Capital Markets Risk Signaling: Linking Financial Asset Risk Pricing to Water Risk Exposures

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Abstract

The impact of water and weather risk exposures on companies across industry sectors is a topic of interest in the accounting and corporate finance literature, in environmental, social and governance (ESG) risk ratings, and credit risk guidance. We posit that water risk represents an idiosyncratic risk, because of the geographic and industry-specific context of its impacts. Given the short-term and high kurtosis characteristics of water and weather risk on share price volatility, water risk pricing can be estimated from tail volatility risk, relative to sector-specific behavior. It is further informed by operational efficiencies relative to fixed assets, and intangible costs. This waterBeta, a portfolio theory-driven excess volatility metric was computed for companies across industry sectors. Integration of waterBeta data in a water risk index, informed by a ten year back test, unlocked 50 bps alpha in the US50 and 90 bps in the Euro50 index. Hence, treating water risk as a volatility risk premium for asset allocation captures value for investors and informs the holdings of embedded risk.

Background

Highly variable weather conditions and extreme events, water quality and quantity, as well as regulatory risks impact cost of operations, supply chain inefficiencies and return on assets (e.g. Morgan and Orr, 2015). Corporate water risk management strategies require decision-making to balance operational risks and future opportunity costs with community engagement and moral hazard issues. To facilitate these decisions, tools have been developed to evaluate water use efficiencies, water footprints, economic costs, and regional asset risk exposures at granular catchment levels (Reig et al., 2013). Most of the attention has been focused on corporate engagement, disclosures and capital-efficient risk response measures including financial hedging and insurance or options contracts. Long-term capex outlay for technological or infrastructure investments related to recycling/re-use and supply extension tend to be a distant second (Larson et al., 2012).

The ripple effect of corporate water risk exposures to capital market signals, beyond credit warnings by ratings agencies and shareholder resolutions, is less clear. In part, the argument is that equity analysts have no clear policy signals to help assess water risks to stocks or corporate bonds. Recently, banks and institutional investors have started to focus on water risk exposures in their (loan and corporate bond) portfolios, and on integrating risk metrics for financial asset allocation across fixed income, public and private equities (Ceres, 2017). Most of these efforts are driven by accounting data such as revenue and cost impacts, and risk management metrics such as water use targets, which are relevant to – but not directly correlated with – returns in the market. Hence, the guidance of these metrics to price volatility (risk) is limited.

Voluntary disclosures on water risk are available from corporate reporting, and present their competitive position with respect to water exposures and risk management practices. In a situation of information asymmetry, the company decides what information to release, and the market needs to decide how to interpret this. There are considerable uncertainties how

environmental disclosures are presented in sustainability reporting (Hahn and Lülfs, 2013). In the past 5 years, NGOs and data providers in the financial industry have attempted to level the asymmetry by providing transparency and standardization of water risk disclosures. Unlike carbon or ESG risk ratings, it is unclear how the markets are using this information to provide guidance on financial asset pricing, or structure indexes, given the broad range of systemic, industry-specific, geographic, and political risk exposures of global companies. A recent report (CDP, 2017) indicated that there is a deficiency between water risk exposures and water risk investment for future resiliency. Part of the challenge is the quantification of water risk.

Research Objective

This paper presents an alternative approach to uncovering capital markets impacts resulting from water and extreme events and corporate risk signaling, based on portfolio theory (e.g. Lee and Faff, 2009). Modern portfolio theory states that the risk (or standard deviation of returns from the benchmark, e.g. the broader market) for individual stock returns has two components: Systemic risk, and unsystematic ("idiosyncratic" or "specific") risk. Systemic market risks affect all stocks, such as interest rates, currency exchange, recessions and wars. Unsystematic risk is specific to individual stocks or industry segments and represents the component of a stock's return that is not correlated with general market movement. Systemic risk (volatility of returns) of a security or a portfolio is represented by financial beta, a measure that relates the standard deviation of the asset returns, relative to the broader market benchmark. Water tends to have idiosyncratic characteristics, since industries are impacted differently depending on their financial proximity to water, and direct or indirect water use in their supply chains. In addition, water or weather events tend to manifest themselves in short-term extreme price volatilities and will be reflected as a value-at-risk signal (95^{th} percentile) (Li and Adriaens, 2017; Mogosanu, 2018).

Methodology

We test the hypothesis that water risk events impact share price volatility in the market and can be explained using a combination of portfolio theory, water resource productivity, and natural language processing (NLP) approaches that uncover risk metrics from unstructured data.

Our research uses empirical market and corporate data (Bloomberg and FactSet), supplemented with water resource information at watershed-level (Bloomberg-Aqueduct) and voluntary and SEC disclosures to identify the capital market impacts resulting from water and extreme events and corporate risk signaling based on portfolio theory.

Water risk can be quantified by uncovering volatility signals in the VaR tails of short-term share price windows. The metric, waterBeta®, is an excess volatility signal representing excess risk from water risk or extreme events, uncorrelated to general market trends, that integrates physical and financial water risk. In other words, it represents a statistical water risk signal in the noise.

$$\mathbf{waterBeta}^{®} = f\left(\frac{VaR_{asset}}{VaR_{index}} * Corr.\left(Price_{asset}, Price_{index}\right), F_{AssetRisk}, \frac{Net\ PPE}{EV}, \beta_{intangibles}\right)$$

Components of waterBeta® methodology include: (1) the Value-at-Risk (VaR) signal of the company stock relative to its relevant industry sector benchmark based on empirical market data, (2) an efficiency metric representing the operational value generated from real asset investments based on corporate accounting data, (3) the fraction of economic output of the company in high risk watersheds based on geographic water risk exposure data and (4) an intangible risk factor (beta prime) that captures the impact of future liabilities, business model or brand, industry value chain position, water intensity and percentage of water withdrawal in a particular industry through data scrapping of voluntary and SEC disclosures including ESG water risk data.

WaterBeta® algorithms are structured based on the following assumptions: (1) it is expressed as a probability loss because the correlation between water risk exposures and returns is mainly observed in extreme events (e.g. drought, flood, Gulf oil spill, etc), the rest being tied to commodity prices and other secondary metrics ; (2) the benchmark used for calculating waterBeta is a relevant industry sector index with similar water exposures; (3) the risk metric is based on Value-at-Risk (VaR) analytics, representing the 95^{th} percentile of quarterly losses based on daily share prices over a 10-year time frame and (4) since water risk impacts corporate operations and intangibles valuation, the waterBeta® needs to be modulated by the (direct or indirect) exposure of the company's real assets to geographic risks at the watershed, catchment, or sub-catchment level.

WaterBeta® can be interpreted to exhibit similar features as financial beta (portfolio theory), whereby volatility is measured relative to a benchmark. However, rather than considering long-term average volatility risk over 2 years relative to broad (cross-sector) market indices, waterBeta® is adjusted for other factors such as corporate efficiency metrics and unstructured data signals.

Major Findings

WaterBeta test

An initial universe of 25 companies across 5 industries (food, beverage, energy utilities, household products and semiconductors) was selected in cooperation with Dana Investment Advisors. Specific criteria such as (1) availability of geographic water risk exposure data, (2) focused line of business based on the NAICS code alignment to ensure a better isolation of the water risk from the diverse type of risks that can affect daily operations, (3) market capitalization higher than $10BN and (4) a minimum of 15 facilities per company for a diverse set of type of facilities and of percentage of water withdrawals from the watershed were applied to select the final 25 US-listed companies with both domestic and international assets (5 companies per industry) for which the waterBeta® analysis was restricted to the US water risk information and output productivity in US water stressed regions.

The process of selecting the benchmark indexes for each industry was based on the following criteria: availability of trading data for the 10-year window period, representative-ness of the companies included in the index relative to the sample companies in terms of primary line of business, and the size of the companies included in the index (percentage of large caps). The resulting benchmark indexes were: (1) for utilities - MSCI USA Utilities Index; (2) for

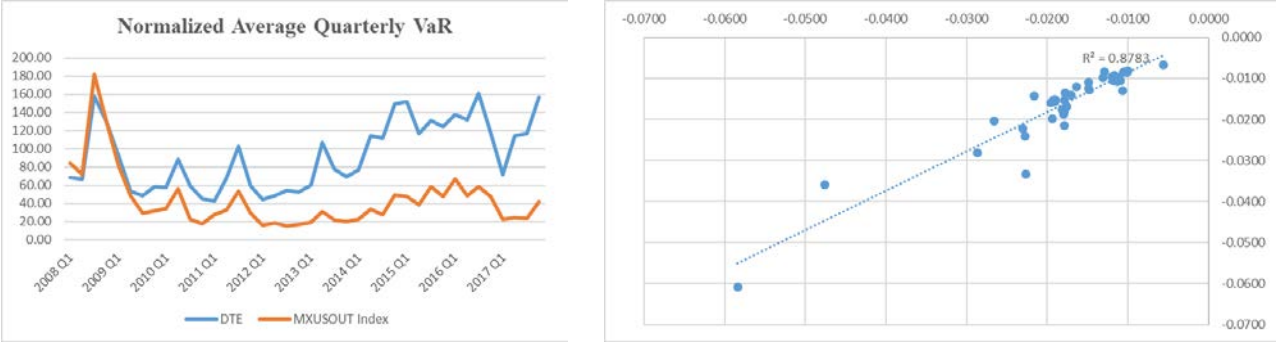


Figure 1. Value at risk (VaR) calculations for DTE Energy and MXUSOUT index (left), and correlation between quarterly DTE Energy and MXUSOUT VaR (2008-2017) (right).

semiconductors - PHLX Semiconductor Index; (3) for food and beverages - S&P Food & Beverage Select Industry Index; (4) for household products - S&P 500 Consumer Staples. Results are shown for the VaR of DTE Energy (an energy utility) relative to the energy index (Figure 1), and waterBeta® relative to the average of selected energy companies (Figure 2).

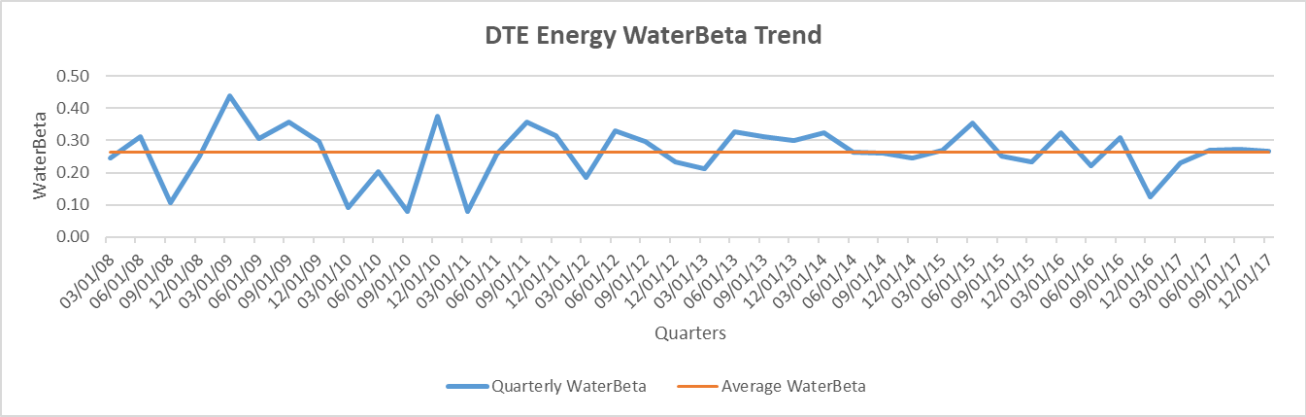


Figure 2. WaterBeta values for DTE Energy since 2008.

By computing the correlations between the quarterly VaR of the security and that of the index, we used the VaR values to explain trends of company volatility relative to the index. The correlation coefficient for DTE Energy is 0.8783, showing a high degree of similarity in volatility with its respective benchmark index. Thus, based on statistical analysis, it is apparent that short-term VaR data have the inherent capacity to expose granular features beyond what is possible using CAPM beta.

To assess the fraction of economic output of a company in water stressed US regions, tools such as Bloomberg-Aqueduct maps provide estimates of the water stress as amount of withdrawals relative to the available flow in the watershed. Since our study focused on the percentage of economic output generated in US regions with high and extremely high water stress, only assets in regions above 40% water risk were considered. For industries where the output capacity of each facility was available in the geographic water risk exposure tools, the fraction of economic output represented the percentage of output from high and extremely high water stressed regions relative to the total output. The fraction of economic output in water stressed US regions is 37.8% for DTE Energy. For industries where the fraction of economic output in water stressed regions is based on percentage of output, the operational efficiency is

quantified by the quarterly ratio of net PP&E (property, plant and equipment – amount in $MM from the company's balance sheet) to EV (enterprise value – amount in $MM from capital markets tools) to assess the operational value generated from real assets investments. The underlying assumption built in this model is that underperforming assets would be depreciated or sold off, including those that are potentially "stranded" due to limited access to water, drought, or other reasons.

The intangibles risk factor represents a weighted average between the ranking of water intensity of the industry and the quantity of water withdrawal by each industry. Other intangibles include brand risk, supply chain risk, regulatory or local issues. The industry with the highest ranking of water intensity, respectively the one with the highest water withdrawal, represent the basis of 1. The other industries are ranked proportionally to 1.

Scaling of waterBeta to broad market index

To confirm the validity of our findings, the initial pilot was extended to the S&P500 index, a market-cap-weighted stock market index that includes 505 US companies in 11 GICS (Global Industry Classification System) sectors (Figure 3). The 25 companies from the initial pilot correspond to the utilities, consumer staples and IT sectors in the market index. Additional companies from the "500" universe were included in the analysis pool to represent the remaining sectors, except for real estate and telecommunications, for which there is currently no geographic water risk data available. These sectors represent a small percentage weight (4.6%) in the index. In total, we computed waterBeta® for 53 companies based on the previously describe methodology.

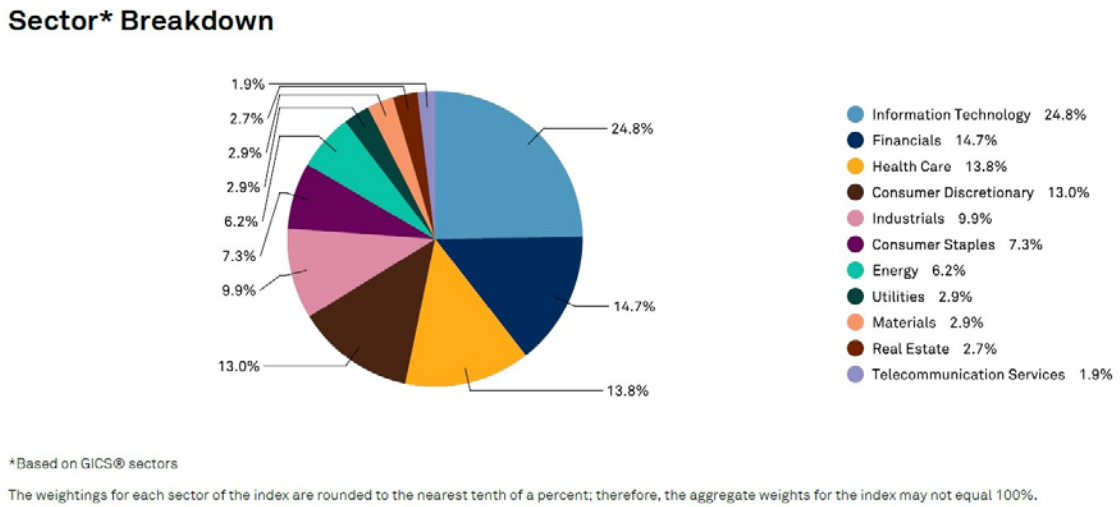
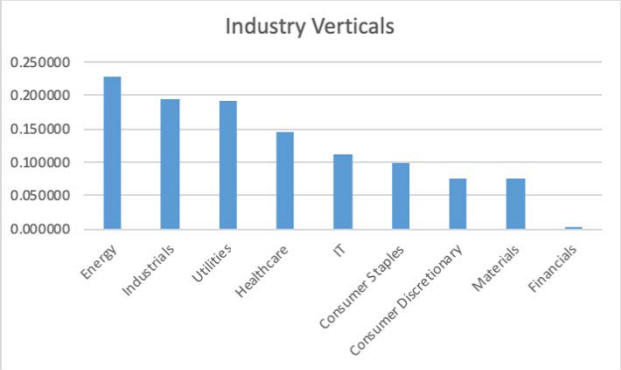


Figure 3. Industry sector weighting in the "500" market index

For the remaining companies in the "500" index, waterBeta® values were imputed using learning models with scaling parameters for each industry sector. Scaling was based on E:P, average sector waterBeta® values, and weighting of the company in the index. For all the companies for which waterBeta® was imputed, the results were checked to verify their value in the 95% and 99% confidence intervals. Any outliers were individually analyzed and waterBeta® was computed from original data. The results are shown in Figure 4, along with top-10 companies with highest 2017 average waterBeta®:



Company	2017 Average waterBeta
Roper Technologies	4.351401
Southwest Airlines	1.445175
Fiserv Inc	1.306042
Regeneron	1.131965
DXC Technology	1.067988
Autodesk Inc.	0.903337
Pioneer Natural Resources	0.791288
American Electric Power	0.779785
Anadarko Petroleum Corp	0.704923
V.F. Corp.	0.624551

Figure 4. Average industry sector waterBeta® (left) and top-10 water risk exposed companies in 2017 (right)

Implications

Investors and asset managers with financial assets exposed to water risk as the result of climate change or environmental regulation have been developing and looking for tools that allow them to systematically manage risk in their portfolios and develop "water alpha" (returns over a benchmark index). More and more asset owners choose to work with data providers and asset managers to develop index products tailored specifically to their requirements to reduce exposure to companies with high specific risks such as water, or reward companies that mitigate or adapt to water/climate change or resource depletion.

The waterBeta® is envisioned to be used for core portfolio management strategy as a volatility risk premium that can be managed or diversified away. Since this is a financial metric, index providers can integrate waterBeta® in their allocation model to create risk-adjusted indexes. The allocation is based on an adjusted beta following the structure:

$$Allocation_{water\ risk} = Allocation_{unadjusted}\left[\frac{\beta}{\beta + water\beta}\right].$$

For a company with a low waterBeta®, no adjustment will be performed in the allocation. For a company with high waterBeta, the allocation would be adjusted downward. A waterBeta®-adjusted water risk index (LYU5WRUN) was published on Bloomberg by LimeYard, a Swiss index provider, showing 50 bps alpha over the US50 index. A second index, the Euro50, shows 10 year back-testing alpha of 90 bps over the benchmark. Since water risk is not included in portfolio allocations, waterBeta® can send a signal to companies to internally invest in water risk mitigation strategies to reduce the volatility of their stock. WaterBeta® doesn't yet provide recommendations to companies on how to manage such water risk because the scope of the metric extends beyond reporting the quantity of water used by integrating weather events, and risk perception by third parties. Further development of an AI platform that would compute data in real-time could provide risk management strategies to both companies and investors.

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