the MSCI World and the Barclays Global Aggregate Bond Index from Thomson Reuters. Daily prices for the Palisades Global Water Index are collected directly from Palisades. For the calculation of Sharpe ratios, we use U.S. Treasury Bills as a proxy for the risk-free interest rate. Interest rates on U.S. T-Bills are provided by the U.S. Department of the Treasury. Figure 1 shows the development of the three indices (January 1, 2001 = 100).

The global bond index shows a steady increase with only small fluctuations as one would expect. However, relative to bonds, stocks did not have a superior development from January 2001 to June 2012 while at the same time showing larger fluctuations. The Palisades Global Water Index shows a peak in October 2007 and a sharp decline during the financial crisis. Since January 2009, the index

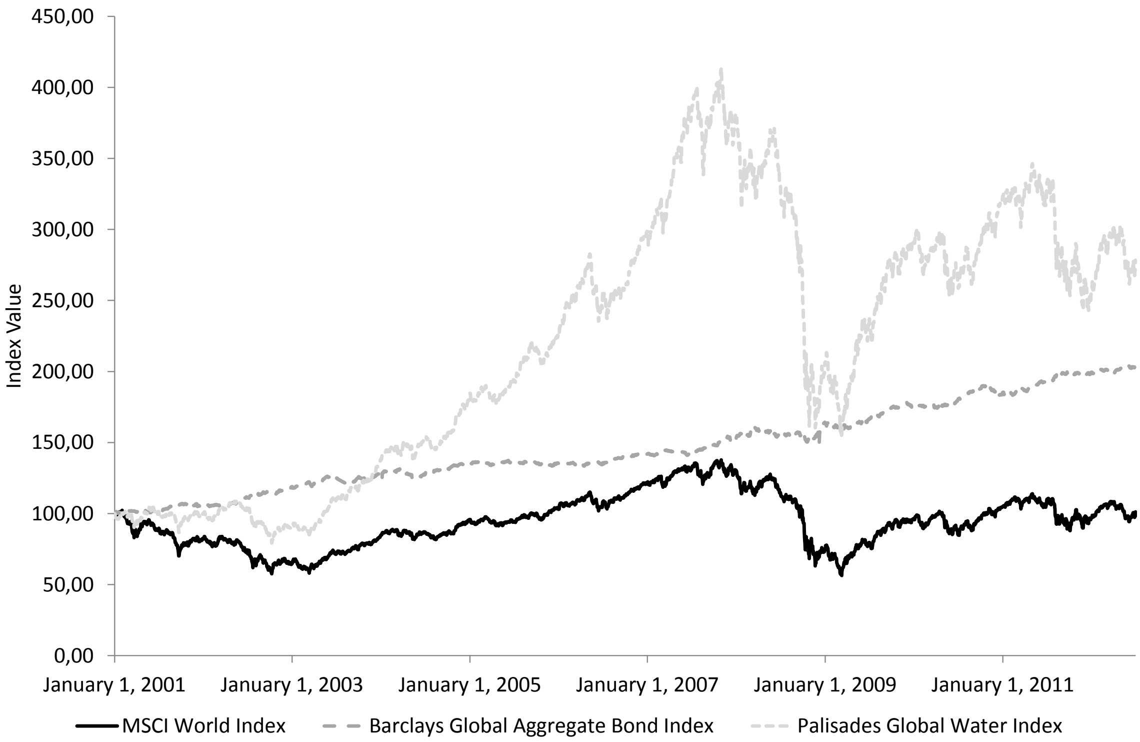

Figure 1: Index Values of Asset Classes from January 2001 to June 2012

has recovered.

During the period under consideration, the Palisades Global Water Index yielded a return of 11.50% p.a., the Barclays Global Aggregate Bond Index a return of 5.01% while the MSCI World Index returned 2.01% per year. Hence, from point of view of enhancing portfolio returns, adding water investments to a traditional stock and bond portfolio seems to be worthwhile. However, the additional return comes at the cost of additional risk as the standard deviation of the Palisades Global Water Index is 17.49% p.a. whereas bonds show a standard deviation of only 5.03%. Thus, the return per unit of risk is greatest for the Barclays Global Aggregate Bond Index and lowest for stocks as stocks show the same risk as investments in water but yield a much lower return. This is also reflected by the Sharpe ratios for the three asset classes. From point of view of diversification potential, the Palisades Global Water Index shows a slightly negative correlation with bonds and a positive correlation with the MSCI World Index. Table 3 summarizes the descriptive statistics and correlations of the asset classes.

	Bonds	Stocks	Water	Mean	Std. Dev.	Return/Risk	Sharpe Ratio
Bonds	1.00			5.01%	5.03%	1.00	0.81
Stocks	-0.14	1.00		2.01%	17.49%	0.11	0.06
Water	-0.05	0.86	1.00	11.50%	17.49%	0.66	0.60

Table 3: Asset Class Correlations and Descriptive Statistics

As the case for including water as an asset is not clear cut, we take a closer look at portfolios with and without water investments. We use the standard Markowitz (1952) approach to portfolio construction to generate the efficient frontiers, i.e., we minimize portfolio variance for different levels of expected portfolio return. Assets with beneficial diversification properties allow investors to get higher returns for a given level of risk or to achieve a given rate of return bearing less risk.

4 Results

As the evaluation of the descriptive statistics of the Palisades Global Water Index shows no clear evidence concerning potential benefits (higher returns that come along with higher risk, high positive correlation with the MSCI World Index and slightly negative correlation with bonds), we compare the efficient frontier of the base case portfolio consisting of stocks and bonds and the efficient frontier achievable when including water as an additional asset. As figure 2 shows, the inclusion of the Palisades Global Water Index allows investors to realize much higher portfolio returns for a given level of standard deviation. The minimum variance portfolio for the enhanced portfolio including water (MV_e) consists of 85.84% invested in bonds, 7.08% invested in stocks and 7.08% invested in the Palisades Global Water Index and has a standard deviation of 4.66% and an expected return of 5.25% whereas for the base case the minimum variance portfolio (MV_b) has a standard deviation of 4.83% and an expected return of 4.78%. In terms of return per unit of risk, MV_e has a value of 1.13 and a Sharpe ratio of 0.92 while MV_b yields a return per unit of risk of 0.99 and a Sharpe ratio of 0.81, respectively. Thus, the inclusion of water as an asset class offers positive diversification benefits to investors.

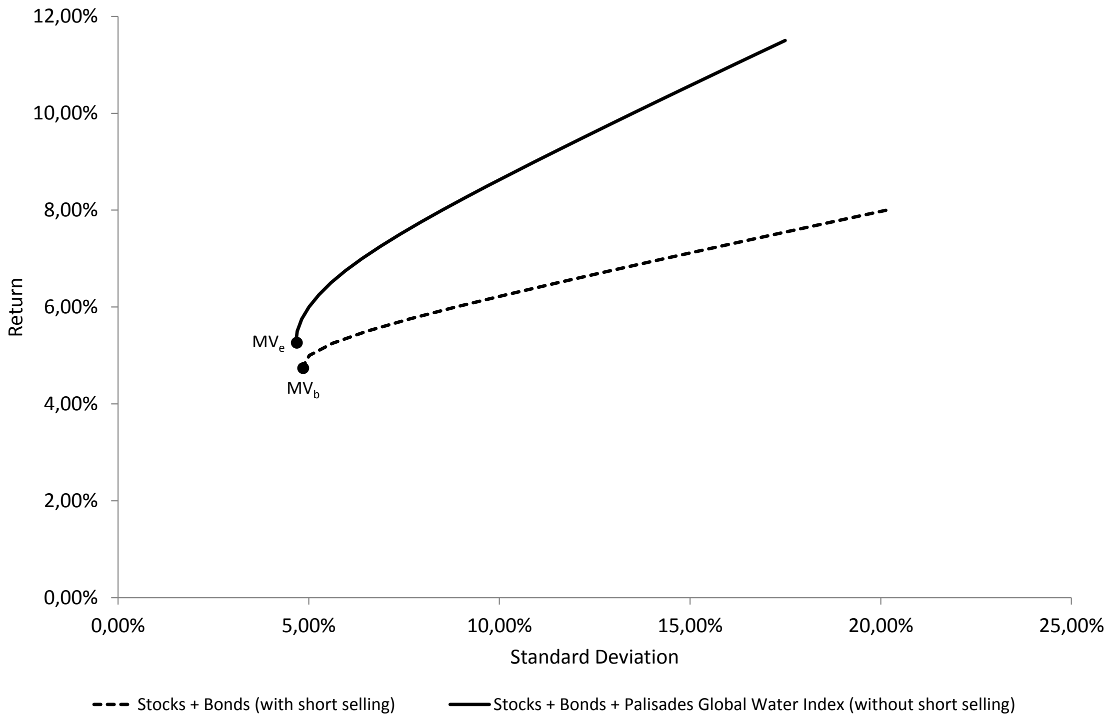

Figure 2: Efficient Frontiers

Figure 3 shows the relative weights of the three assets for given levels of expected portfolio performance. Portfolios up to an expected return of 4.50% p.a. consist solely of bonds and stocks. As the Barclays Global Aggregate Bond Index delivers higher returns at less risk than the MSCI World Index during the observation period, the proportion of stocks is decreased in favour of larger exposure to bonds. As investors demand portfolio returns greater than 4.50%, some part of the capital endowment is invested in the Palisades Global Water Index. Portfolios with an expected return of 6.25% and above consist solely of bonds and the Palisades Global Water Index. As the expected portfolio return increases, so does the proportion of funds allocated with the water investment.

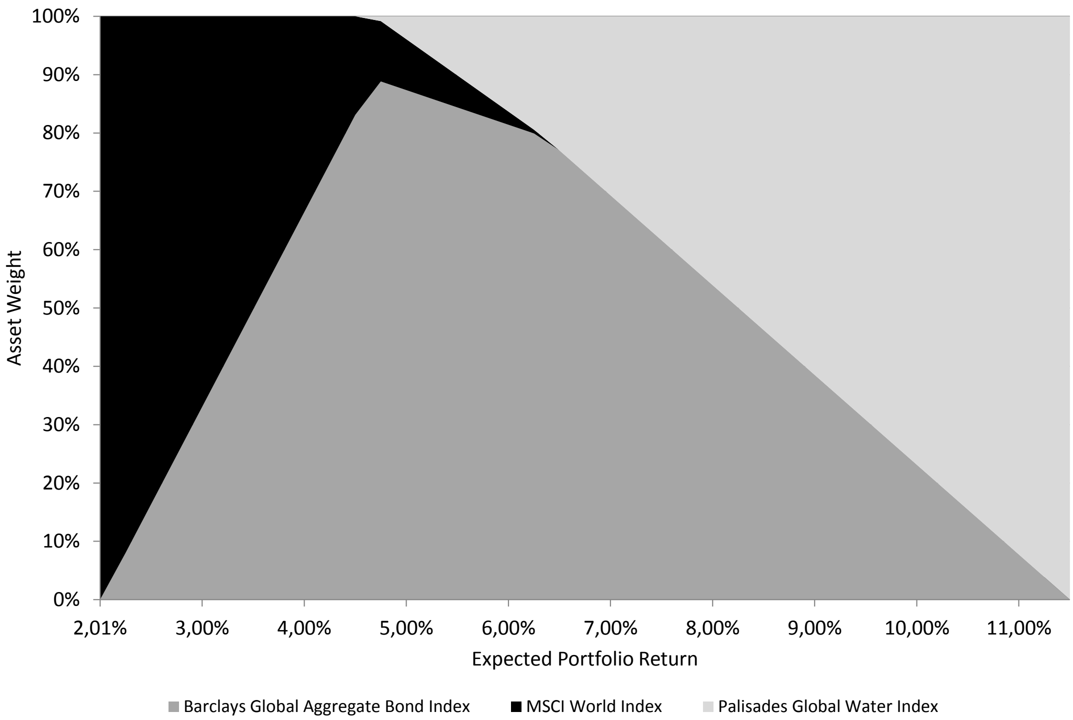

Figure 3: Asset Weights for Different Portfolio Returns

However, besides showing diversification benefits that are of economic significance, the question remains whether these diversification gains are of statistical significance. In order to test the efficiency gains of including water as an asset for portfolio diversification, we use the methodology developed by Gibbons, Ross & Shanken (1989):

$$W = \left[\frac{\sqrt{1+SR_e^2}}{\sqrt{1+SR_b^2}} \right]^2 - 1 \tag{1}$$

where SR_e denotes the Sharpe ratio of an enhanced portfolio via the inclusion of additional assets and SR_b denotes the Sharpe ratio for the base case portfolio without the additional asset. Hence, W is based on a comparison of the Sharpe ratios of the two portfolios: Under the null hypothesis, the Sharpe ratios of the two portfolios are equal and $W = 0$. The Wishart distributed test statistic can be converted into an F distribution with N and $T - N - 1$ degrees of freedom:

$$\left[\frac{T(T-N-1)}{N(T-2)}\right] W \sim F_{N,(T-N-1)} \tag{2}$$

where T denotes the number of observations and N denotes the number of assets added to the portfolio. As the power of the test statistic depends on the relation between T and N, Gibbons, Ross & Shanken (1989) recommend that $N \leq 1/3T$.

Table 4 presents the results for a base line portfolio consisting of 75% invested in the Barclays Global Bond Index and 25% invested in the MSCI World Index. The weight attached to bonds is kept fix whereas the weight of stocks is decreased in favour of the Palisades Global Water Index in steps of 5%. The inclusion of water as an asset increases the expected return (4.26% for the base case vs. 6.16% for a 20% investment of funds in the Palisades Global Water Index) and the Sharpe ratio of the portfolio (0.62 vs. 0.95, respectively). Thus, the addition of the Palisades Water Index leads to a better risk-adjusted return of the portfolio. However, the W test statistic is not statistically significant.

To shed further light on whether water investments are beneficial or not, we calculate the value at risk (VaR) (see for example Longerstacy & Spencer (1996) and Jorion (2001)) for the different portfolios in table 4. We use Monte Carlo simulation (MC) to arrive at our results and proceed as follows:

1. Generation of independent and identically distributed (i.i.d.) random variables.

	Weight	Mean	Std. Dev.	SR	W	F	p	VaR
Barclays Global Bond Index	75.00%							
MSCI World Index	25.00%	4.26%	5.35%	0.62	na	na	na	0.67%
Palisades Global Water Index	0.00%							
Barclays Global Bond Index	75.00%							
MSCI World Index	20.00%	4.73%	5.33%	0.71	0.09	0.27	0.85	0.60%
Palisades Global Water Index	5.00%							
Barclays Global Bond Index	75.00%							
MSCI World Index	15.00%	5.21%	5.35%	0.80	0.18	0.55	0.66	0.55%
Palisades Global Water Index	10.00%							
Barclays Global Bond Index	75.00%							
MSCI World Index	10.00%	5.68%	5.40%	0.88	0.28	0.84	0.51	0.50%
Palisades Global Water Index	15.00%							
Barclays Global Bond Index	75.00%							
MSCI World Index	5.00%	6.16%	5.50%	0.95	0.37	1.13	0.40	0.47%
Palisades Global Water Index	20.00%							

Note: We used base portfolios of 50% bonds and 50% stocks, and 25% bonds and 75% stocks to conduct additional significance tests. The general results are the same: The addition of water as an asset to the base portfolio leads to higher returns, lower volatility, an improvement of the Sharpe ratio and a lower value at risk. As before, the results are not statistically significant. The additional tables are available from the authors on request.

Table 4: Statistical Significance of Diversification Properties for a Base Portfolio Consisting of 75% Bonds and 25% Stocks

2. Usage of Cholesky decomposition in order to preserve the correlation structure.

3. Simulation of different portfolio values.

4. Calculation of VaR.

Assuming an investment of USD 1,000,000, the one day VaR (95% confidence level) for the base portfolio consisting of 75% invested in the Barclays Global Bond Index and 25% invested in the MSCI World Index is about USD 6,700, i.e., 0.67% of the total portfolio value. Adding the Palisades Water Index reduces the value at risk to 0.47% or USD 4,700.

As a last analysis in our attempt to determine the advantages of water as an asset, we investigate whether the returns of the Palisades Water Index are driven by the overall market movement or whether the returns of the index are driven by its "waterness". Hence, we regress the returns of the Palisades Water Index on the returns of the market. As additional factors that might drive the returns of the water index, we control for movements of bond and commodity returns:

$$WATER = \alpha + \beta_1 MARKET + \beta_2 BOND + \beta_3 COMMODITY + \varepsilon \quad (3)$$

where $WATER$ is represented by the Palisades Water Index, $MARKET$ is represented by the MSCI World Index, $BOND$ is represented by Barclays Global Bond Index and $COMMODITY$ is represented by the S&P GSCI TR Index, accordingly. If there really is a water factor inherent, we would expect a positive α. Table 5 shows the results.

The majority of movement of the returns can be explained by movements of the overall market (slope coefficient: 0.8487). The constant term has a value of 0.0004 and is statistically significant at the 1%-level. Hence, one would expect the returns of the Palisades Water Index to increase by 0.0004% on a daily basis independent of movements of the stock, bond and commoditiy markets. Assuming 260 trading days, this translates into 0.10% on an annual basis. As returns of the water index are mainly driven by movements of the market as such, the diversification properties again seem rather limited.

Independent Variables	(i)	(ii)	(iii)	(iv)
Constant	0.0004	0.0004	0.0003	0.0004
	(4.92)	(2.69)	(1.85)	(4.32)
MARKET	0.8471			0.8487
	(105.46)			(101.21)
BOND		-0.1492		0.2117
		(-3.04)		(8.22)
COMMODITY			0.1804	0.0173
			(18.04)	(3.08)
R^2	0.7260	0.0020	0.0717	0.7311

Note: t statistics in parenthesis.

Table 5: Regression Results for the Palisades Global Water Index

5 Conclusion

As correlations between asset classes increased and beneficial diversification properties vanished during the financial crisis, investors are searching for new and potentially uncorrelated asset classes to improve their portfolios. At the same time, the ever increasing demand for water caused by a growing world population leads to heavy investment needs in the water industry. For example, the World Bank Group will lend funds in the size of US$ 21 to US$ 25 billion in the period 2010 to 2013 for projects in the water sector (World Bank (2010)). Therefore, companies active in this industry provide investment opportunities as their business is expected to grow. In the ongoing search for new and potentially uncorrelated assets, our study is the first to acknowledge these investment opportunities and to look at potential diversification benefits of water as an asset class. Besides a high expected return and a slightly negative correlation with bonds, the consideration of water in a portfolio context is able to shift the efficient frontier of a traditional stock and bond portfolio upward, to increase the Sharpe ratio and to lower the value at risk (VaR). However, using the efficiency test proposed by Gibbons, Ross & Shanken (1989), the improvement of the portfolio's Sharpe ratio is not found to be statistically significant. In addition, the returns of the water index are largely determined by the overall market movement rather than the idiosyncratic "waterness". Hence, we conclude that investors benefit from including water as an asset in their portfolios. These gains are, however, rather limited. Further research should carefully monitor the developments in the global water business in order to seek further investment opportunities that provide diversification benefits and lead to more efficient portfolios.

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