Alternative Energy Indexes and Oil

N. Alper Gormus
Texas A&M University - Commerce

Salil Sarkar
University of Texas at Arlington

Numerous studies evaluate the effects of oil price shocks on the stock market. However due to it being a recent phenomenon, models about alternative energy source related companies are relatively rare. In this study, the effects of oil price shocks on the performance of alternative energy companies, including renewable sources, are explored. The study also evaluates the effects of 'carbon market' on renewable alternative energy stocks. We found using Vector Auto Regression analysis that oil prices have a significant effect on the performance of alternative energy firms both renewable and nonrenewable types, including some of the newly emerging alternative energy sources. In line with past results, this paper also finds natural gas stocks to be most sensitive to oil shocks, whereas, alternative energy stocks are found to be very responsive as well. This study creates a hierarchical view of how each alternative reacts to fluctuations in oil prices in order to aid investors in market anticipation and portfolio diversification.

INTRODUCTION

Energy commodities such as oil and natural gas provide diversification opportunities for investors, hedging opportunities for users of these hard assets and trading opportunities for speculators. Modern portfolio theory recommends investors to diversify their portfolio in order to reduce any unsystematic risk, which is often done using different asset classes, as they are assumed to be not perfectly positively correlated. Commodities are becoming an ever important asset class, as the uncertainty in the general economy increases casting a doubtful shadow on the future of US Dollar. While, "old" (oil, natural gas and coal) energy related assets are still used fairly heavily, the "new" (green) energy related assets are causing a large impact and speculation in the market, increasing the available asset classes and choices for the market participants. While some studies suggest that futures on energy commodities do not provide an increased return to an efficient energy stock portfolio **(**Galvani and Plourde 2010), others analyze the green energy stocks and suggest that these companies have a superior performance which is not just explicable by their size, sector and style (Chia et al. 2009).

This paper analyzes the relationship between the fluctuations of oil prices (attributed as the largest energy commodity) and the stock performance of other energy groups; both "old" and "new". The idea is to see the inter-relation of these assets to aid the market participants in holding appropriate positions in line with their respective forecasts. A better understanding of the co-movements within the industry and commodity market is necessary especially in the light of the numerous IPO's recently created for the new

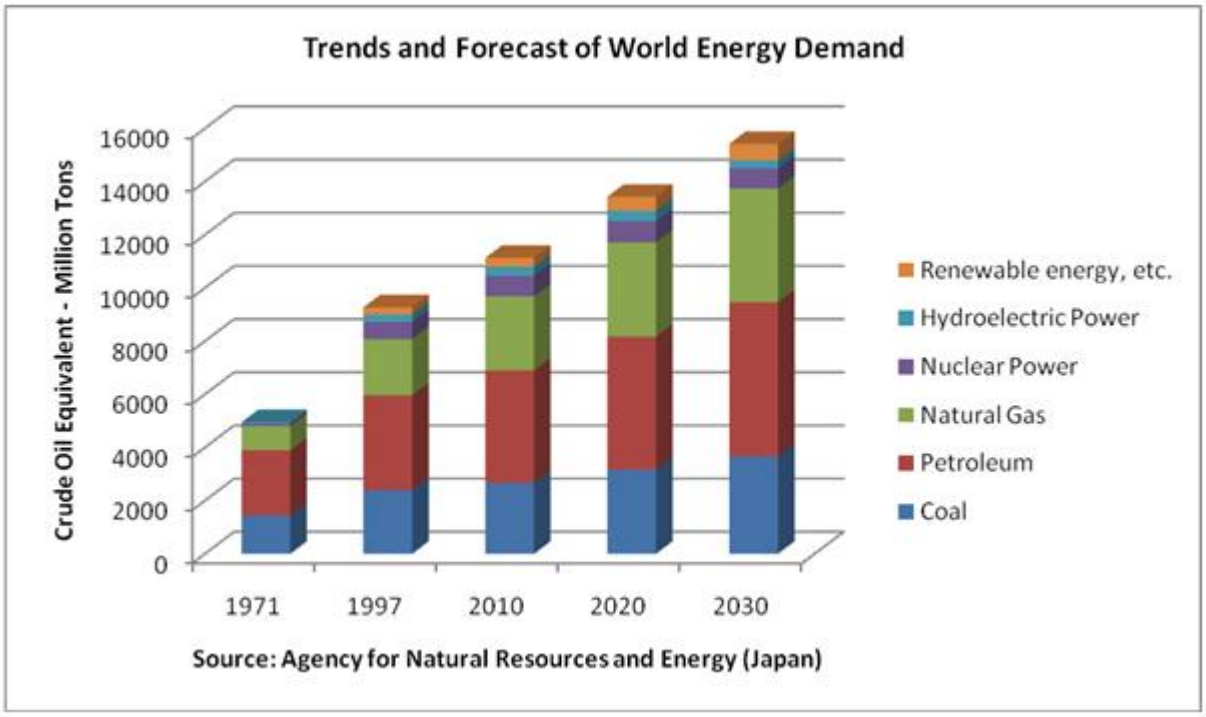
energy groups. Also, by many, the "carbon market" has been regarded as an important and influential market; however the significance of this market has not been evaluated.

TABLE 1
OIL CONSUMPTION FOR CHINA, INDIA, USA AND THE WORLD
(THOUSAND BARRELS)

	China	India	USA	World
1997	4179	1828	18621	73598
1998	4228	1963	18917	73939
1999	4477	2134	19519	75573
2000	4772	2254	19701	76340
2001	4872	2284	19649	76904
2002	5289	2374	19761	77829
2003	5803	2420	20033	79296
2004	6772	2573	20731	82111
2005	6984	2569	20802	83317
2006	7530	2580	20687	84230
2007	7855	2748	20698	85220

Source: BP Statistical Review of World Energy - June 2008

As it can be seen from Table 1, the energy consumption of developed and developing countries has increased at a steady level.



It is, without contest, expected that fluctuations on the price of oil will have significant effects on the economies of countries that depend on this energy source. Numerous studies have been conducted about the effects of oil prices on the macroeconomic variables of a given country and, as expected, significant correlations are observed. According to Cheung and Ng (1998) increases in oil prices are positively correlated with the production cost and an increase results in a fall in aggregate economic activity. Aside from these macroeconomic variables, intuitively, one can expect that there should exist a relationship between oil prices and the stock performance of its alternatives. However, the magnitude and strength (which is crucial in creating a diversified portfolio) of this effect have been rarely studied.

CARBON MARKETS

In an effort to attack the carbon emissions problem, 'carbon markets' were developed. The idea behind this notion was simple: every carbon emitting plant is given a quota on how much polluting emissions they can produce a year. If a company can utilize less of this quota, it can sell the remainder to another company which may need more than the initial quota that was assigned to it. The carbon market in the US is the Chicago Climate Exchange where these transactions are completed daily.

LITERATURE REVIEW

One of the common investor strategies of diversification includes combining the energy stocks with underlying commodity in a given portfolio. Galvani and Plourde (2010) tested whether combining energy futures with stocks related to oil, natural gas, refining, and integrated firms improve the performance of a portfolio. They found that this approach fails to help the performance of the energy related stocks given an interest in maximizing risk-return relationship. However; they also found that, given a buy-and-hold portfolio, investors interested in hedging (or insuring) against fluctuations in energy commodity prices would be benefiting from such approach.

Woloski (2006) argued that the rocketing oil prices demand a higher level of attention towards alternative energy sources and research. The higher price and difficulties associated with attaining these alternative sources will outweigh the benefits of energy independence and the decrease in pollution. No alternative energy source is yet a perfect substitute to oil due to limited research and the economics of scale for large production of fossil fuels. This, however, is normal and will change as more and more emphasis is given on alternative energy.

Clements and Krolzig (2002) investigated the relationship between oil prices and the business cycle asymmetries. Through a three-state Markov-Switching model they found that although some downturns in activity that lead to recessions can be attributed to strong shifts in oil prices, the asymmetries detected in the business cycle in general are not explicable by oil prices.

In an attempt to study the psychological aspect of green energy, Bolsen and Cook (2008) analyze the public's perception and priorities on traditional energy sources, and alternative energy sources. Through extensive polls they find that the majority of the public favored developing new energy over protecting the environment in respect to the initial priority for the US. Also it was found that the majority supported the administrative attention to be towards development of new energy alternatives/supplies rather than trying to control increasing oil prices in the short-term.

In another study evaluating oil price shocks, Chiou et. al (2008) looked at the relationship between oil price shocks and S&P 500 index returns. They found that a unidirectional relationship exist between oil shocks and the S&P 500 index.

Testing 16 different indices under the Turkish stock exchange (ISE), Eryigit (2009) found that Electricity, Wholesale and Retail Trade, Insurance, Holding, Investment, Wood, paper, printing, Basic Metal, Metal Products, machinery and Non-Metal and Mineral Products indices were significantly affected by oil price shocks.

DATA

As for the data; daily closing values of S&P 500 (SP500), S&P Global Alternative Energy Index (SPAE), and S&P US Carbon Efficient Index (SPCE) obtained from http://www2.standardandpoors.com , Chicago Climate Index (CCX) (for 2007 contracts) obtained from http://www.chicagoclimatex.com, Ardour Solar Index (SO) obtained from http://ardour.snetglobalindexes.com, Stowe Global Coal Index (CO) obtained from http://stowe.snetglobalindexes.com, Dax Global Nuclear Energy index (NU) obtained from http://www.vaneck.com, AMEX Natural Gas Index (NG) obtained from http://finance.yahoo.com, and tier-one Oil Futures (FOIL) obtained from http://www.eia.doe.gov are used. The data sample range used for this study is from September 11, 2007 to September 10, 2009.

METHODOLOGY

This study uses a Vector Autoregression (VAR) model to identify the effects of oil price shocks on the market performance of companies which are involved in energy resources that are alternatives to oil. The VAR model is a nonstructural approach. In contrast to the OLS models, there are no particular relationships between variables imposed. The information required only consists of a set of interacting variables and a sufficient number of lags to capture the interrelations between those variables. This technique also eliminates autocorrelation in the error terms (Pindyck & Rubinfeld 1998). All of the variables used are treated as endogenous variables to avoid the simultaneity bias.

The unrestricted reduced form of the VAR model can be described as the following:

$$\mathbf{X_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots\ldots\ldots + \beta_p X_{t-p} + e_t}$$

Where:

X_t = [SP500, SPAE, SPCE, CCX, SO, CO, NU, NG, FOIL] is a (n x k) matrix containing each of the n variables included in the VAR. Where k is the number of variables.

β_0 = (n x 1) vector of intercepts

β_i = (n x n) coefficient matrices

e_t = (n x 1) vector of error terms

All variables calculated in a return format where the first difference of their natural logs are used in the regressions.

After evaluating using the appropriate lags using the Schwarz Information Criterion, VAR(1) was found to be the best fit.

Lag	LogL	SC
0	10401.06	-42.51313
1	10706.81	-42.73871*
2	10872.81	-42.39154
3	10955.96	-41.70485
4	11038.46	-41.01548
5	11110.23	-40.28210
6	11167.00	-39.48727
7	11239.68	-38.75765
8	11332.16	-38.10920

* indicates lag order selected by the criterion

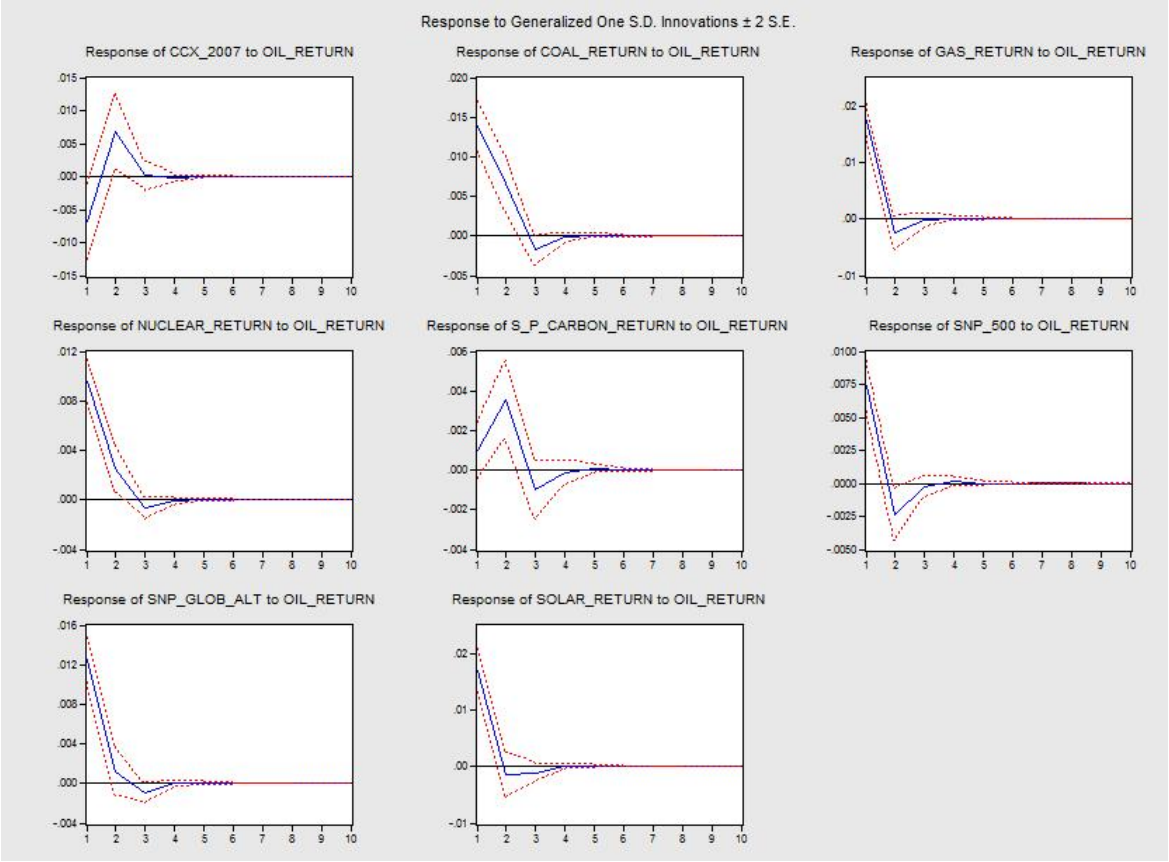
Root	Modulus
-0.094608 - 0.254049i	0.271093
-0.094608 + 0.254049i	0.271093
-0.164933 - 0.144020i	0.218963
-0.164933 + 0.144020i	0.218963
-0.174451	0.174451
0.105208	0.105208
-0.103236	0.103236
0.050042 - 0.077316i	0.092097
0.050042 + 0.077316i	0.092097

No root lies outside the unit circle.
VAR satisfies the stability condition.

ANALYSIS AND RESULTS

Our results indicate a strong relationship between oil price shocks and the market performance of companies which are involved alternative energy (to oil) resources . Although the existence of a relationship was an expected result, the magnitude and strength of these relationships were surprising.

CHART 1
IMPULSE RESPONSE OF OIL ALTERNATIVES TO OIL PRICE SHOCKS

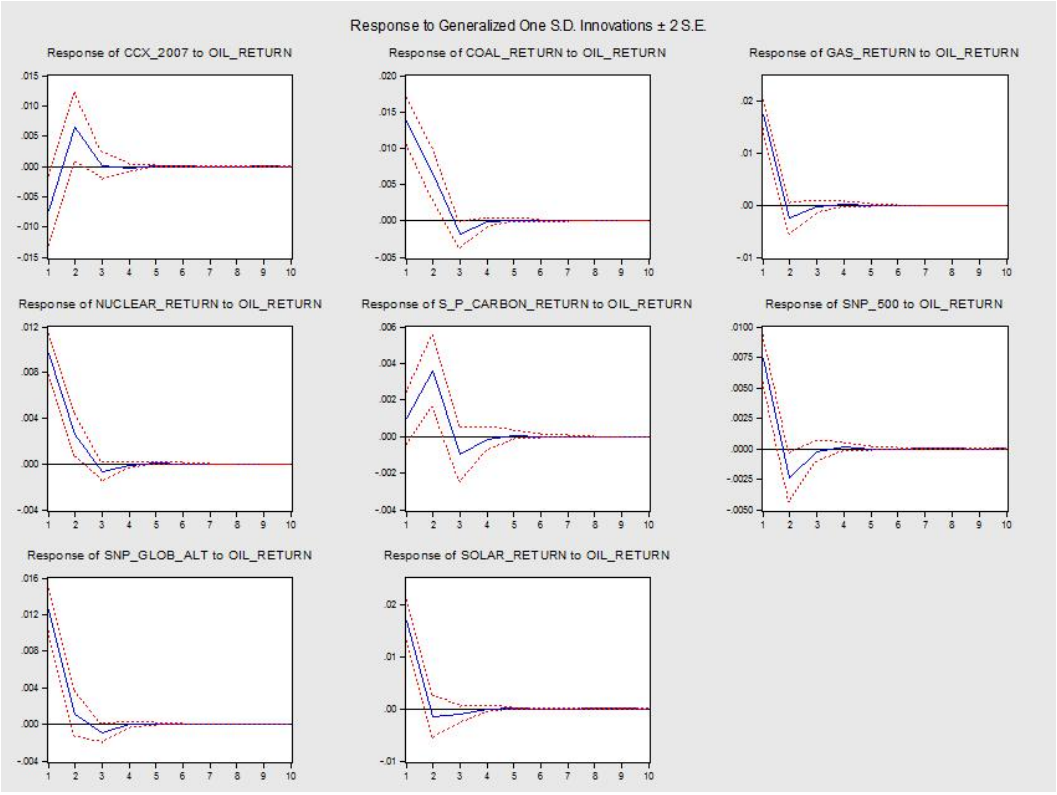


All of the oil alternatives gave a significant response to oil price shocks. While the natural gas related company stocks gave the most reaction, it was surprising to find solar energy related companies giving almost an identical response. This is especially interesting due to a few factors. First of all, natural gas and solar energy face completely different types of supply curves. While natural gas is a scarce resource and have an inelastic supply, solar energy faces no scarcity and have a somewhat completely elastic supply curve. Previous research shows that oil companies react positively to oil price shocks. From an investor perspective, solar energy (or any other green/renewable energy) related companies might appear as a good diversification tool in the light of fossil fuel scarcity. This, however, is not supported with our results.

The other oil alternatives tested in this study painted a similar picture. Although the reaction was comparatively less than natural gas and solar, companies related to coal and nuclear energy still gave significant positive responses to oil price shocks. SPCE and SPAE were similarly responsive. The carbon market was also responsive to the oil price shocks but the relationship was negative. None of the responses to oil price shocks were permanent and were dissipated within two to three days.

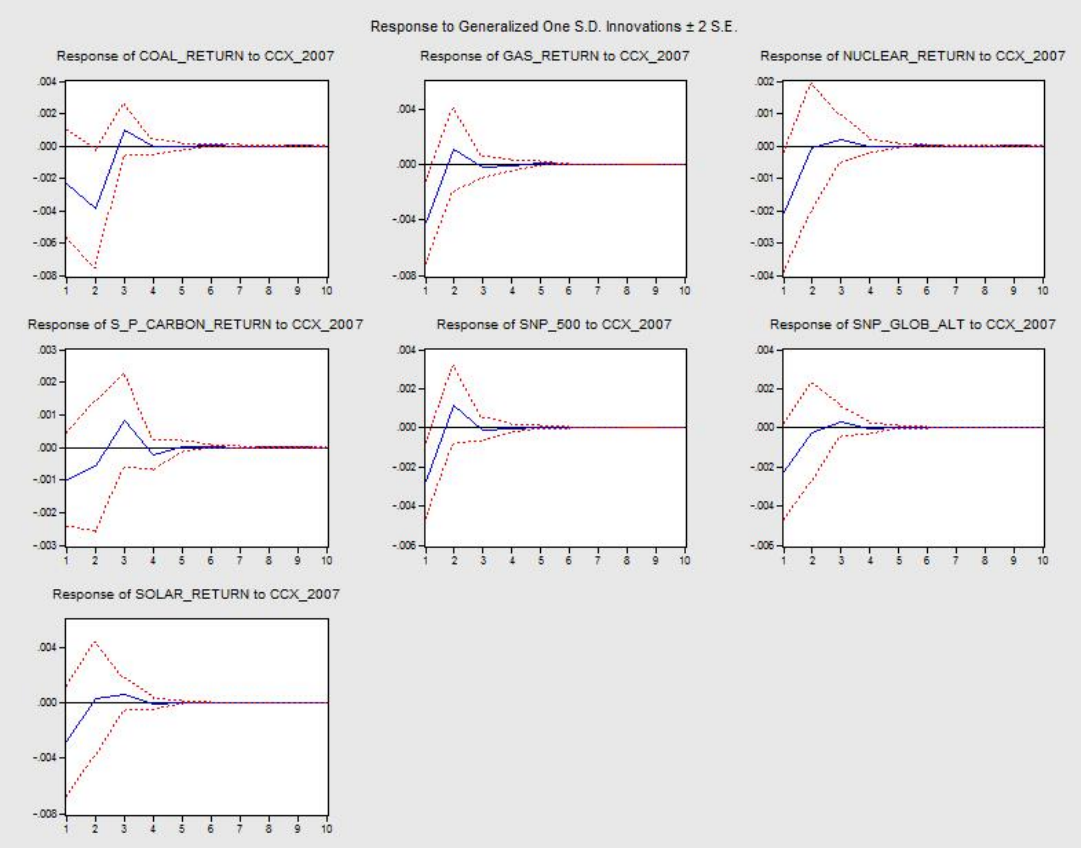
The next step in this study included the controlling for the oil crisis of 2008. Since our sample was from 2007 to 2009, this provided a good time-frame to evaluate if the relationships previously found would still hold. Using a dummy variable for the peak of oil prices in 2008, we re-tested the relationships. Our findings were merely mirror images of the ones previously found without the crisis dummy.

CHART 2
IMPULSE RESPONSE OF OIL ALTERNATIVES TO OILPRICE SHOCKS WITH CRISIS DUMMY



In addition to testing the responses to oil shocks, we also examined the relationship between the carbon market and the alternative energy related company performance.

CHART 3
IMPULSE RESPONSE OF OIL ALTERNATIVES TO CCX



Since it was expected that the carbon market was more of a reactionary exchange (by definition, it was created as a response to fossil fuel dynamics), as expected, we found no significant effect of this market on the stock performance of alternative energy companies.

An interesting result which we found on both test of reactions to oil shocks was the reaction of the Carbon Market. While all alternatives to oil gave a positive reaction to oil price shocks, the CCX gave a negative reaction. This was an unexpected result due to our first expectation that all markets would be positively reacting. This shows that as prices of oil go up, companies are to use less of it, hence not face as tough situations trying to meet their carbon quota. In other words, cheap oil allows for higher levels of production and, therefore, higher levels of pollution.

CONCLUSIONS

The exponential increase in energy demand around the world is a well known fact. With the emergence of large developing countries such as China and India, the increasing trend is observed to only get worse. Although around for decades, recently more emphasis have been given to investigation and creation of alternative energy resources. Now a commonly accepted fact, global warming has raised alarm bells around the world which also directed more interest in the causes and possible solutions to this problem. Oil, being the most predominant source of energy and the highest contributor to carbon

emissions in the world today, is a scarce and an increasingly limited resource. Although there are other fossil fuel alternatives to oil such as natural gas and coal, the increasing footprint of renewable energy sources such as solar, nuclear, wind, and hydroelectric is apparent in the world today.

From a hedging and speculating perspective, energy commodities provide diversification and trading opportunities. From an unsystematic risk perspective, portfolio diversification with limited correlation between asset groups is recommended. In the light of fossil fuel scarcity and environmental consciousness, the green energy related assets have gained considerable attention and offer investment alternatives to the market.

In this study we analyzed the relationship between the oil prices and stock performance of companies related to the energy alternatives to oil. We observed a very strong reaction by those companies to oil price shocks. This was somewhat expected given intuition and previous research. Previous research shows that, especially natural gas related companies, react strongly and positively to oil price shocks. However; our study clearly showed that green energy companies, especially solar energy, displayed an almost identical positive reaction to natural gas. In the light of having different supply elasticities, intuitively, one should expect that as oil prices go up, either oil related company stocks should portray a negative reaction (which is not the case) or the alternatives to oil should give a negative reaction. In a hierarchical perspective, we observed that natural gas and solar showed the largest responses, followed by coal and nuclear energy. We observed very strong influence of oil prices on the natural gas, solar, nuclear, and coal related stocks.

Similar to alternative energy related companies and indexes related to such industries, the Carbon Markets seem to react to oil price shocks. However; a reverse relationship was observed in this study. The validity of carbon markets still seem elusive, yet, results show a direct relationship between oil prices and companies' ability to achieve higher levels of production and, therefore, higher levels of pollution. The higher the pollution, the higher is the need for companies to trade in the Carbon Market. As oil prices go up, this need diminishes.

It should be recognized that this study is only scratching the surface and cause effect relationships between oil and its alternatives should be further investigated. Although the effects of oil prices on macroeconomic indicators is widely studied, more research will be needed to create a model which more completely explains the performance of alternative energy related stocks and their place in a diversified energy portfolio.

REFERENCES

Bolsen T, Cook, F.L.(2008) ,*"* The Polls—Trends" *Public Opinion Quarterly*, Vol. 72, No. 2, Summer, pp. 364–388

Brown, S. P. A , Yücel, M. K. (2008) "What Drives Natural Gas Prices?" *Energy Journal*, Vol. 29 Issue 2, p45-60, 16p

Cheung, Y. W., and Ng, L. K. (1998) "International evidence on the stock market and aggregate economic activity." *Journal of Empirical Finance*; Vol. 5, p:281–296.

Chiou,J, Lee, Y, Lin, C. (2008) "Existence of a Long-Run Equilibrium between the S&P 500 and Oil Prices." *International Research Journal of Finance & Economics*; Issue 21, p68-75

Clements, M. P. Krolzig, H. M. (2002) " Can oil shocks explain asymmetries in the US Business Cycle", *Empirical Economics* 27:185–204

Eryigit, M. (2009) "Effects of Oil Price Changes on the Sector Indices of Istanbul Stock Exchange" *International Research Journal of Finance & Economics*, Issue 25, p209-216

Faff, R. W., and Brailsford, T.J. (1999) "Oil price risk and he Australian stock markets." *Journal of Energy Finance and Development;* Vol. 4, p: 68-87.

Owen, A. D. (2004) "Environmental Externalities, Market Distortions and the Economics of Renewable Energy Technologies." *Energy Journal*; Vol. 25 Issue 3, p127-156

Pindyck, R.S. & Rubinfeld, D.L. (1998). *Econometric models and Economic Forecasts* (4th ed.). Boston, Mass.: Irwin/McGraw-Hill.

Sadorsky, P. (2009) “Oil price shocks and stock market activity.” *Energy Economics*; Vol. 21, pp.449−469.
Shipworth, D. (2006)“Qualitative modeling of sustainable energy scenarios: an extension of the Bon qualitative input–output model.” *Construction Management and Economics,* July, 24, 695–703
Galvani V. and Plourde A. “Portfolio Diversification in energy Markets.” (2010) *Energy Economics*, March, 32, Issue 2, 257-268
Woloski, A. (2006) “Fuel of the Future” *Harvard International Revi*ew; Winter, Vol. 27 Issue 4, p40-43