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The Price of Oil and the Returns of Alternative Energy Companies: A Firm-Level Approach

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A B S T R A C T

This paper examines the impact of changes in oil prices on the returns of alternative energy companies. Using the individual companies included in the Wilderhill Index from Quarter II 2009 to Quarter II 2017, this paper shows that accounting for firm-level dynamics is important for capturing the impact of changes in oil prices on the returns of alternative energy companies' stocks. For instance, most companies in "cleaner fuels" and in "energy harvesting" exhibit sensitivity to fluctuations in oil prices. Meanwhile, only some companies in the business of power delivery react to oil market changes. Yet, companies in the business of energy conversion, energy storage and greener utilities do not generally show sensitivity to oil market fluctuations. Finally, the results in this paper suggest that the relationship between oil price fluctuations and the returns of alternative energy companies changed after the collapse of oil prices in the summer of 2014.

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1. Introduction

According to the Energy Information Administration, fossil fuels have provided more than 80% of total U.S. energy consumption for more than 100 years. While the United States continues to produce historically high levels of crude oil and natural gas, the share of renewable energy consumption is on the rise, hitting a peak of 10.5% in 2016. Yet, the renewable energy industry has struggled to gain a larger share of US energy consumption, which the financial press asserts is not a result of low oil prices. This paper explores this assertion by examining the impact of changes in oil prices on the stock returns of alternative energy companies. Understanding this relationship is important for investors in fossil fuel companies exposed to stranded asset risk, namely the loss of value associated with the possibility that fossil fuel reserves become unburnable given ongoing efforts to avoid catastrophic climate change outcomes. Investors are paying increased attention to stranded asset risk (Byrd and Cooperman (2017, 2018); Silver (2017)) as a result of multiple factors including environmental challenges, changing resource landscapes, regulations, falling clean technology costs, and evolving social norms (Caldecott et al. (2016)). Investors in fossil fuel companies concerned with protecting their portfolios against stranded asset risk can diversify by selecting investments in alternative energy companies, particularly if alternative energy stocks are negatively related or less sensitive to changes in oil prices.

The purpose of this paper is to examine the sensitivity of alternative energy company returns to changes in oil prices. While renewable energy use is on the rise, petroleum continues to be the largest source of energy consumption in the U.S. and its usage has increased in the past four years—not surprisingly coinciding with the significant decline in oil prices starting in the fall of 2014 as seen in Figure 1.

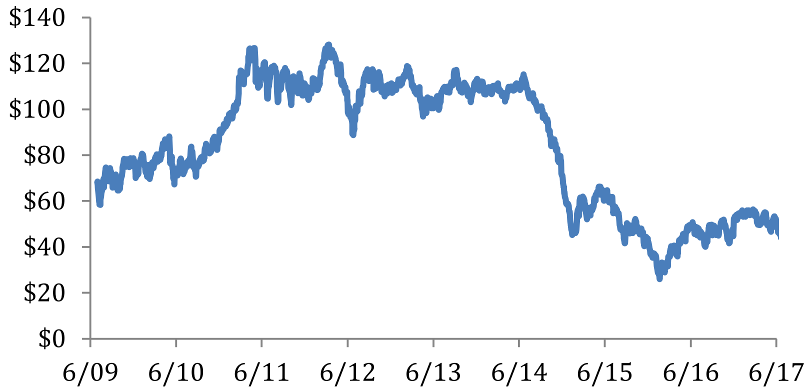

Figure 1 Brent Crude Oil Price
Source: Federal Reserve Bank of St. Louis

This paper contributes to the literature in distinct ways. First, the paper considers the impact of oil prices on alternative energy stocks on a firm-level basis. Existing literature has found mixed evidence of the impact but all work has considered only the impact of oil prices on the values of a clean energy index (Kumar and Managi (2012), Bondia et al.(2016), Henriques and Sadorsky (2008), Managi and Okimoto (2013), Reboredo(2015)). However, the realm of renewable energy has many different dimensions. Adopting a firm-level analysis provides investors better assessments of the risk involved with investing in these securities. For instance, the Wilderhill Clean-Energy Index, commonly used in the empirical literature, divides companies into the following areas:

Renewable Energy Supplies-Harvesting-Producers of energy that is renewably-made, or manufacturers relevant to green energy.

Energy Storage-Wide-ranging category includes advanced batteries and materials that hold energy in familiar and novel ways.

Energy Conversion: Devices that convert an assortment of power, or fuels, or other inputs…into the more desired electrical, motive, lighting, or other power/force wherever needed.

Power Delivery and Conservation: Electronics and other items needed to improve efficiency and energy conservation…as well as capital equipment for production or manufacture of clean energy systems.

Greener Utilities: Explicitly emphasiz[e] cleaner methods of making electric power including wind, solar, biogas, geothermal, hydro and others that can prevent pollution, while also ensuring greater price stability for the consumer.

Cleaner Fuels: Includes various liquid, solid, and other biofuels derived from renewable sources or crops[1].

In addition, the study focuses on the post-financial crisis period—specifically from Quarter II, 2009 until Quarter II, 2017. Focusing on this time period provides interesting dynamics in the oil market. First, the time period captures the low oil prices associated with the aftermath of the global financial crisis, their recovery to record highs and their subsequent fall in the summer of 2014. The period of low oil prices in recent years is particularly interesting because it has been driven, not by declines in energy consumption but by the excess supply of oil arising from the shale oil revolution. Consequently, this paper also considers whether the sensitivity of alternative energy stocks' returns to fluctuations in oil prices changed in the aftermath of the 2014 collapse in oil prices.

Using the individual companies included in the Wilderhill Index from Quarter II 2009 to Quarter II 2017, this paper shows that accounting for firm-level dynamics is important for capturing the impact of changes in oil prices on the returns of alternative energy companies' stocks. For instance, most companies in "cleaner fuels" and in "energy harvesting" exhibit sensitivity to fluctuations in oil prices. Meanwhile, only some companies in the business of power delivery react to oil market changes. Yet, companies in the business of energy conversion, energy storage and greener utilities do not generally show sensitivity to oil market fluctuations. Finally, the results in this paper suggest that the relationship between oil price fluctuations and the returns of alternative energy companies changed in after the collapse of oil prices in the summer of 2014.

The remainder of this paper is organized as follows. Section II reviews the existing literature. Section III presents the sample and empirical model. Section IV details the empirical results and Section V concludes.

2. Literature Review

Henriques and Sadorksy (2008) examine the question of how oil prices impact the pricing of alternative energy companies using a Vector Autoregression (VAR) of the weekly returns on the Wilderhill Index, the S&P 500, the NYSE Arca index, oil prices and interest rates. Granger causality tests indicate information flows from lagged oil returns, the tech sector and interest rates to the clean energy index. However, impulse response functions do not support an impact from oil prices to alternative energy prices. Kumar and Managi (2012) extend Henriques and Sadorky's work by also considering effects from the carbon market on clean energy companies. They include multiple indices to measure clean energy—the Wilderhill Clean Energy Index, the WilderHill New Energy Global Innovation Index and the S&P Global Clean Energy Index. Variance decompositions suggest that oil prices and interest rates explain approximately 25% of the variability of clean energy firms. Sadorksy (2012) utilizes multivariate GARCH models to examine correlations and volatility spillovers between oil markets and

[1] A more detailed description of the types of companies in each area is available at: https://wildershares.com/about.php

clean energy companies. Results suggest that clean energy company returns, as measured by changes in the Wilderhill index, are more correlated with technology sector returns than with oil prices. In addition, Managi and Okimoto (2013) examine this question using a Markov-switching model to control endogenously for structural changes in the oil market. They document a positive relationship between oil prices and the Wilderhill Clean Energy Index after controlling for a structural break in late 2007. Bondia, Ghosh and Kanjilal (2016) extend the work of Managi and Okimoto by using threshold cointegration tests which endogenously incorporate structural breaks in the variables in the model. They find cointegration among clean energy indices, technology companies, oil prices and interest rates. While they find that in the short-run clean energy companies are impacted by the technology sector, oil prices and interest rate, no Granger causality is detected in the long run. Reboredo (2015) uses copulas to model the dependence structure between oil markets and clean energy indices. He documents that oil price dynamics contribute approximately 30% to downside and upside risk of renewable energy companies.

An important limitation of the literature is that it focuses on changes in the value of an alternative energy index. However, membership in an index is not static. For instance, in this work, we find that at least 17 companies were introduced to the Wilderhill Clean Energy Index during 2006-2007. According to WilderShares, companies are also added/removed from the index based on whether they "stand to benefit substantially from a societal transition toward use of cleaner energy and conservation." In addition, companies are removed from the index after delisting, bankruptcy or acquisition. Given changes in the index over time and cross-sectional differences in the companies included in the index, studies focusing only on the impact of oil prices on an index of alternative energy companies provide an incomplete picture of the factors that drive the returns of these firms. This paper seeks to provide a better assessment of how oil prices affect the returns of alternative energy companies by adopting a firm-level approach.

3. Sample and Methodology

Sample construction begins with the list of 138 companies appearing as constituents in the Wilderhill Index during Quarter II, 2005 through Quarter II, 2017. This represents all available constituents on Wilderhill's website. The present study focuses on the period following the 2008 financial crisis, specifically QIII, 2009-QII, 2017. This choice is driven by two factors: the limited impact of oil prices on alternative energy indices documented in the pre-financial crisis period; and data limitations including bankrupt, acquired, and delisted firms. Furthermore, the sample includes only companies included in the Wilderhill Index for more than 2 consecutive years and with available stock price data on Bloomberg. This results in a final sample of 59 companies included in the sample.

Table 1 displays the fifty-nine companies included in the sample along with descriptive statistics for their log returns during the sample period. The descriptive statistics show that daily returns for alternative energy companies are, on average, small and in most cases negative during 2009-2017. Furthermore, the daily returns of alternative energy companies exhibit greater volatility than the market, with Idacorp exhibiting the lowest standard deviation at 0.0117. Yet, during the observed time period, the market, as measured by the S&P 500, exhibited a daily average return of 0.0004 and a standard deviation of 0.0096.

Table 1 Descriptive Statistics for Sample of Clean Energy Firms

Company	Ticker	Mean	Std. Dev.	Min	Max
Clean Fuel					
Amyris	AMRS	-0.0030	0.0518	-0.4721	0.2427
Air Products & Chemicals	APD	0.0004	0.0135	-0.0710	0.0723
Cosan	CZZ	0.0001	0.0263	-0.1784	0.1203
Gevo	GEVO	-0.0058	0.0733	-0.6385	0.8014
Renewable Energy Group	REGI	-0.0002	0.0275	-0.1584	0.1524
Solazyme	TVIA	-0.0021	0.0508	-0.8694	0.2833
Energy Conversion					
Advanced Energy	AEIS	0.0012	0.0228	-0.2374	0.2292
Ballard Power Systems	BLDP	-0.0006	0.0398	-0.1547	0.4490
Fuelcell Energy	FCEL	-0.0011	0.0445	-0.2770	0.2634
Molycorp	MCPI	-0.0032	0.0490	-0.3355	0.2724
Power-One	PWER	-0.0008	0.0392	-0.2382	0.4491
Rare Element Resources	REEM	-0.0029	0.0467	-0.2034	0.2470
Gentherm	THRM	0.0009	0.0281	-0.1478	0.1637
Tesla Motors	TSLA	0.0017	0.0317	-0.2148	0.2183
Power Delivery & Conservation					
Aixtron Aktiengesellschaft	AIXN	-0.0012	0.0292	-0.1458	0.1581
Ameresco	AMRC	-0.0004	0.0292	-0.1925	0.1596
American superconductor	AMSC	-0.0026	0.0433	-0.5420	0.2465
Comverge	COMV	-0.0036	0.0391	-0.1998	0.1147
Cree	CREE	-0.0001	0.0291	-0.2529	0.1993
Echelon	ELON	-0.0015	0.0355	-0.2178	0.3052
EnerNoc	ENOC	-0.0002	0.0413	-0.4881	0.5275
Enphase	ENPH	-0.0013	0.0535	-0.4679	0.3263
GT Advanced	GTAT	-0.0037	0.1118	-2.6256	0.5140
International Rectifier	IRF	0.0007	0.0241	-0.1261	0.3867
ITC Holdings	ITC	0.0005	0.0120	-0.0672	0.0887
Itron	ITRI	0.0001	0.0206	-0.1527	0.1844
Universal Display	OLED	0.0012	0.0359	-0.2284	0.2279
PowerSecure	POWR	0.0012	0.0473	-0.9773	0.6304
Quanta Services	PWR	0.0002	0.0206	-0.3355	0.1101
Rubicon	RBCN	-0.0017	0.0408	-0.2454	0.1840
ReneSola	SOL	-0.0012	0.0474	-0.2397	0.2776
STR Holdings	STRI	-0.0027	0.0418	-0.2942	0.2455
SunEdison	SUNE	-0.0054	0.0818	-0.7932	0.4580
Energy Storage					
A123 Systems	AONE	-0.0046	0.0563	-0.2730	0.4182
Energy Conversion Devices	ENER	-0.0058	0.0474	-0.2423	0.2292
Fuel Systems Solutions	FSYS	-0.0009	0.0322	-0.2046	0.2708
Maxwell Technologies	MXWL	-0.0004	0.0355	-0.4983	0.2055
OM Group	OMG	0.0001	0.0245	-0.1481	0.2489
Polypor International	PPO	0.0008	0.0315	-0.3556	0.2242
Sociedad de Chile	SQM	-0.0005	0.0195	-0.1877	0.1197
Greener Utilities					
CPFL	CPL	0.0000	0.0165	-0.0895	0.0716
Idacorp	IDA	0.0006	0.0117	-0.0671	0.0583
Pattern Energy	PEGI	-0.0003	0.0204	-0.1013	0.1132
SolarCity	SCTY	0.0001	0.0455	-0.3467	0.2931
Sky Solar	SKYS	-0.0035	0.0665	-0.4348	0.6339
Silver Springs Networks	SSNI	-0.0008	0.0367	-0.3749	0.1994
TerraForm Power	TERP	-0.0015	0.0393	-0.2408	0.2822
Renewable Energy Harvesting					
Broadwind Energy	BWEN	-0.0063	0.0498	-0.3440	0.2407
Canadian Solar	CSIQ	-0.0002	0.0445	-0.2007	0.2888
First Solar	FSLR	-0.0007	0.0356	-0.2921	0.3752
Hanwha Q Cells	HQCL	-0.0008	0.0499	-0.2537	0.3134
JA Solar	JASO	-0.0007	0.0424	-0.1873	0.5328
China Ming Yang Wind	MY	-0.0011	0.0443	-0.2057	0.3109
Ormat Technologies	ORA	0.0002	0.0189	-0.1052	0.1116
Sunpower	SPWR	-0.0005	0.0404	-0.3602	0.3918
SunTech Power	STPF	-0.0041	0.0511	-0.3066	0.2599
Trina Solar	TSL	-0.0001	0.0442	-0.2943	0.2692
Yingli Green Energy	YGE	-0.0022	0.0489	-0.4607	0.2189
Zoltek	ZOLT	0.0005	0.0359	-0.1988	0.3596

Notes: Includes 59 companies listed in Wilderhill Index durig Quarter III, 2009 through Quarter II, 2017. Sample includes only companies included in the indes for more than 2 consecutive years and with available stock price data on Bloomberg.

As previously discussed, most literature examining the impact of oil prices on stocks of alternative energy companies examine indices and take on various forms of Vector Autoregressive (VAR) or Vector Error Correction (VEC) models. Given the individual firm approach utilized in this paper, we deviate from this approach and instead rely on the models employed by literature examining the impact of oil prices on the returns of oil companies. In this study we examine the relationship between alternative energy returns and oil price in an approach similar to Faff and Brailsford (1999), El-Sharif et al. (2005), Sadorksy (2008), and Mollick and Nguyen (2015). The model utilized in the current paper follows the following form:

$$\boldsymbol{R_{i,t} = \alpha_i + \beta_{1,i}R_{mkt,t} + \beta_{2,i}R_{oil,t} + \beta_{3,i}R_{spread,t} + \beta_{4,i}R_{fx,t} + \varepsilon_{i,t}} \quad (1)$$

where: $R_{i,t}$ is the stock return for alternative energy company *i* at time *t*. $R_{mkt,t}$ are the log returns on the market, as measured by the S&P 500 index. $R_{oil,t}$ are the daily changes in the log price of Brent crude oil. $\beta_{3,i}R_{spread,t}$ are the changes in the log yield spread which is in turn defined as the difference between the yields on a 10-year Treasury note and the 3-month Treasury bill. As described in Hahn and Lee (2006), the difference between yields on the 10-year Treasury note and the 3-month T-bill measure is the term spread which in turn reflects expectations about future interest rates and can explain systematic differences in average returns similar to the Fama-French factors. The term spread factor for the aforementioned regressions is defined as changes in the term spread[2]. $R_{fx,t}$ are the changes in the log values of the trade-weighted US dollar index. We include the exchange rate control because of the global nature of alternative energy companies and because the sample includes companies that are trading in the US in the form of American Depositary Receipts (ADRs). Empirical evidence suggests ADR prices are influenced by exchange rate fluctuations (Bae et al. (2008); Bin et al. (2004); Liang and Mougoue (1996)). $\varepsilon_{i,t}$ represents the idiosyncratic error term[3].

In addition, this study considers whether alternative energy companies exhibit asymmetric exposure to changes in oil prices. That is, this study asks the question: do decreases in oil prices impact alternative energy company returns as increases in oil prices? Evidence on the asymmetric impact of oil price fluctuations on stock returns is documented in (Mohanty et al. (2011). To investigate this possibility, we estimate Equation (2) below:

$$\boldsymbol{R_{i,t} = \alpha_i + \beta_{1,i}R_{mkt,t} + \beta_{2,i}R_{oil,t} + \beta_{3,i}R_{spread,t} + \beta_{4,i}R_{fx,t} + \beta_{5,i}Asymetry_{oil,t}\varepsilon_{i,t}} \quad (2)$$

where all variables correspond to the aforementioned definitions for Equation (1) and $Asymetry_{oil,t}$ is the interaction of $R_{oil,t}$ and a dummy variable that takes on the value of 1 if a change in $R_{oil,t}$ is negative and zero otherwise.

4. Empirical Results

Empirical estimates of Equation (1) are presented in Table 2. The results indicate that the sensitivity of alternative energy companies' returns to fluctuations in oil prices varies significantly across firms. Overall, one quarter of the sample exhibits positive and statistically significant coefficients on the $R_{oil,t}$

[2] For consistency in measuring changes over time, this paper transforms the spread variable using natural logarithms before measuring changes over time.

[3] To address any persistence in the return series, we fit Equation (1) as an Autoregressive AR(p) model where the lag order is determined by the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). Ljung-Box Q-tests are used to assess model fit.

factor. This result is not surprising. It suggests that if renewable energy is an alternative to oil, then a decrease in the price of oil makes oil more attractive. Therefore, consumer interest in alternative energy will fall, thus leading to decreases in the prices of alternative energy stocks. However, the aforementioned 25% is not consistent across different types of alternative energy. For instance, companies engaged in the business of cleaner fuels appear more exposed to oil price fluctuations. Over 80% (5/6) of the firms in this category show positive and statistically coefficients ranging from 0.126 to 0.286. To a lesser extent, approximately 40% (5/12) companies examined in the renewable energy harvesting area also exhibit significant exposure to oil price changes with an average coefficient of 0.15. In addition, the percentage of companies exhibiting exposure to changes in oil prices declines to approximately 21% (4/19) in the area of power delivery, with the magnitude of exposure closely resembling companies in cleaner fuels and renewable energy harvesting. Only one company of the seven considered in energy storage shows a statistically significant coefficient on the oil variable. However, this company, Maxwell Technologies, appears to be an outlier since the estimates are unusually large in magnitude. Similarly, only 1 company in the greener utilities sector shows exposure to fluctuations in oil. The coefficient on Pattern Energy (PEGI) is similar to other companies at a magnitude of 0.108. Finally, no companies in the energy conversion sector show any statistically significant exposure to fluctuations in oil prices. Overall, these results reconcile the mixed findings in the literature and suggest that an examination of the impact of oil prices on alternative energy companies necessitates a firm-by-firm approach.

Table 2 Regression Estimates: The Impact of Oil Price Fluctuations on the Returns of Alternative Energy Companies

	AR(p)	C	$R_{oil,t}$	$R_{spread,t}$	$R_{fx,t}$	$R_{mkt,t}$	N	Adj. R2	AIC	SIC	DW	Q(5)
Cleaner Fuels												
APD	3	0.000	0.020	0.002	-0.130*	0.991***	1673	51.81%	-6.487	-6.461	2.098	8.933
		0.000	(0.013)	(0.011)	(0.061)	(0.035)						
AMRS	1	0.004	0.126*	-0.102*	0.058	1.307***	1473	5.08%	-3.138	-3.117	1.975	3.871
		0.004	(0.073)	(0.058)	(0.298)	(0.160)						
CZZ	1	0.000	0.229***	-0.059*	-0.473***	1.276***	1817	30.31%	-4.798	-4.780	2.018	4.919
		(0.001)	(0.038)	(0.025)	(0.160)	(0.066)						
GEVO	2	-0.006	0.229***	0.080	-0.632	1.150***	1358	4.67%	-2.454	-2.428	2.037	6.394
		(0.002)	(0.113)	(0.087)	(0.553)	(0.231)						
REGI	4	0.000	0.136*	-0.060	-0.072	1.165***	751	12.72%	-4.536	-4.481	1.940	0.606
		(0.001)	(0.054)	(0.040)	(0.205)	(0.118)						
TVIA	1	-0.002*	0.286***	0.011	-0.446	1.370***	1069	10.43%	-3.215	-3.188	2.106	7.763
		(0.001)	(0.091)	(0.059)	(0.397)	(0.168)						
Energy Conversion												
AEIS	4	0.001	-0.035	0.002	0.306**	1.365***	863	21.09%	-4.883	-4.833	2.065	7.855
		(0.001)	(0.027)	(0.029)	(0.156)	(0.111)						
DBLDP	2	-0.001	0.105	-0.004	-0.316	0.847***	655	14.76%	-3.759	-3.711	2.095	3.776
		(0.001)	(0.083)	(0.055)	(0.289)	(0.133)						
DFCEL	4	-0.003	0.076	-0.028	-0.085	1.628***	1259	15.88%	-3.611	-3.575	2.047	2.317
		(0.001)	(0.072)	(0.057)	(0.253)	(0.139)						
MCPI	1	-0.004	0.007	-0.046	0.223	1.587***	961	8.72%	-3.320	-3.289	2.141	4.056
		(0.001)	(0.119)	(0.077)	(0.540)	(0.134)						
PWER	1	-0.001	0.064	-0.174**	0.093	1.437***	563	12.18%	-3.759	-3.713	2.061	0.827
		(0.001)	(0.097)	(0.072)	(0.347)	(0.201)						
DREEM	4	-0.004***	-0.061	0.014	-0.489	1.504***	696	12.99%	-3.508	-3.449	2.192	5.974
		(0.002)	(0.133)	(0.085)	(0.584)	(0.175)						
THRM	5	0.000	0.050	0.040	-0.099	1.438***	1550	28.45%	-4.646	-4.611	2.115	5.216
		(0.001)	(0.036)	(0.034)	(0.161)	(0.092)						
TSLA	2	0.001	0.041	-0.053	0.209	1.280***	1483	13.24%	-4.249	-4.224	2.018	5.216
		(0.001)	(0.037)	(0.033)	(0.177)	(0.088)						
Power Delivery												
AIXN	1	-0.002***	-0.052	0.101***	-0.897***	1.395***	1248	31.13%	-4.582	-4.557	1.994	5.014
		(0.001)	(0.060)	(0.031)	(0.198)	(0.083)						
AMRC	2	-0.001	0.043	0.019	-0.273	1.252***	1413	18.73%	-4.433	-4.407	2.099	3.609
		(0.001)	(0.045)	(0.037)	(0.189)	(0.090)						
AMSC	1	-0.004***	0.039	-0.026	0.412	1.730***	1251	15.77%	-3.630	-3.606	2.084	8.671
		(0.001)	(0.090)	(0.056)	(0.300)	(0.148)						
COMV	1	-0.004***	0.190**	-0.095	0.560	1.547***	571	22.19%	-3.873	-3.827	2.092	7.253

	AR(p)	C	$R_{oil,t}$	$R_{spread,t}$	$R_{fx,t}$	$R_{mkt,t}$	N	Adj. R2	AIC	SIC	DW	Q(5)
		(0.001)	(0.090)	(0.078)	(0.355)	(0.155)						
CREE	2	-0.001**	-0.057	0.0417*	-0.268*	1.451***	1744	25.76%	-4.571	-4.549	2.094	5.407
		(0.001)	(0.036)	(0.024)	(0.148)	(0.106)						
ELON	1	-0.003***	-0.031	-0.043	-0.252	1.500***	1304	17.70%	-4.003	-3.979	2.019	1.262
		(0.001)	(0.067)	(0.043)	(0.212)	(0.125)						
ENOC	2	-0.001	0.165***	-0.035	-0.364	1.350***	1195	9.40%	-3.736	-3.707	2.081	2.840
		(0.001)	(0.059)	(0.047)	(0.227)	(0.168)						
ENPH	1	-0.002	-0.054	0.050	-0.732	2.148***	962	10.20%	-3.080	-3.050	2.084	5.627
		(0.002)	(0.094)	(0.072)	(0.454)	(0.255)						
GTAT	3	-0.005	0.227	0.048	1.787	2.377***	672	3.55%	-1.451	-1.398	2.060	8.459
		(0.005)	(0.242)	(0.115)	(2.201)	(0.574)						
IRF	1	0.000	-0.003	0.044*	-0.021	1.389***	1195	35.99%	-5.028	-5.003	2.122	2.702
		(0.001)	(0.037)	(0.023)	(0.170)	(0.108)						
ITC	1	0.000	0.036**	-0.073***	-0.012	0.584***	1197	20.48%	-6.285	-6.259	1.995	2.198
		(0.000)	(0.018)	(0.016)	(0.083)	(0.038)						
ITRI	2	0.000	-0.032	0.025	-0.125	1.099***	1744	26.60%	-5.202	-5.180	2.101	3.643
		(0.000)	(0.024)	(0.019)	(0.098)	(0.062)						
OLED	1	0.000	-0.025	-0.050	-0.017	1.831***	1817	21.36%	-4.020	-4.002	2.045	6.078
		(0.001)	(0.044)	(0.038)	(0.193)	(0.110)						
POWR	1	0.001	0.105	-0.067	-0.250	1.508***	1010	7.22%	-3.268	-3.239	2.050	2.160
		(0.002)	(0.105)	(0.071)	(0.222)	(0.160)						
PWR	1	0.000	0.041	0.041**	-0.081	1.171***	1817	34.18%	-5.332	-5.314	2.048	3.987
		(0.000)	(0.025)	(0.019)	(0.122)	(0.061)						
RBCN	5	-0.002**	0.093	0.066	-0.125	1.400***	1210	14.86%	-3.724	-3.682	2.064	1.172
		(0.001)	(0.071)	(0.058)	(0.269)	(0.131)						
SOL	1	-0.002**	0.139**	-0.007	-0.556**	1.661***	1704	14.63%	-3.415	-3.396	2.047	5.143
		(0.001)	(0.057)	(0.053)	(0.249)	(0.143)						
STRI	1	-0.002**	-0.133	0.024	-0.807**	1.363***	964	14.15%	-3.724	-3.694	2.033	3.074
		(0.001)	(0.103)	(0.057)	(0.316)	(0.138)						
SUNE	5	-0.006**	0.278	-0.209	0.131	2.207***	579	0.070	-2.379	-2.304	1.933	6.732
		(0.003)	(0.326)	(0.176)	(0.803)	(0.372)						
Energy Storage												
AONE	1	-0.005***	0.064	0.119	1.056*	2.077***	567	20.96%	-3.136	-3.090	1.959	2.721
		(0.002)	(0.152)	(0.104)	(0.603)	(0.325)						
ENER	2	-0.007***	0.115	-0.162	0.480	1.455***	496	11.23%	-3.376	-3.316	2.153	8.849
		(0.002)	(0.133)	(0.147)	(0.497)	(0.235)						
FSYS	1	-0.002***	0.054	-0.019	-0.479**	1.506***	1421	24.14%	-4.275	-4.253	2.032	1.285
		(0.001)	(0.051)	(0.043)	(0.192)	(0.130)						
MXWL	1	-0.012	-0.915**	-0.251	-4.621**	18.486***	1817	18.29%	0.852	0.870	2.012	0.741
		(0.009)	(0.402)	(0.434)	(1.855)	(1.238)						
OMG	5	-0.001	0.031	0.027	-0.153	1.488***	1160	44.26%	-5.220	-5.177	2.008	1.426
		(0.001)	(0.046)	(0.028)	(0.147)	(0.067)						
PPO	2	0.000	-0.047	-0.017	-0.264	1.519***	1030	21.49%	-4.298	-4.264	2.151	3.135
		(0.001)	(0.076)	(0.058)	(0.271)	(0.142)						
SQM	1	-0.001**	0.002	-0.002	-0.386***	1.007***	1304	30.93%	-5.374	-5.350	1.985	2.438
		(0.000)	(0.029)	(0.035)	(0.130)	(0.102)						
Greener Utilities												
CPL	4	0.000	-0.003	-0.079***	-0.385***	0.902***	906	34.90%	-5.798	-5.751	2.031	1.173
		(0.000)	(0.032)	(0.025)	(0.117)	(0.062)						
IDA	1	0.000	-0.011	-0.032**	0.080	0.873***	967	58.20%	-6.930	-6.900	2.015	1.940
		(0.000)	(0.020)	(0.014)	(0.075)	(0.035)						
PEGI	1	-0.001	0.108***	-0.079**	-0.218	1.018***	796	16.58%	-5.107	-5.071	2.059	4.727
		(0.001)	(0.037)	(0.035)	(0.172)	(0.123)						
SCTY	5	-0.001	0.107	0.006	0.113	1.369***	717	8.70%	-3.373	-3.309	2.017	0.440
		(0.002)	(0.091)	(0.069)	(0.386)	(0.244)						
SSNI	1	-0.001	-0.074	0.068*	-0.508**	1.391***	909	8.55%	-3.824	-3.792	2.015	7.134
		(0.001)	(0.060)	(0.039)	(0.257)	(0.150)						
SKYS	5	-0.004*	0.067	0.080	0.045	-0.442	414	3.50%	-3.226	-3.128	2.100	1.684
		(0.002)	(0.146)	(0.093)	(0.505)	(0.548)						
TERP	4	-0.003	0.076	0.093	-0.190	1.471***	502	14.57%	-3.771	-3.695	1.893	5.478
		(0.002)	(0.090)	(0.067)	(0.449)	(0.232)						
Energy Harvesting												
BWEN	1	-0.007***	0.201	-0.134	0.356	1.600***	516	15.04%	-3.309	-3.259	2.023	1.896
		(0.002)	(0.140)	(0.145)	(0.564)	(0.229)						
CSIQ	1	-0.001	0.185***	-0.017	-0.137	1.982***	1646	20.43%	-3.613	-3.594	2.056	5.277
		(0.001)	(0.049)	(0.049)	(0.233)	(0.134)						
FSLR	2	-0.001*	-0.006	0.065	-0.277	1.394***	1744	16.26%	-3.992	-3.970	2.100	7.980
		(0.001)	(0.041)	(0.043)	(0.192)	(0.132)						
HQCL	2	-0.002	0.207***	-0.061	-0.127	1.748***	1246	9.81%	-3.299	-3.270	2.019	5.330
		(0.001)	(0.071)	(0.064)	(0.406)	(0.199)						
JASO	2	-0.001*	0.104**	-0.004	-0.238	1.711***	1744	17.07%	-3.672	-3.650	2.059	3.235
		(0.001)	(0.044)	(0.040)	(0.213)	(0.125)						
MY	1	-0.002*	0.026	-0.035	-0.755**	1.297***	1239	9.49%	-3.548	-3.523	2.031	6.451
		(0.001)	(0.055)	(0.058)	(0.303)	(0.141)						

	AR(p)	C	$R_{oil,t}$	$R_{spread,t}$	$R_{fx,t}$	$R_{mkt,t}$	N	Adj. R2	AIC	SIC	DW	Q(5)
ORA	2	0.000	0.046*	-0.031	-0.145	1.082***	1744	32.34%	-5.498	-5.476	2.002	4.019
		(0.000)	(0.024)	(0.019)	(0.095)	(0.062)						
SPWR	4	-0.002**	0.205***	-0.008	-0.115	1.630***	1612	18.96%	-3.823	-3.793	2.116	3.448
		(0.001)	(0.050)	(0.050)	(0.236)	(0.136)						
STPF	3	-0.005***	0.021	0.086	-0.731*	1.714***	778	18.49%	-3.305	-3.257	2.029	1.691
		(0.002)	(0.107)	(0.086)	(0.441)	(0.233)						
TSL	3	-0.001	0.030	0.014	-0.378	1.796***	1518	18.21%	-3.612	-3.584	1.985	2.472
		(0.001)	(0.051)	(0.051)	(0.259)	(0.153)						
YGE	1	-0.003***	0.081	0.024	-0.442	1.759***	1421	15.90%	-3.402	-3.379	2.039	0.692
		(0.001)	(0.071)	(0.063)	(0.372)	(0.148)						
ZOLT	3	-0.001	0.045	0.025	-0.217	1.752***	940	30.97%	-4.224	-4.183	2.154	3.599
		(0.001)	(0.068)	(0.047)	(0.249)	(0.136)						

Notes: Daily data from 6/30/2009 to 6/30/2017. OLS estimates where: $R_{oil,t}$ are the daily changes in the log price of Brent crude oil. $\beta_{3,i}R_{spread,t}$ are the changes in the log yield spread which is in turn defined as the difference between the yields on a 10-year Treasury note and the 3-month Treasury bill. $R_{mkt,t}$ are the log returns on the market, as measured by the S&P 500 index. Robust standard errors are shown in parentheses. *,**, *** represent statistical significance at the 10%, 5%, and 1% respectively.

The results in Table 2 also reveal other important insights about the dynamics of alternative energy markets. Approximately 20% (12/59) companies exhibit statistically significant coefficients on the spread variable although the coefficients are mixed—negative in seven of the cases and positive in five. The variation in sign on the spread coefficient is also found in Hahn and Lee (2006) where the sign switches from negative for lower book-to-market portfolios to positive for higher book-to-market portfolios. Furthermore, 25% of our sampled companies exhibit sensitivity to exchange rate fluctuations. In the majority of cases, (13 of 15) the coefficient is statistically significant and negative suggesting that an appreciation of the US dollar relative to a trade weighted basket of currencies adversely impacts the returns of alternative energy companies. The companies exhibiting these negative coefficients include both US-based companies and foreign companies listing their stock in US markets in the form of an ADR. For the US companies, the negative coefficient could reflect a reliance on exports since these would decline in a strong dollar environment.

Not surprisingly, all but one company in the sample exhibits a positive and statistically significant coefficient on the market returns variable. The coefficients vary from 0.584 for ITC, to 2.377 for GT Advanced; both companies are in the area of Power Delivery. The average coefficient on the market return variable is 1.45 (excluding the outlier Maxwell at a value of 18.486). These estimates are in line with Henriques and Sadorksy (2008) who find a beta coefficient of 1.40 for the Wilderhill Clean Energy Index during the period 2001-2007.

This paper also considers how the impact of oil price fluctuations impacted alternative energy companies in a period of rising oil prices, Quarter III, 2009 to Quarter II, 2014 versus the period of declining and low prices, QIII, 2014-QII, 2017. The results for the first sub-period, shown in Table 3, suggest that the sensitivity of alternative energy company returns to changes in oil prices is weaker in a period of rising oil prices[4]. Only 9 firms exhibit statistically significant coefficients on the oil price variable: 2 in cleaner fuels, 1 in energy conversion, 3 in power delivery and 3 in energy harvesting. For 6 of those 9, the same relationship between oil prices and stock returns was found in the full period as well. Yet, for 3 companies, the results indicate a statistically significant relationship between oil prices and stock returns in the sub-period but not in the full period which indicates that the impact of oil prices on the stocks of alternative energy companies changes over time.

[4] For ease of exposition, remaining tables only report firms exhibiting positive and statistically significant coefficients on the oil variable(s). Full results are available from the author upon request.

Table 3 Regression Estimates: The Impact of Oil Price Fluctuations on the Returns of Alternative Energy Companies, June 30, 2009-June 30, 2014

	AR(p)	C	$R_{oil,t}$	$R_{spread,t}$	$R_{fx,t}$	$R_{mkt,t}$	N	Adj. R2	AIC	SIC	DW
Cleaner Fuels											
APD	3	0.000	0.038**	0.010	-0.181**	0.958***	1044	0.559	-6.482	-6.444	2.147
		(0.000)	(0.019)	(0.014)	(0.084)	(0.043)					
CZZ	1	0.000	0.098**	-0.058**	-0.539***	1.249***	1135	0.384	-5.193	-5.167	2.012
		(0.001)	(0.046)	(0.024)	(0.172)	(0.074)					
Energy Conversion											
DFCEL	4	-0.003**	0.164**	-0.077	0.330	1.779***	1005	0.182	-3.602	-3.558	2.041
		(0.001)	(0.080)	(0.063)	(0.295)	(0.140)					
Power Delivery											
COMV	1	-0.004***	0.190**	-0.095	0.560	1.547***	571	0.222	-3.873	-3.827	2.092
		(0.001)	(0.090)	(0.078)	(0.355)	(0.155)					
OLED	1	0.000	0.163**	-0.051	0.556*	1.937***	1135	0.237	-3.858	-3.831	2.059
		(0.001)	(0.080)	(0.059)	(0.294)	(0.137)					
SOL	1	-0.002	0.246**	0.057	-0.445	1.719***	1135	0.167	-3.261	-3.235	2.039
		(0.001)	(0.103)	(0.073)	(0.387)	(0.176)					
Energy Harvesting											
JASO	2	-0.002	0.185**	-0.001	-0.185	1.690***	1744	0.171	-3.671	-3.642	2.060
		(0.001)	(0.082)	(0.040)	(0.213)	(0.127)					
ORA	2	-0.001*	0.107*	-0.017	0.035	1.129***	1089	0.353	-5.349	-5.317	2.058
		(0.000)	(0.046)	(0.030)	(0.155)	(0.079)					
SPWR	4	-0.002	0.134*	0.005	-0.327	1.572***	1005	0.189	-3.752	-3.708	2.154
		(0.001)	(0.079)	(0.059)	(0.362)	(0.169)					

Notes: Daily data from 6/30/2009 to 6/30/2014. OLS estimates where: $R_{oil,t}$ are the daily changes in the log price of Brent crude oil. $\beta_{3,i}R_{spread,t}$ are the changes in the log yield spread which is in turn defined as the difference between the yields on a 10-year Treasury note and the 3-month Treasury bill. $R_{mkt,t}$ are the log returns on the market, as measured by the S&P 500 index. Robust standard errors are shown in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% respectively.

Table 4 shows the regression estimates for the period after the 2014 decline of oil prices. The results show that the impact of oil is more prominent during the period of declining oil prices as the returns of fifteen alternative energy companies exhibit sensitivity to fluctuations in oil prices. The results, when compared to the full sample estimates, are particularly interesting. In the full sample, fifteen companies had been found to exhibit exposure to oil price fluctuations. However, the breakdown by time period reveals that for 9 of those companies, the full period results are driven by the post-2014 sub-period. Only 4 companies exhibit sensitivity to oil prices across all periods examined. Interestingly there is one company (OLED) for which the coefficient for the oil variable is statistically significant in the two sub-periods but not the full period. This result is explained by a change in the sign of the coefficient from positive to negative across periods.

Table 4 Regression Estimates: The Impact of Oil Price Fluctuations on the Returns of Alternative Energy Companies, July 1, 2014-June 30, 2017

	AR(p)	C	$R_{oil,t}$	$R_{spread,t}$	$R_{fx,t}$	$R_{mkt,t}$	N	Adj. R2	AIC	SIC	DW
Cleaner Fuels											
AMRS	1	-0.004**	0.155*	-0.014	-0.062	0.885***	683	2.01%	-3.014	-2.974	1.979
		(0.002)	(0.092)	(0.084)	(0.397)	(0.234)					
CZZ	1	-0.001	0.300***	-0.063	-0.710***	1.482***	683	24.23%	-4.373	-4.334	2.037
		(0.001)	(0.050)	(0.045)	(0.269)	(0.153)					
GEVO	2	-0.007**	0.350**	0.006	-0.231	0.811*	656	1.94%	-2.022	-1.974	2.031
		(0.003)	(0.135)	(0.141)	(0.930)	(0.425)					
REGI	4	0.000	0.152***	-0.083**	-0.104	1.154***	608	15.30%	-4.671	-4.606	1.969
		(0.001)	(0.055)	(0.041)	(0.213)	(0.125)					
TVIA	1	-0.004	0.345***	0.002	-0.877	1.571***	394	8.24%	-2.637	-2.576	2.077
		(0.003)	(0.122)	(0.114)	(0.707)	(0.388)					
Energy Conversion											
AEIS	4	0.002**	-0.046*	-0.008	0.017	1.300***	608	28.29%	-5.356	-5.291	2.033
		(0.001)	(0.026)	(0.029)	(0.142)	(0.100)					
Power Delivery											
ENOC	2	-0.002	0.157**	-0.002	-0.608**	1.244***	656	7.79%	-3.487	-3.439	2.075
		(0.002)	(0.067)	(0.063)	(0.281)	(0.242)					
ITC	1	0.000	0.056**	-0.088	-0.070	0.561***	522	19.49%	-6.322	-6.273	1.981
		(0.000)	(0.022)	(0.025)	(0.122)	(0.068)					
OLED	1	0.001	-0.120**	-0.038	-0.302	1.591***	683	16.49%	-4.385	-4.346	2.033
		(0.001)	(0.052)	(0.045)	(0.250)	(0.143)					
SOL	1	-0.002	0.114*	-0.103	-0.149	1.265	570	8.58%	-3.829	-3.783	2.072
		(0.001)	(0.066)	(0.069)	(0.320)	(0.223)					
		(0.001)	(0.091)	(0.176)	(0.457)	(0.343)					
Greener Utilities											
PEGI	1	-0.001	0.104***	-0.071**	-0.202	1.090***	683	18.55%	-5.061	-5.022	2.057
		(0.001)	(0.038)	(0.036)	(0.176)	(0.134)					
Energy Harvesting											
CSIQ	1	-0.001	0.230***	0.026	-0.129	1.791***	683	21.89%	-4.041	-4.001	2.155
		(0.001)	(0.058)	(0.068)	(0.279)	(0.185)					
HQCL	2	-0.001	0.255***	-0.031	0.165	1.335***	656	8.90%	-3.528	-3.481	2.010
		(0.002)	(0.080)	(0.081)	(0.536)	(0.234)					
JASO	2	0.000	0.106**	-0.005	-0.035	1.220***	656	16.77%	-4.628	-4.580	2.011
		(0.001)	(0.043)	(0.040)	(0.234)	(0.120)					
SPWR	4	-0.003**	0.250***	-0.026	-0.013	1.750***	608	18.56%	-3.931	-3.866	2.039
		(0.001)	(0.067)	(0.082)	(0.303)	(0.254)					

Notes: Daily data from 7/1/2014 to 6/30/2017. OLS estimates where: $R_{oil,t}$ are the daily changes in the log price of Brent crude oil. $\beta_{3,i}R_{spread,t}$ are the changes in the log yield spread which is in turn defined as the difference between the yields on a 10-year Treasury note and the 3-month Treasury bill. $R_{mkt,t}$ are the log returns on the market, as measured by the S&P 500 index. Robust standard errors are shown in parentheses. *,**, *** represent statistical significance at the 10%, 5%, and 1% respectively.

Furthermore, Table 5 shows the results from estimating Equation (2) which tests for an asymmetric impact of oil returns on the returns of alternative energy companies during the later sample period, post the 2014 collapse of oil prices. Of the 46 companies examined, 17 (37%) exhibited some type of exposure to fluctuations in oil prices. Ten of the seventeen companies exhibited symmetric exposure to increases and decreases in the price of oil; the oil coefficient is positive and statistically significant but the asymmetry variable is not statistically significant at any conventional level. The results do indicate evidence of asymmetrical impacts in seven firms. In three cases, the asymmetry variable exhibited a statistically significant coefficient while the coefficient on the original oil variable was statistically indifferent from zero. This suggests that for MCPI in Energy Conservation, SSNI in Greener Utilities and YGE in Energy Harvesting only decreases in oil prices impact returns. However, the signs on the coefficients are inconsistent suggesting that lower oil prices are consistent with lower returns for MCPI and YGE but with higher returns for SSNI. For the remaining four companies that show a statistically significant Asymmetry variable, the results are mixed. Both the Asymmetry variable and the oil returns variable are statistically significant. The signs are different and the magnitude on the Asymmetry variable coefficient is larger. These coefficients appear to suggest that all changes in oil are consistent with decreasing returns in the stock of AIXN and ELON but with an increase in returns for APD (Cleaner Fuels) and RBCN (Power Delivery).

Table 5 Regression Estimates: The Asymmetric Impact of Oil Price Fluctuations on the Returns of Alternative Energy Companies, July 1, 2014-June 30, 2017

	AR(p)	C	Asymetry	$R_{oil,t}$	$R_{spread,t}$	$R_{fx,t}$	$R_{mkt,t}$	N	Adj. R2	AIC	SIC	DW
Cleaner Fuels												
APD	3	-0.001	-0.079*	0.043**	-0.004	-0.051	1.018***	630	0.430	-6.481	-6.417	2.024
		(0.001)	(0.047)	(0.019)	(0.017)	(0.105)	(0.067)					
CZZ	1	-0.001	0.002	0.299***	-0.063	-0.710***	1.482***	683	0.241	-4.371	-4.324	2.037
		(0.002)	(0.143)	(0.085)	(0.045)	(0.269)	(0.154)					
GEVO	2	-0.008*	-0.063	0.376*	0.007	-0.232	0.815*	656	0.018	-2.019	-1.964	2.031
		(0.004)	(0.387)	(0.224)	(0.140)	(0.931)	(0.428)					
REGI	4	-0.001	-0.147	0.217**	-0.080**	-0.103	1.165***	608	0.154	-4.670	-4.598	1.974
		(0.001)	(0.143)	(0.090)	(0.040)	(0.211)	(0.124)					
Energy Conversion												
MCPI	1	0.001	3.132**	-2.402	-0.476	-1.659	1.888***	117	0.049	-2.895	-2.729	2.062
		(0.007)	(1.401)	(1.137)	(0.362)	(1.746)	(0.694)					
Power Delivery												
AIXN	1	0.002	0.660**	-0.371**	0.094	-0.335	0.853***	229	0.114	-4.618	-4.513	1.958
		(0.003)	(0.265)	(0.161)	(0.078)	(0.431)	(0.268)					
ELON	1	0.000	0.793**	-0.530**	0.163	-1.04**	0.633**	170	0.067	-3.862	-3.733	2.135
		(0.004)	(0.392)	(0.220)	(0.129)	(0.513)	(0.286)					
ENOC	2	-0.004	-0.204	0.243**	0.003	-0.610**	1.256***	656	0.078	-3.485	-3.430	2.077
		(0.002)	(0.187)	(0.108)	(0.063)	(0.281)	(0.238)					
PWR	1	-0.001	-0.098	0.099*	0.109***	-0.416**	1.108***	683	0.236	-5.041	-4.995	2.105
		(0.001)	(0.076)	(0.055)	(0.032)	(0.195)	(0.089)					
RBCN	5	-0.014***	-0.752***	0.535***	0.018	0.197	0.762**	245	0.033	-3.423	-3.266	2.014
		(0.004)	(0.284)	(0.164)	(0.102)	(0.467)	(0.307)					
Greener Utilities												
PEGI	1	0.000	0.022	0.094*	-0.072**	-0.202	1.089***	683	0.184	-5.059	-5.012	2.056
		(0.000)	(0.088)	(0.052)	(0.036)	(0.176)	(0.135)					
SSNI	1	-0.003*	-0.258*	0.030	0.072*	-0.607**	1.488***	683	0.152	-4.251	-4.204	2.016
		(0.002)	(0.146)	(0.082)	(0.040)	(0.261)	(0.153)					
Energy Harvesting												
CSIQ	1	0.000	0.153	0.165*	0.0230	-0.128	1.781***	683	0.219	-4.039	-3.993	2.150
		(0.002)	(0.159)	(0.088)	(0.068)	(0.280)	(0.186)					
HQCL	2	-0.003	-0.177	0.330**	-0.027	0.164	1.345***	656	0.089	-3.527	-3.472	2.014
		(0.002)	(0.218)	(0.136)	(0.081)	(0.536)	(0.233)					
ORA	2	0.001	0.018	0.012**	-0.051	-0.157	0.942***	656	0.260	-5.838	-5.783	1.875
		(0.001)	(0.059)	(0.039)	(0.021)	(0.104)	(0.083)					
SPWR	4	-0.002	0.146	0.187*	-0.029	-0.015	1.741***	608	0.185	-3.929	-3.856	2.038
		(0.002)	(0.176)	(0.101)	(0.059)	(0.312)	(0.187)					
YGE	1	-0.001	0.835*	-0.296	-0.081	-0.823	1.545***	287	0.116	-3.013	-2.924	2.137
		(0.004)	(0.452)	(0.251)	(0.172)	(1.108)	(0.360)					

Notes: Daily data from 7/1/2014 to 6/30/2017. OLS estimates where: $Asymetry_{oil,t}$ is the interaction of $R_{oil,t}$ and a dummy variable that takes on the value of 1 if a change in $R_{oil,t}$ is negative and zero otherwise, $R_{oil,t}$ are the daily changes in the log price of Brent crude oil. $\beta_{3,i}R_{spread,t}$ are the changes in the log yield spread which is in turn defined as the difference between the yields on a 10-year Treasury note and the 3-month Treasury bill. $R_{mkt,t}$ are the log returns on the market, as measured by the S&P 500 index. Robust standard errors are shown in parentheses. *,**, *** represent statistical significance at the 10%, 5%, and 1% respectively.

5. Conclusion

This paper investigates whether fluctuations in oil prices influence the returns of alternative energy companies by adopting a firm-level approach. The findings in this paper suggest that struggles of alternative energy companies are not primarily related to low oil prices. During the sample period, our data show that alternative energy stocks have exhibited negative results, on average. Furthermore, the empirical results support the notion that not all alternative energy companies behave in the same manner and only approximately 25% of our sample exhibits sensitivity to the prices of oil. For those cases, the relationship is as one would expect; lower oil prices lead to lower returns for alternative energy companies. This supports the idea that oil and alternative energy are substitutes. However, not all areas of alternative energy behave in a similar fashion. For example, this paper documents that most companies engaged in the business of cleaner fuels see their stock prices fluctuate with changes in oil prices while the returns of stocks in the business of energy conversion show little to no sensitivity to changes in the market for oil. In addition, this paper considers how the collapse in oil prices of 2014 affected the prices of alternative energy stocks. Our results indicate that for most companies that exhibit sensitivity to changes in oil prices, the effect is driven by the period of falling oil prices. Finally, the findings in this paper suggest only limited evidence of an asymmetric impact of oil price fluctuations on the returns of alternative energy companies.

The findings of this paper should be relevant to investors and policymakers alike. For investors interested in alternative energy stocks, these findings highlight differences in alternative energy companies and provide information on the risk factors for these companies. For investors in fossil fuel companies, the results presented here indicate that alternative energy stocks provide a valuable diversification alternative against stranded asset risk. For policymakers interested in advancing clean energy initiatives, the results indicate that favorable oil prices are a factor, not the main driving force impeding the advancement of alternative energy. More importantly, differences exist across types of alternative energy and policy efforts should carefully consider those differences.

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