Cogent Economics & Finance ›
Volume 4, 2016 - Issue 1

Research Article

Water exchange traded funds: A study on idiosyncratic risk using Markov switching analysis

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Article: 1139437 | Received 20 Oct 2015, Accepted 05 Jan 2016, Published online: 28 Jan 2016

Cite this article https://doi.org/10.1080/23322039.2016.1139437 Check for updates

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Keywords: idiosyncratic risk water investment transition probabilities Markov switching model water exchange traded funds

Public Interest Statement

Water is essential for life and has been studied to some extent but not as much in terms of major investments and their associated risks. The issues related to climate change has increased the risk of even more people in the world living with lack of adequate water for drinking. To remove this crisis, water investments in a number of areas are urgently needed. This study provides impetus for further study of the financial aspects of the water industry and its related risks. In particular, this paper contributes by increasing the investor’s understanding of the idiosyncratic risk of water investments. The results and findings will guide investors’ in decision-making.

1. Introduction

Although water is essential for life, it is in severe shortage around the world (Tularam &
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compound the existing problems of water availability. However, the urgently developing interfaces in many countries including much needed trade liberalizations together appear to present much important information on the values, benefits, and costs of investing in water (Roca et al., 2015; Tularam, 2014).

Clearly, if the water shortages are to be addressed, the existing global water industry needs to examine the rapidly changing market (Jin et al., 2015b; Roca & Tularam, 2012; Roca et al., 2015). There is a major drinking water crisis worldwide and therefore investments in water are urgently needed (Jin et al., 2015a; Roca et al., 2015). The rapidly changing dynamics of the modern world suggest that water investing can be increasingly popular to investors (Roca & Tularam, 2012; Tularam, 2014). Investing in water companies and water stocks has been the most commonly adopted approach as alternative to direct investment it seems (Jin et al., 2015a). If the water sector expands and the market being rather economically resilient, investments in this industry should lead to fruitful financial returns. Investors could also gain better diversification benefits by involving investments in water within their portfolios (Roca et al., 2015).

In recent times, the development of the water market has led to the development of water exchange traded index funds (ETFs). Water EFTs, are baskets of water-related shares aimed at replicating the performance of the water market. They offer investors the flexibility of buying or selling in the whole water market with a single transaction
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indices generate only a small portion of their revenue from water-related products or services. Therefore, questions have been raised such as the need to examine whether these water ETFs can be defined as pure water funds (Kearney, 2008; Roca et al., 2015).

To the best of our knowledge no study has investigated the relationship between idiosyncratic risk and return of ETFs in the water sector using Markov switching model. More importantly, in terms of the motivation of this study, none of studies reported appear to have investigated the changes of the idiosyncratic risk and risk-return relationship of the water ETF across different regimes. Therefore, this study contributes to investor's understanding of the idiosyncratic risk of water investments. The results will guide investors' in decision-making. Since the research on idiosyncratic risk of ETF is generally lacking, our study therefore aims to fill in this important gap. The main aim of this article was to investigate the relationship between idiosyncratic risk and return among four water exchange traded funds—PowerShares Water Resources Portfolio (PHO), PIO, First Trust ISE Water Index Fund (FIW), and Guggenheim S&P Global Water Index ETF using the Markov switching model for the period 2007–2015. In particular, we examine the effect of water exchange traded funds regimes on water investment using the Markov switching model.

The rest of this paper is organized as follows. In Section 2, we review the related
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Goyal and Santa-Clara (2003) published a paper with the provocative title "Idiosyncratic risk matters!" They reported that there is a positive relation between market return and average idiosyncratic risk for the period of 1963–1999. Later, Bali, Cakici, Yan, and Zhang (2005) expand the Goyal and Santa-Clara's sampling period using two more years of data to find the relation uncovered by Goyal and Santa-Clara is sample specific. They note that sample is driven by small stocks traded on NASDAQ. A dependence on the weighting scheme is partly attributed to liquidity premium. Wei and Zhang's (2005) approach does not allow for the possibility that the relation between idiosyncratic risk and return may be different across high and low volatility states. Guo and Savickas (2003) state that Goyal and Santa-Clara's (2003) did not find further co-movements of average stock volatility with stock market volatility.

Angelidis and Tessaromatis (2009) perform regressions analysis of the monthly value weighted excess market return on lagged value (equally) weighted idiosyncratic volatility. The absence of a relation using value weighted idiosyncratic volatility is consistent with Bali et al. (2005) and Wei and Zhang (2005) research. However, in the case of equally weighted idiosyncratic volatility, it is noted that there is strong evidence of a positive relation only when the stock market is in the low volatility state. While the relation between returns and risk is positive it is not statistically significant in the high volatility state. Huimin, Cheung, and Roca (2010) also find a positive relationship
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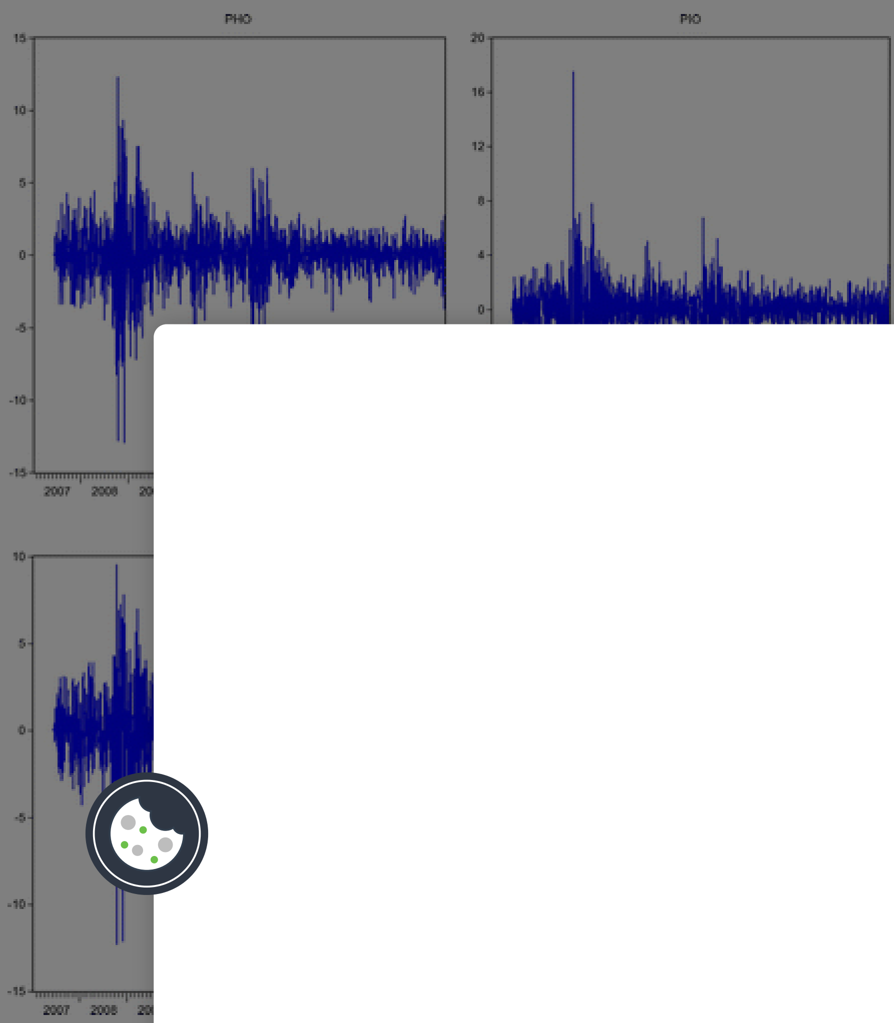
3. Data and methodology

3.1. Data

This study utilizes the PHO, PIO, First Trust ISE FIWand Guggenheim S&P Global Water Index ETF (GGW), all obtained from the Thomson Reuters DataStream database. The particular water exchange traded funds have been selected based on the completeness of data starting from the same date, 15 June 2007. The sample period is from 15 June 2007 to 31 August 2015. Daily data utilized is in the form of returns on the price indices; as calculated by the following formula: Rt=ln(Pricet/Pricet-1×1002; the returns are in US dollars (Figure 1).

Figure 1. PHO, PIO, FIW, and GGW water exchange traded funds movement, 2007–2015



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3.2. Me

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Quandt (1958), introduced a method of estimating the position of a single switching point for a linear regression system obeying two regimes. Goldfeld and Quandt (1973) presented a particularly useful version of these models which is called a Markov switching model. Hamilton (1989) proposed a multivariate generalization of the univariate Markov switching model. Particularly, we use Calice, Mio, Štěrba, and Vašíček (2015) and Calice, Ioannidis, and Miao (2012). According to them

$$\sigma_1^2=(1-S_{i,t})\sigma_{1h}^2+S_{1,t}\sigma_{1l}^2,\sigma_{1h}^2>\sigma_{1l}^2$$

$$\sigma_2^2=(1-S_{i,t})\sigma_{2h}^2+S_{2,t}\sigma_{2l}^2,\sigma_{2h}^2>\sigma_{2l}^2$$

When both $S_{1,t}$ and $S_{2,t}$ are zeros, the two components will be in the high volatility state as $\sigma_1^2=\sigma_{1h}^2$ and $\sigma_2^2=\sigma_{2h}^2$ similarly if $s_{1,t}$ $S_{1,t}$ and $S_{2,t}$ equal 1, the two components will be in the low volatility state since $\sigma_1^2=\sigma_{1l}^2$ and $\sigma_2^2=\sigma_{2l}^2$.

3.3. Transition probabilities

The regime generating process in Markov switching model is an ergodic Markov chain with a finite number of states which means that the current value of the process at time t depends only on its previous value at time t − 1 (Calice et al., 2012, 2015) and Garcia (1998). The transition probabilities from one state to the other are shown below

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Markov chain probability of P_{ij} is shown as follows:

$$\rho k,i,j=Pr(Sk,t=jSK,t-1=i]with\sum j-im\rho ij=1,\forall iandk=\{1,\ldots,m\}$$

3.4. Regime probabilities

This procedure estimates the coefficient matrix, the variance–covariance matrix for each regime, the transition matrix, and the optimal inference for the regimes throughout the sample period. The latter is referred to as the regime probabilities ψtt^/T defined subsequently, where T denotes the end period for the estimation.

$$\psi tt\hat{}=Pr(St=i)fori=1,\ldots,mandt=1,\ldots,T$$

Three types of regime probabilities are involved. However the choice depends on the differences in the existing results. The three types of regime probabilities are written as follows:

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ψt/Tt^,ς=t filtered regime probabilities

ψt/Tt^,t<ς<T smoothed regime probabilities

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idiosyncratic risk and returns by regressing daily water ETFs stock returns by implementing of the CAPM with a time-varying coefficient.

$$R_t=\mu_0+\beta_i^{PHO}f_t^{PHO}+\beta_i^{PIO}f_t^{PIO}+\beta_i^{FIW}f_t^{FIW}+\beta_i^{GGW}f_t^{GGW}+\varepsilon_{ti}$$

where R_t represents the returns on an investment of water ETFs; $i=1,2,\ldots,N$ β_i^{PHO}, β_i^{PIO}, β_i^{FIW}, and β_i^{GGW} are the time series regression coefficients of R_t; $i=1,2,\ldots,N$ in the equation to emphasize age returns across assets; f_t^{PHO}, f_t^{PIO}, f_t^{FIW}, and f_t^{GGW} are the returns on the CAPM. μ_0 is the intercept and ε_{ti} is the error term.

Further, we test the following model to run a regression of the relationship between idiosyncratic risk and returns of water ETFs in regime t by following Angelidis and Tessaromatis (2009) and Huimin et al. (2010) by running OLS time-series regressions. According to them

$$R_t=\mu_0+bX_t+\xi_t$$

where R_t represents the returns on an investment of water ETFs, μ_0 is the intercept, X_t is the idiosyncratic risk, and ξ_t is the error term.

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4.2. Unit root test

The presence of a unit root in the water ETFs returns are tested using both the augmented Dicky–Fuller (ADF) and Phillips–Perron (PP). Table 2 shows that ADF and PP testing procedures of the data PHO, FIW, and GGW at 1%; and PIO at 5% level of significance. Hence, the ADF and PP tests consistently reject the null hypothesis. Both unit root tests suggest the funds' returns those of stocks are stationary. Consequently, the returns time series are used in the subsequent analysis without further differencing or testing for co-integration.

Table 2. Unit root tests results

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4.3. Regime and transition probabilities

Table 3 presents the corresponding probabilities and characteristics for each of the three regimes in the PHO, PIO, FIW, and GGW models. Table 3 shows the funds stayed most of the time; and the longest time in Regime 2. The three numbers in a particular row show the probability of a regime shifting into Regime 1, 2, and 3, respectively. For example, in row 1, the first number 96.44%, which indicates the probability of Regime 1 shifting i nd number 1.63% s ows the probabil Regime 3 staying i shifting to Regimes e probabil

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2.75%, and 97.22% are probabilities of shifting to Regime 1, 2, and 3, respectively, as well.

Similarly, for the FIW, the probability of staying in Regime 1 is 3587% (therefore 45.68% probability of switching to Regime 2; and 43.46% probability of switching to Regime 3); and 20.2345% probability of Regime 3 staying in itself (951025.12% and 2.13% probabilities of shifting to Regime 2 and 1, respectively). Consequently, 43.46%, 02.75%, and 36.30% are probabilities of shifting to Regime 1, 2, and 3, respectively, as well. Again the probability of staying in Regime 1 of GGW is 08.81% (and therefore 39.50% probability of switching to Regime 2; and 51.68% 21.37%) and 02.09% in Regime 3. Consequently, 96.29% and 01.6041.43 are probabilities of shifting to Regime 2 and 1, respectively). Hence, 61.30, 26.94, and 11.75% are probabilities of shifting to Regime 1, 2, and 3, respectively, as well.

Thus, these figures show that there is a high and low probability of switching between Regimes 1 and 3. This means that these regimes are highly and lowly volatile, which further confirms that the water exchange traded funds with the water sector is characterized by more regime stability compared to the funds relationship with the equity market (Roca, Tularam, & Wong, 2011).

A graphical representation of the regime probabilities is presented in Figures 2–4.

Figure 2.

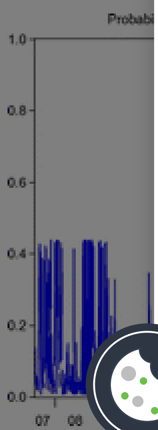

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Figure 3.

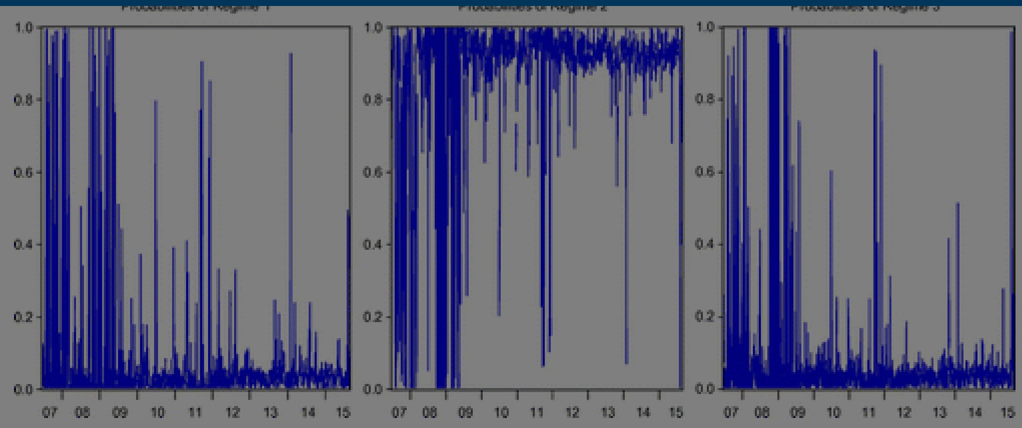

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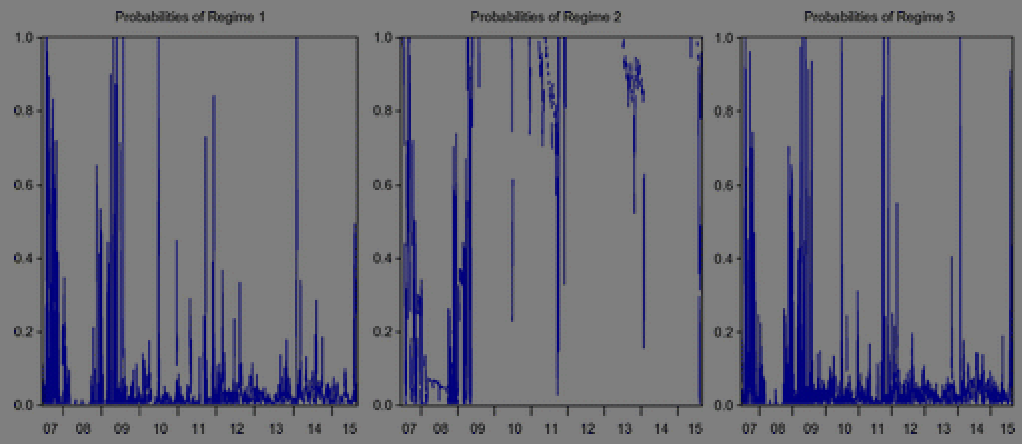
Figure 4. Smoothed regime probabilities.



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their corresponding benchmark indices during different regimes because of the low volatility of four ETFs.

Table 4. Estimated idiosyncratic risk

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4.6. The relationship between idiosyncratic risk and return

From Table 5 it can be seen that during Regime 1, the beta coefficients of four water ETFs are found to be positive. The Three ETFs (PHO, PIO, and FIW) are significant at the 1% level of significance. The beta coefficients are all positive for the four water ETFs at Regime 2 and Regime 3, respectively. All ETFs are significant at the 1% level of significance during Regime 2. However, three ETFs (PHO, FIW, and GGW) are significant at the 1% level of significance during Regime 3. Overall, the results show that water ETFs' beta coefficients' entire values are less than 1, which implies that water investment has a lower idiosyncratic risk which coincide with Angelidis and Tessaromatis (2009) and most of the beta coefficients are positive and significant at Regime 1, Regime 2, and Regime 3, respectively. The results indicate that idiosyncratic risk has a positive effect on the water ETFs returns during different regimes. Based on the time ... of

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from the data-stream database based on the time series data (period 15 June 2004–31 August 2015). In so doing, the study has taken into account of the regime effects.

In this paper, the ADF and PP testing results show that PHO, FIW, and GGW at 1%; and PIO at 5% level of significance. Both unit root tests confirm that the ADF and PP tests consistently reject the null hypothesis and the funds' returns those of stocks are stationary.

The transition probabilities show that there is a high and low probability of switching between Regimes 1 and 3, respectively. The transition probabilities show that three regimes are both highly and lowly volatile. The Markov switching model results show that the idiosyncratic risk of the exchange traded funds (ETFs) are not constant across the three regimes and that the water ETFs appear to have little influence on the idiosyncratic risk. Moreover, the "standard error" terms for regressions across regimes outputs are rather low. In a similar manner, water ETFs affect the total risk. We also identify that the beta coefficients are positive and entire values are less than 1 at Regime 1, Regime 2, and Regime 3, respectively. It seems that water investment has a lower systematic risk and a positive effect on the water ETFs returns during different regimes. Thus, as the Markov switching model is changing when the regime either falls or rises, higher idiosyncratic risk of different regimes illuminating greater returns of water ETFs accordingly.

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