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Impact of Water Management Policies on Volatility Transmission in the Energy Sector

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Abstract: Purpose: This study evaluates the impact of the water management policies of energy companies on their volatility interactions with energy commodities. Design/methodology: We tested for volatility transmissions between 66 energy funds and fossil-fuel commodities. After identifying possible integrations, we investigated whether water management policies, after controlling for other fund characteristics, impact the probability of integration. Results: Our findings indicate strong volatility transmission from oil prices to energy funds. However, a reverse of this information flow was not observed. From the perspective of natural gas, we found strong bi-directional integration with energy funds. When we analyzed the influence of fund characteristics on the previously established integrations, water management policies do not impact the probability of the integration of oil. However, these policies are shown to have a significant influence on integration with the natural gas market. Originality/value: While there are multiple studies that show the integration between energy companies and corresponding commodities, according to our knowledge, this is the first study that evaluates the significance of water management policies with respect to volatility integration. This study highlights the importance of water-related policies with respect to the susceptibility of energy firms to volatility contagion from the natural gas market.

Keywords: water management; energy funds; volatility transmission

JEL Classification: G11; G15; Q43

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1. Introduction

Funds have a variety of specializations, including sectors and/or trading strategies. These specializations allow for funds' performances to vary based on the manager's chosen styles of investment and sectors of interest (see Kacperczyk et al. 2005; Pollet and Wilson 2008; Ferreira et al. 2013; and others). Over time, as fund managers specialize in a sector, they are expected to develop further expertise and efficient decision processes within that sector. This specialization also allows fund managers to determine what information has significance within their industry and trade accordingly (Nanda et al. 2004).

The literature shows energy commodities interacting with stock markets. Several researchers found volatility transmissions between these markets in varying directions and with varying degrees of statistical significance (see Le and Chang 2015; Mensi et al. 2017; Gormus et al. 2014). Energy mutual funds heavily interact with the energy commodity markets (Gormus et al. 2018, 2023). Of particular interest when examining oil and gas focused mutual funds is how a firm deals with water issues. Almost every aspect of oil and gas exploration and production relies upon water (Clark et al. 2013). Large amounts of water are used in drilling and completion processes. Drilling engineers use water to mix specific recipes of mud and chemicals for the fracking of wells in order to promote hydrocarbon migration and extraction. In this process, water is routinely produced along with oil and gas (Morgan 2014). Not only is water crucial for energy production, but it is also crucial for the economy and society at large. Producing energy requires water, and populations require water to survive. While the increased need for potable water is clear, this resource is becoming increasingly scarce (Carrillo and Frei 2009). Thus, a compromise between the various important uses of water must be found.

The hydraulic-fracturing (fracking) revolution has been incredibly meaningful to the energy industry since its inception. However, fracking relies heavily on using and producing large amounts of water. Shale gas is a massive resource found in the midcontinent of North America. It is also no secret throughout this industry that producing shale gas also produces massive amounts of what the industry has termed "produced water" (Clark et al. 2013). This has resulted in water policies becoming very important to energy producers, and, in an increasingly environmentally conscious society, water policies have become critical to energy companies. In the few several years, the impact of water on energy companies has come to the forefront. As established above and well known to many, energy and water are closely linked, and public pressure is forcing the issue of the good stewardship of the water used and produced to the forefront (Scott et al. 2011).

Traditionally, produced water has been viewed as waste, and water used from fracking has been viewed as little more than an input that is expended in the process of bringing a well online. However, this notion is being revisited. Many experimental projects are showing that useful and valuable minerals, as well as water suitable for agriculture, can be derived from produced water (Guerra et al. 2011). This means that produced water will need to be viewed more so as a resource to be managed rather than a cost to be overcome (Hagström et al. 2016).

Water management and corresponding policies for firms are increasingly important due to the attention given to Corporate Social Responsibility (CSR) and Environmental, Social, and Governance (ESG) criteria. Furthermore, as we move into a future that contains a mix of energy sources, the importance of water policies will increase in the future. A significant future conflict is expected between renewable energy production and water availability. The relative implications of this conflict need to be investigated and understood so that future water and energy policies can be drafted sustainably (Elcock 2010).

The literature shows ESG components to be significant in relation to driving integration between energy funds and energy commodities (Gormus et al. 2023). However, the implications of water-related dimensions have not been explored. Given the impact of water on the energy industry, our aim in this study is to test whether these policies have any influence on the market interactions of the oil and gas industry. In order to accomplish this, we first tested for a direct volatility connection between energy mutual funds and energy commodities (oil and natural gas). In the second part, we tested whether certain fund characteristics, including water policies, drive the volatility interactions we previously identified.

Our model first evaluates volatility transmission between 66 energy mutual funds individually against the oil and natural gas markets. We evaluated these transmissions in both directions. In other words, we tested whether volatility transmission is directional or if there is volatility feedback between the assets. After reporting on those interactions, we collected the statistical artifacts from these regressions for use as a dependent variable in the second part of our study.

After identifying volatility transmissions, we tested whether water policy coverage in these funds had any impact on the previously identified integrations. In addition to the water-related variable, our regressions control for other commonly utilized fund characteristics, including the age of a fund, manager tenure, the expense ratio, and Morningstar sustainability rating.

Our results suggest oil volatility transmits to most funds. More interestingly, we found bi-directional transmission between energy funds and the natural gas market. While at a first glance this might appear to be surprising, volatility feedback is expected given the size and implications of the mutual funds with respect to the commodity market. As for the impact of fund characteristics on the identified volatility interactions, we found that oil and natural gas integration differ in how they react. While for the oil market we find the expense ratio and the age of a fund to be important, water management policies seem to be an important driver for the natural gas market.

We suspect our results reflect the unique nature of natural gas production. Shale-drilling projects, which require an abundance of water, are inherently gas-heavy. Oftentimes, the Barrel of Oil Equivalent (BOE) standard is used to communicate regarding dissimilar oil and gas projects on similar terms for things like daily production volume and remaining reserves (Gair 2021). However, BOE reporting blurs the distinction between oil, condensate, and gas, all of which have differing market prices at different reservoirs and points in time. The BOE can obscure how much gas a company is actually producing. Therefore, given the gas-intense nature of shale drilling, it is very likely that companies that produce copious amounts of gas from these projects also generate large amounts of produced water. These water-centric processes influence the significance of corresponding corporate policies.

2. Econometric Methodology

2.1. Testing for Volatility Transmission with Structural Breaks

The model we used to test volatility transmissions is based on a Fourier-augmented GARCH(1,1) model developed by Li and Enders (2018) and includes the Lagrange Multiplier volatility model developed by Hafner and Herwartz (2006). The Fourier approximation aids in capturing structural breaks of any type, size, or magnitude (including gradual/smooth structural breaks)[1]. The final model is defined as follows:

$$\sigma_{it}^2 = \omega_{0i} + \sum_{k=1}^{n} \omega_{1i,k} sin\left(\frac{2\pi k_i t}{T}\right) + \sum_{k=1}^{n} \omega_{2i,k} cos\left(\frac{2\pi k_i t}{T}\right) + \alpha_i \varepsilon_{it-1}^2 + \beta_i \sigma_{it-1}^2 \tag{1}$$

This test statistic is labeled as Fourier λ_{LM} ($F\lambda_{LM}$) in our results. Since using Fourier approximation does not change the number of misspecification indicators in $F\lambda_{LM}$, it follows an asymptotic chi-square distribution with two degrees of freedom.

2.2. Significance of Fund Characteristics

In the second part of our study, we evaluate the significance of each fund characteristic for the volatility interactions we previously identified. In order to accomplish this, we employ a logit framework.

$$pr(y_i = 1|x_i, \theta) = e^{x_i'\theta} / \left(1 + e^{-x_i'\theta}\right) \tag{2}$$

where y_i denotes binary data that corresponds to a value of 1 if there is a transmission identified and 0 otherwise. The fund characteristics we use are represented by the vector x_i. e is the base of the natural logarithm, and θ is the coefficient matrix. Our logit model is estimated using maximum likelihood. Since the transmission results do not show extensive variation (for example, almost all of the funds are impacted by oil prices), we divide the continuous $F\lambda_{LM}$ test statistic based on the median value and consider values above the median to be 1 and values below it to be 0.

3. Data

Our data consist of 66 mutual funds categorized under the "Energy Sector" in the Morningstar database. Due to data availability, our dataset consists of daily observations from 20 September 2016 to 31 August 2023. We also utilize several fund characteristics provided by the same database in the second section of our study. The critical characteristic we use is WATMNGCOV. Morningstar defines these data as follows: "The percentage of the covered long only portfolio invested in corporate securities that is exposed to corporations that have a Water Management policy".

Since oil prices have previously been shown to suffer from structural breaks, we conduct unit root tests of stationarity. We utilize the Fourier-Augmented Dickey–Fuller test, developed by Enders and Lee (2012), to test for a unit root. Our results show that a unit root cannot be rejected[2]. Therefore, our model, which accounts for structural breaks, is appropriate.

4. Results and Discussion

In our analysis, we started by testing each energy mutual fund volatility against oil price volatility. As our findings in Table 1 show, almost all of the funds are impacted by oil price volatility. However, we did not find a similar result in the opposite direction.

Table 1. Volatility transmission between oil and energy fund returns.

Fund	From Oil		*p*-Value	To Oil	*p*-Value
BACIX	12.5375	***	0.0019	0.5111	0.7745
GAGEX	17.9649	***	0.0001	0.4033	0.8174
HNRIX	19.0353	***	0.0001	0.3567	0.8366
XLE	12.4752	***	0.0020	0.8068	0.6680
RSPG	16.9103	***	0.0002	0.6542	0.7210
IXC	14.5067	***	0.0007	0.4373	0.8036
IXC	14.4910	***	0.0007	0.4374	0.8036
CRAK	16.1191	***	0.0003	0.5955	0.7425
IEO	14.8113	***	0.0006	0.7972	0.6713
JNLM	13.3354	***	0.0013	0.7990	0.6706
FTXN	10.6019	***	0.0050	1.0878	0.5805
FILL	13.9952	***	0.0009	0.4447	0.8007
IYE	13.1431	***	0.0014	0.7231	0.6966
IYE	13.1022	***	0.0014	0.7236	0.6964
FSTEX	10.9771	***	0.0041	0.5970	0.7419
VGENX	15.1405	***	0.0005	0.3890	0.8233
FXN	14.1861	***	0.0008	0.4898	0.7828
FENY	13.0501	***	0.0015	0.7918	0.6731
VDE	12.9345	***	0.0016	0.7894	0.6739
FAGNX	14.5772	***	0.0007	0.8479	0.6544
FSENX	17.2370	***	0.0002	0.6345	0.7282
PXE	15.5088	***	0.0004	1.0161	0.6017
IEYYX	13.1407	***	0.0014	0.5777	0.7491
FNARX	16.4717	***	0.0003	0.4410	0.8021
AIWEX	6.7127	**	0.0349	1.2263	0.5416
XOP	12.3642	***	0.0021	0.9146	0.6330
RYEIX	16.6952	***	0.0002	0.5498	0.7597
FCG	11.1562	***	0.0038	0.5959	0.7423
ICPAX	14.2067	***	0.0008	0.6927	0.7073
MLOIX	17.7016	***	0.0001	0.2786	0.8700
CCCNX	20.1755	***	0.0000	0.2543	0.8806
EINC	15.3190	***	0.0005	0.2877	0.8660
MLPX	16.4072	***	0.0003	0.3108	0.8561
INFIX	17.3012	***	0.0002	0.3184	0.8528
PXI	11.1886	***	0.0037	0.7646	0.6823
TPYP	16.2388	***	0.0003	0.2979	0.8616
TMLPX	14.0120	***	0.0009	0.2856	0.8669
TORIX	17.1906	***	0.0002	0.2855	0.8670
HMSIX	15.2637	***	0.0005	0.2901	0.8650
ENFR	16.7165	***	0.0002	0.2743	0.8719
SOAEX	22.3703	***	0.0000	0.3063	0.8580
IEZ	12.0735	***	0.0024	0.4417	0.8018
OIH	11.2356	***	0.0036	0.4458	0.8002
EIPIX	12.8376	***	0.0016	0.2740	0.8720
EMLP	13.4716	***	0.0012	0.2741	0.8719
MLPNX	22.9959	***	0.0000	0.2281	0.8922
MLPOX	24.1569	***	0.0000	0.2467	0.8840
VLPIX	20.4718	***	0.0000	0.4136	0.8132

Table 1. *Cont.*

Fund	From Oil		*p*-Value	To Oil	*p*-Value
SMLPX	12.7847	***	0.0017	0.3666	0.8325
RYVIX	12.6448	***	0.0018	0.4486	0.7991
CSHZX	19.9075	***	0.0000	0.2672	0.8750
EGLIX	0.1684		0.9193	0.2043	0.9029
MLXIX	18.4912	***	0.0001	0.3020	0.8599
IMLPX	19.8318	***	0.0000	0.3484	0.8401
NXGNX	6.6898	**	0.0353	0.5953	0.7426
PSCE	11.1639	***	0.0038	0.5087	0.7754
PRPZX	18.6515	***	0.0001	0.2865	0.8666
GMLPX	18.5714	***	0.0001	0.2791	0.8697
XES	13.2441	***	0.0013	0.4685	0.7912
OEPIX	12.6700	***	0.0018	0.3601	0.8352
PXJ	13.4825	***	0.0012	0.7036	0.7034
AMLP	16.5845	***	0.0003	0.2694	0.8740
AMZA	20.4931	***	0.0000	0.2211	0.8953
MLPA	17.9075	***	0.0001	0.2438	0.8852
MLPTX	23.1367	***	0.0000	0.2355	0.8889
MLPZX	19.8080	***	0.0001	0.2748	0.8716

Notes: Volatility transmission results. "From Oil" refers to volatility transmitting from the oil prices to the mutual funds. "To Oil" refers to volatility transmitting from mutual fund prices to the oil market. ***, **, and * refer to statistical significance with 1%, 5%, and 10% levels, respectively.

We repeated the volatility transmission tests using the natural gas prices. As shown in Table 2, the implications of directional volatility transmission are different compared to those for the oil market. Our results provide evidence of bi-directional volatility transmission between energy mutual funds and the natural gas market. In other words, there is volatility feedback between the asset groups.

Table 2. Volatility transmission between NGas and energy fund returns.

Fund	From Ngas		*p*-Value	To Ngas		*p*-Value
BACIX	16.9243	***	0.0002	6.6924	**	0.0352
GAGEX	22.1379	***	0.0000	6.3974	**	0.0408
HNRIX	24.9969	***	0.0000	6.1239	**	0.0468
XLE	15.4523	***	0.0004	6.7486	**	0.0342
RSPG	21.5759	***	0.0000	6.1595	**	0.0460
IXC	18.5607	***	0.0001	6.8586	**	0.0324
IXC	18.4971	***	0.0001	6.8491	**	0.0326
CRAK	15.9114	***	0.0004	8.4957	**	0.0143
IEO	19.3685	***	0.0001	6.6295	**	0.0363
JNLM	16.4844	***	0.0003	6.6259	**	0.0364
FTXN	13.6781	***	0.0011	7.2761	**	0.0263
FILL	9.1908	**	0.0101	7.1204	**	0.0284
IYE	16.3000	***	0.0003	6.6743	**	0.0355
IYE	16.2279	***	0.0003	6.6664	**	0.0357
FSTEX	17.7184	***	0.0001	6.0957	**	0.0475
VGENX	18.5259	***	0.0001	6.7867	**	0.0336
FXN	20.9859	***	0.0000	6.3524	**	0.0417
FENY	16.3461	***	0.0003	6.6505	**	0.0360
VDE	16.3323	***	0.0003	6.6019	**	0.0368
FAGNX	18.5255	***	0.0001	6.4303	**	0.0401

Table 2. *Cont.*

Fund	From Ngas		*p*-Value	To Ngas		*p*-Value
FSENX	9.3424	***	0.0094	7.1017	**	0.0287
PXE	19.1021	***	0.0001	6.1164	**	0.0470
IEYYX	15.9897	***	0.0003	5.7732	*	0.0558
FNARX	23.2712	***	0.0000	6.2617	**	0.0437
AIWEX	10.1296	***	0.0063	7.0501	**	0.0295
XOP	18.5583	***	0.0001	5.7601	*	0.0561
RYEIX	21.3886	***	0.0000	6.1388	**	0.0464
FCG	20.0220	***	0.0000	5.5705	*	0.0617
ICPAX	17.2346	***	0.0002	6.3413	**	0.0420
MLOIX	24.0695	***	0.0000	6.7028	**	0.0350
CCCNX	25.4711	***	0.0000	6.3030	**	0.0428
EINC	22.6395	***	0.0000	6.6049	**	0.0368
MLPX	24.2556	***	0.0000	6.6136	**	0.0366
INFIX	20.8632	***	0.0000	6.5789	**	0.0373
PXI	15.4835	***	0.0004	5.8643	*	0.0533
TPYP	21.7319	***	0.0000	7.1786	**	0.0276
TMLPX	19.1257	***	0.0001	7.2870	**	0.0262
TORIX	24.7581	***	0.0000	6.7603	**	0.0340
HMSIX	20.0445	***	0.0000	6.7369	**	0.0344
ENFR	24.1204	***	0.0000	6.6689	**	0.0356
SOAEX	26.1882	***	0.0000	6.6075	**	0.0367
IEZ	19.7313	***	0.0001	5.9283	*	0.0516
OIH	19.1504	***	0.0001	5.8265	*	0.0543
EIPIX	15.2719	***	0.0005	8.0786	**	0.0176
EMLP	15.4644	***	0.0004	8.2359	**	0.0163
MLPNX	32.4202	***	0.0000	6.4410	**	0.0399
MLPOX	31.4990	***	0.0000	6.3859	**	0.0411
VLPIX	25.7470	***	0.0000	6.9207	**	0.0314
SMLPX	21.3924	***	0.0000	7.1620	**	0.0278
RYVIX	19.1018	***	0.0001	5.6501	*	0.0593
CSHZX	25.5002	***	0.0000	6.4412	**	0.0399
EGLIX	0.2597		0.8782	5.4362	*	0.0660
MLXIX	25.7775	***	0.0000	6.5919	**	0.0370
IMLPX	27.1546	***	0.0000	6.5496	**	0.0378
NXGNX	7.2705	**	0.0264	8.2743	**	0.0160
PSCE	16.3240	***	0.0003	5.6123	*	0.0604
PRPZX	23.8058	***	0.0000	6.7240	**	0.0347
GMLPX	25.8147	***	0.0000	6.6503	**	0.0360
XES	18.2242	***	0.0001	5.6718	*	0.0587
OEPIX	21.8454	***	0.0000	6.0618	**	0.0483
PXJ	20.8835	***	0.0000	5.9821	*	0.0502
AMLP	24.2260	***	0.0000	6.4531	**	0.0397
AMZA	28.0736	***	0.0000	6.2440	**	0.0441
MLPA	27.0466	***	0.0000	6.0823	**	0.0478
MLPTX	30.2882	***	0.0000	6.1794	**	0.0455
MLPZX	26.0866	***	0.0000	6.1795	**	0.0455

Notes: Volatility transmission results. "From NGas" refers to volatility transmitting from the natural gas prices to the mutual funds. "To NGas" refers to volatility transmitting from mutual fund prices to the natural gas market. ***, **, and * refer to statistical significance with 1%, 5%, and 10% levels, respectively.

Following our volatility transmission tests, in the second part of our study, we tested whether fund characteristics (including water management policy) influence the volatility interactions we previously identified. As we mentioned before, since there is not adequate differentiation between funds with some volatility transmission results (for example, most energy funds are impacted by oil volatility), we used the continuous $F\lambda_{LM}$ test statistic based on the median value and considered values above the median to be 1 and values below it to be 0.

Table 3 provides our logit regression findings for the impact of characteristics on the volatility interaction with the oil market. We observed that the water-related characteristic is not influential. However, we found the age of a fund and the expense ratio to be factors that impact volatility transmissions.

Table 3. Impact of fund characteristics on volatility transmission between oil and energy funds.

Probability Tests								
	Oil to Funds				Funds to Oil			
Variable	Coefficient		z-Statistic	Prob.	Coefficient		z-Statistic	Prob.
AGE	−0.0002		−1.4099	0.1586	0.0005	**	2.4607	0.0139
TEN	−0.1036		−1.3583	0.1744	0.0438		0.4501	0.6527
SIZE	0.0000		−0.1977	0.8432	−0.0001		−1.3557	0.1752
EXPR	1.0662	*	1.6902	0.0910	−2.6882	***	−2.9269	0.0034
MSSUS	−0.1910		−0.4777	0.6329	−0.5757		−1.2011	0.2297
WATMNGCOV	−0.0183		−1.0124	0.3114	0.0340		1.5733	0.1156

Notes: Logit Regressions assessing the impact of each fund characteristic on the probability of previously identified volatility transmission. "Oil to Funds" references a fund characteristic's impact on the volatility transmission from oil to mutual fund prices and vice versa for "Funds to Oil". ***, **, and * refer to statistical significance with 1%, 5%, and 10% levels, respectively.

In the last section, we repeated the logit regressions for the natural gas market. As presented in Table 4, the water-related characteristic significantly influences the volatility interactions between the variables. In addition, we found that the age of the funds as well as the expense ratio are still important.

Table 4. Impact of fund characteristics on volatility transmission between natural gas and energy funds.

Probability Tests								
	Natural Gas to Funds				Funds to Natural Gas			
Variable	Coefficient		z-Statistic	Prob.	Coefficient		z-Statistic	Prob.
AGE	−0.0003	**	−2.2738	0.0230	−0.0003	**	−2.3999	0.0164
TEN	−0.0354		−0.4162	0.6772	−0.0765		−0.9110	0.3623
SIZE	0.0000		−0.2194	0.8264	0.0003		1.2863	0.1983
EXPR	1.7824	**	2.3234	0.0202	−0.9742		−1.3313	0.1831
MSSUS	−0.1926		−0.4453	0.6561	0.6398		1.3211	0.1865
WATMNGCOV	−0.0408	*	−1.9227	0.0545	0.0753	***	2.8527	0.0043

Notes: Logit Regressions assessing the impact of each fund characteristic on the probability of the volatility transmission previously identified. "Natural Gas to Funds" references a fund characteristic's impact on the volatility transmission from natural gas to mutual fund prices and vice versa for "Funds to Natural Gas". ***, **, and * refer to statistical significance with 1%, 5%, and 10% levels, respectively.

5. Concluding Remarks

In this study, we tested for direct as well as bi-directional volatility transmission between energy mutual funds and the oil and gas markets. As a result of the rising importance of ESG characteristics in investing and, more specifically, in the energy industry, we examined whether certain fund characteristics, including corporate maintenance of a water management policy, drive the identified volatility interactions.

Evaluating the transmission from energy funds to oil and gas markets, we found that the two markets differ in how they react. While for the oil market we find that volatility transmits to most funds, this volatility is not bi-directional. Interestingly, our results indicate bi-directional transmission between energy funds and the natural gas market. For the oil market, we found that the expense ratio and the age of a fund are important. On the other hand, we found that water management policies are potentially an important driver for the natural gas market.

Our finding of bi-directional transmission between energy funds and the natural gas market indicates that energy companies producing shale gas, incorporating water-centric processes for development and production, prioritize maintaining corporate water policies. From an investor's perspective, our findings are important because the natural gas market shows a different sensitivity to some of the energy company characteristics (e.g., the existence of water management policies). This added information would be valuable during the creation of relevant portfolios. Future research could shed more light on the importance of these company characteristics. For example, additional water-related characteristics could be tested simultaneously, which could clarify specific policy attributes that drive the interactions we identified in this study.

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Data Availability Statement: Data used in this study are available from Morningstar database.

Conflicts of Interest: Authors declare no conflict of interest.

Notes

[1] In order to save space, we are not including the derivation of this model. Interested readers can refer to (Li and Enders 2018; Hafner and Herwartz 2006).

[2] In order to save space, we are not including those results here. Findings are available upon request.

References

Carrillo, Anna Merce Rio, and Christoph Frei. 2009. Water: A key resource in energy production. *Energy Policy* 37: 4303–12. [CrossRef]

Clark, Corrie E., Robert M. Horner, and Christopher B. Harto. 2013. Life cycle water consumption for shale gas and conventional natural gas. *Environmental Science & Technology* 47: 11829–36.

Elcock, Deborah. 2010. Future US water consumption: The role of energy production 1. *JAWRA Journal of the American Water Resources Association* 46: 447–60. [CrossRef]

Enders, Walter, and Junsoo Lee. 2012. The flexible Fourier form and Dickey-Fuller type unit root tests. *Economics Letters* 117: 196–99. [CrossRef]

Ferreira, Miguel A., Aneel Keswani, António F. Miguel, and Sofia B. Ramos. 2013. The determinants of mutual fund performance: A cross-country study. *Review of Finance* 17: 483–525. [CrossRef]

Gair, Robert. 2021. To Boe or Not to Boe. RSS. Available online: https://www.pdqdecide.com/post/to-boe-or-not-to-boe (accessed on 1 February 2024).

Gormus, Alper, John David Diltz, and Ugur Soytas. 2018. Energy mutual funds and oil prices. *Managerial Finance* 44: 374–88. [CrossRef]

Gormus, Alper, Saban Nazlioglu, and Steven L. Beach. 2023. Environmental, Social, and Governance Considerations in WTI Financialization through Energy Funds. *Journal of Risk and Financial Management* 16: 231. [CrossRef]

Gormus, Alper, Ugur Soytas, and J. David Diltz. 2014. Volatility transmission between energy-related asset classes. *Global Finance Journal* 25: 246–59. [CrossRef]

Guerra, Katie, Katharine Dahm, and Steve Dundorf. 2011. *Oil and Gas Produced Water Management and Beneficial Use in the Western United States*; Washington, DC: US Department of the Interior, Bureau of Reclamation, pp. 1–113.

Hafner, Christian M., and Helmut Herwartz. 2006. A Lagrange multiplier test for causality in variance. *Economics Letters* 93: 137–41. [CrossRef]

Hagström, Earl L., Christopher Lyles, Mala Pattanayek, Bridgette DeShields, and Mark P. Berkman. 2016. Produced water—Emerging challenges, risks, and opportunities. *Environmental Claims Journal* 28: 122–39. [CrossRef]

Kacperczyk, Marcin, Clemens Sialm, and Lu Zheng. 2005. On the industry concentration of actively managed equity mutual funds. *The Journal of Finance* 60: 1983–2011. [CrossRef]

Le, Thai-Ha, and Youngho Chang. 2015. Effects of oil price shocks on the stock market performance: Do nature of shocks and economies matter? *Energy Economics* 51: 261–74. [CrossRef]

Li, Jing, and Walte Enders. 2018. Flexible Fourier form for volatility breaks. *Studies in Nonlinear Dynamics & Econometrics* 22: 1–19.

Mensi, Walid, Shawkat Hammoudeh, Syed Jawad Hussain Shahzad, and Muhammad Shahbaz. 2017. Modelling systemic risk and dependence structure between oil and stock markets using a variational mode decomposition-based copula method. *Journal of Banking & Finance* 75: 258–79.

Morgan, Geoffrey R. 2014. Market for investment in water technologies. *Journal (American Water Works Association)* 106: 126–30. [CrossRef]

Nanda, Vikram, Zhi Jay Wang, and Lu Zheng. 2004. Family values and the star phenomenon: Strategies of mutual fund families. *Review of Financial Studies* 17: 667–98. [CrossRef]

Pollet, Joshua M., and Mungo Wilson. 2008. How does size affect mutual fund behavior? *The Journal of Finance* 63: 2941–69. [CrossRef]

Scott, Christopher A., Suzanne A. Pierce, Martin J. Pasqualetti, Alice L. Jones, Burrell E. Montz, and Joseph H. Hoover. 2011. Policy and institutional dimensions of the water–energy nexus. *Energy Policy* 39: 6622–30. [CrossRef]