Oil Price Impact on the US Financial Landscape

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Abstract
We investigate the differential impact of falling oil prices on stocks in various industries and how industries and investors respond differently to changes in oil prices. A systematic linear regression analysis is performed to measure the industry sensitivities to these changes. Hedging and portfolio rebalancing strategies are examined and assessed for a selected range of industries and investors. We also analyze the consequences of sovereign wealth funds liquidation. Lastly, we discuss international and domestic wealth distribution and the macroeconomic impact on global growth in the context of declining oil prices.

Keywords
Oil Prices — Industry Stock Returns — Derivatives Hedging — Portfolio Rebalancing — Sovereign Wealth Funds

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1. Introduction

Crude oil is a vital source of energy which drives modern economies. Industrialized countries continue to be heavily dependent on oil, either domestically produced or imported from overseas. Consequently, political actions of oil exporting nations, economic growth or slowdown of emerging markets, and technological advances in oil exploration and production can have significant effects on these economies.

Crude oil prices fell sharply since the third quarter of 2014 as global supply exceeded demand. There exists evidence that oil price impacts are largely dissimilar across industries. The aim of this paper is to look into the differential impact of oil prices on stocks in various industries and how industries and investors would respond to changes in the price of oil. A systematic investigation of these issues is critical for many decisions including the formulation of macroeconomic policy, asset pricing, risk management and portfolio management.

1.1 Oil Market

In this section, we briefly review the price history of crude oil, using West Texas Intermediate (WTI) delivered at Cushing as an example, and the underlying reasons for the decline of oil price since August 2014. Figure 1 depicts the evolution of the price of WTI crude from May 1983 to January 2016, with several historical events that are believed to influence the spot prices of WTI crude marked. Geopolitical events in oil producing countries disrupt oil supply and tend to drive up oil prices. For example, a spike in Figure 1 can be observed in 1990 associated with the Gulf War. Changes in quotas or production policies often result in changes in oil prices: for example, OPEC production target cutbacks to 1.7 million barrels per day in 1999 and 4.2 million barrels per day in 2009. Global macroeconomic conditions also seem to influence the oil price significantly. For example, a sharp drop in the price of oil was observed following the 1997-1998 Asian financial crisis and the 2007-2008 credit crunch, and a rise was accompanied by booming global economies during 2003-2007. Finally, inclement weather conditions and natural disasters such as Hurricane Katrina in August 2005 and the earthquake and accompanying tsunami in Japan in March 2011 tend to put upward pressures on oil prices.

The period from 2011 to mid-2014 witnessed a largely stable oil market, signifying an underlying balance between supply and demand. As shown in Figure 1, the economic recovery from the financial crisis stimulated a gradual growth in

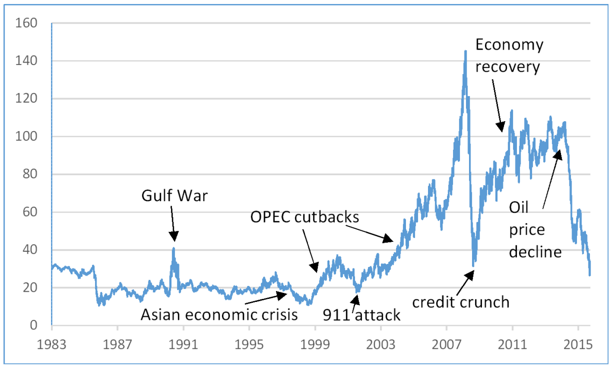

Figure 1. WTI crude oil price history from May 1983 to January 2016, in units of USD per barrel.

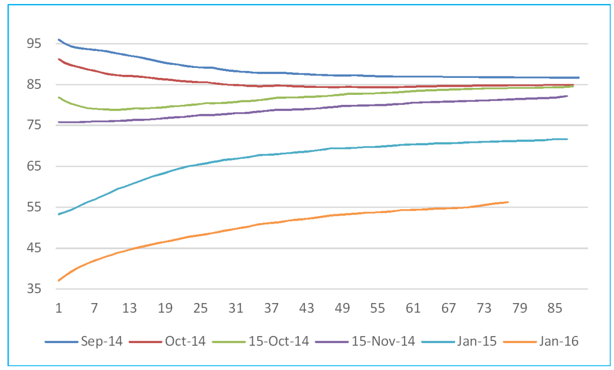

Figure 2. WTI crude oil forward curves, as functions of the number of months to expiry, observed between September 2014 and January 2016. The forward curves change shape from backwardation to contango around October 2014, a few months after the beginning of the decline of oil prices. The prices are in units of USD per barrel.

demand, which was in turn supported by the North American shale oil production with increasing efficiencies. However, oil prices remained supported at a level well above $100 due to production outages in oil producing countries caused by civil unrest. For example, Libya's oil exports decreased to negligible levels in 2011, slightly recovered in 2012, and encountered another shut-in in mid-2013. The sanctions imposed against Iran since 2006 have gutted its oil production and kept its oil export below its OPEC determined quota level. More recently, geopolitical uncertainties in the northern part of Iraq and at the Ukraine-Russia boundary contributed to the concern over potential short supply.

The well-balanced oil market, following four years of relative stability, started to experience a sharp decline in price since the third quarter of 2014. Looking backward, WTI crude oil prices have fallen drastically from a level around $105 per barrel in mid-2014 to less than $30 per barrel by February 2016. This decline in oil prices observed recently has also been driven by an interplay between supply and demand factors [1].

From the supply side, in spite of Saudi Arabia's decision to refrain from production cuts, the US hydraulic fracturing technology for shale oil production has steadily advanced, reducing the U.S.' need to import crude oil from overseas, facilitating a redirection of over-supply flow into the European market. In the meantime, Libya's export terminals were re-opened after a year of blockade and its production recovered noticeably since the second half of 2014. More recently, oil and financial sanctions on Iran were lifted in January 2016 after international inspectors concluded that the country had complied with obligations to restrict its nuclear program. Overall, the concern over potential short supply of crude oil due to geopolitical tension has been alleviated. From the demand side, growth in global oil demand is slowing down, in connection with higher interest rates in the United States and weaker expectations for Chinese and European appetites for crude oil. This has caused the International Energy Agency (IEA) to modify its global oil demand growth forecast for 2016 to 1.2 million barrels per day [2].

As the decline of oil prices sets in, market sentiment toward the subdued oil prices and the expectations of higher future prices manifest themselves in the forward curve of crude oil contracts. In mid October 2014, the shape of the WTI futures curve, after being backwardated for many years, changed to contango, in which longer-dated futures are more expensive than near-term contracts, as shown in Figure 2. This indicates that participants in oil market regard the current spot prices as too low for supply and demand to balance in the near future.

1.2 Oil-Stock Relationship

Oil price changes can affect stock prices through their effects on the expected cash flows. Empirical studies in the literature on the oil-stock relationships fall into two main categories depending on the level of aggregation: aggregate level (e.g., S&P 500) and disaggregated industry level. The empirical evidence for the existence and the sign of this relationship is mixed or inconclusive at the aggregate stock market index level. The pioneering research in this direction is Driesprong *et al.* (2008) [3]. On the other hand, several studies employed regression analysis using disaggregated industry or firm-level data, and the general conclusion is that changes in oil prices affect specific industry groups in different ways, depending on the market structure, level of competition, and whether oil acts as a key input or output for each industry. For example, in oil-related industries such as the oil and gas sector where oil is a key output, a decrease in oil prices leads to lower expected cash flows and to negative changes in stock returns. In contrast, for oil-consuming industries such as airlines and distributors, lower oil prices reduce the firm's marginal cost of production and are negatively correlated to their stock returns. Finally, oil price changes can affect a firm's cash flow from the demand side. For example, consumers' consumption and investment confidence is expected to rise in response to declining oil prices as a lower chance of future unemployment is perceived. A scenario is automobile manufacturing and consumer goods industries. In the following sections, these issues will be explored in detail.

2. Data

2.1 Crude Oil Spot and Futures

The international oil market is the most active commodity market in the world. For brevity, we focus on results for WTI crude oil, which is highly correlated with other crude oil benchmarks such as North Sea Brent or Arab light, and is more pertinent for a study of the U.S. industries. For spot prices, we use Bloomberg's daily time series of spot crude oil price indications of WTI crude at Cushing, OK, which typically trades in pipeline lots of 1000 to 5000 barrels a day for delivery between the 25th of one month to the 25th of the next month. These prices are for physical shipments. This time series for WTI spot prices is available since May 16, 1983, but we focus our analysis on the post-crisis period starting at February 2009. For futures contracts, we use the WTI Crude Oil subindex from Bloomberg, which solely reflects the movements of the underlying commodity futures price and is quoted in USD. The associated daily time series starts from January 1991. It is believed that spot prices reflect information available to the markets up to a given time. This means that conditioning industry returns on oil returns provides an efficient indicator for co-movement with industry returns. On the other hand, futures prices measure the sentiments of market participants towards the short term future.

2.2 Aggregated Industry Indexes

The Standard & Poor's 1500 Composite covers 90% of the market capitalization of U.S. stocks and was developed with a base value of 100 as of December 30, 1994. In this paper, we use the daily total return time series of Bloomberg's S&P Supercomposite Sub-Industry Index aggregated with respect to GICS (Global Industry Classification Standard), where the daily total return index is calculated based on a start date one day prior to the end date (as of date) including dividends. Historically, this is the total return index from the provided start date to the provided end date. Gross dividends are used. These industry-level time series start from Dec 31, 1994, but we focus our analysis on the post-crisis period starting at February 2009.

3. Methods

3.1 Basic Regression Model

To measure the differential impact of oil prices on stocks in various industries, we incorporate an oil variable r_t in the following simple regression model [4][5]

$$R_t = \alpha + \sum_{j=0}^{L} \beta_j r_{t-j} + \gamma Z_t + \varepsilon_t, \quad t = 1, \cdots, T \qquad (1)$$

where R_t is the first difference of the logarithm of the disaggregated S&P Composite 1500 Index for an industry group categorized by the GICS, r_t is the log-return in WTI spot oil price, ε_t is the error term, t is the daily time variable, L is the lag order in time and T is the total sample size. Note that we included both contemporaneous and lagged explanatory oil variables to investigate the co-movements and potential under-reacting effects of industry-level returns to oil price changes. To examine the combined explanatory power of oil prices with daily stock market growth as a whole, an additional variable Z_t for the aggregate S&P Composite 1500 Index is included. In this method, we choose the lag order to be a business week $L = 5$ days.

Based on the above OLS model, we estimate the industry sensitivities to oil prices by the slope coefficients β and test whether they are significantly different from zero. The statistical inference is based on the HAC covariance matrix estimator from Newey and West (1987). To examine how the estimated sensitivities change over time, we divide the time period since the end of the 2007-2008 financial crisis into approximately one-year time windows and perform the regression analysis for each window individually. In Section 4, we report the empirical results on a selected list of industries from the regression analysis. The estimation risk oil price βs in this model could be caused by the model risk, i.e. the linear model, which implies that stock returns moves proportionately with oil return regardless of the magnitude, could be inadequate. To reduce the estimation risk of oil price β, the regression model needs to be refined to take into account non-linear effects [5]. Another possible source of the estimation risk is related to distribution of oil price β. In other words, the sensitivities of industry stock returns to oil price changes could be random variables with probability distributions, whereas the constant β-coefficient assumed by the linear model corresponds to an effective mean estimation.

3.2 Granger Causality Test

To further address the issue of under-reaction effects of industry returns to oil price changes, we use the well-known linear Granger causality approach to test whether lagged oil variables help describe the dynamics of industry stock returns. The model is formulated in an autoregressive form

$$R_t = \mu + \sum_{j=1}^{L} \phi_j R_{t-j} + \sum_{j=1}^{L} \varphi_j r_{t-j} + \varepsilon_t, \quad t = 1, \cdots, T \quad (2)$$

where R_t, r_t and ε_t are defined in Equation 1, and assumed to be stationary time series within the selected time-frame. Within the framework of this VAR model, Granger causality tests are defined as follows: if the null hypothesis that all φ_js equal zero is rejected, it is argued that oil returns *Granger-cause* industry returns. If the null hypothesis holds, the full model Equation 2 is reduced to the restricted model:

$$R_t = \mu + \sum_{j=1}^{L} \phi_j R_{t-j} + \varepsilon'_t, \quad t = 1, \cdots, T \qquad (3)$$

where ε'_t is the error term for the restricted model. An F-test is applied to obtain a p-value for whether the full model results in a better variance in error term than the restricted model, in which case it is argued that oil returns *Granger-cause* industry returns.

4. Differential Impact of Oil Prices

We performed a systematic examination of the effect of oil prices on various industries categorized by GICS standards, including all level 1 and level 2 sectors and samples of level 3 and level 4 industry groups. In this section, the regression analysis of a representative list of industries is reported to illustrate the differential impact of oil prices.

4.1 Measurement of Sensitivities

The oil and gas industry is strongly impacted by oil prices and has suffered significantly since August 2014. Table 1 reports the regression results on how sensitivities of oil and gas industries to oil prices change over time.

Industry	Time Periods	β_0	p-value	γ
Oil&Gas	2009/02 ~ 2009/12	**0.161**	$< 10^{-2}$	0.87
	2010/01 ~ 2010/12	**0.115**	$< 10^{-2}$	0.97
	2011/01 ~ 2011/12	**0.173**	$< 10^{-2}$	1.02
	2012/01 ~ 2012/12	**0.176**	$< 10^{-2}$	0.94
	2013/01 ~ 2014/07	**0.157**	$< 10^{-2}$	0.88
	2014/08 ~ 2016/01	**0.270**	$< 10^{-2}$	1.01

Table 1. Regression of the oil and gas industry equity returns on oil prices.

Most of the chemical products, plastics and synthetic fibers in the North American market, are derivatives of ethylene, which is most commonly produced by cracking either naphtha or ethane. While naphtha is derived from crude oil, ethane is a natural gas liquid (NGL) that is produced at natural gas processing plants. Naphtha, crude oil and heavy fuel oil prices tend to follow each other. Regarding ethane, its prices has at times moved in line with the prices of natural gas. The production cost of ethylene from ethane cracking is much lower than from naphtha cracking. However, the collapse in crude oil prices resulted in a reduction in competitiveness of ethane compared to naphtha. Basically chemicals made from naphtha have moved into a more favorable position relative to the situation before the decline of oil price, while chemicals made from ethane no longer have the crushing advantage they once held. This effect is supported by our regression results reported in Table 2 for the period of time since August 2014.

Table 3 reports the empirical results for the contemporaneous oil effects on the transportation industries, under which we use airlines as a specific example. Airline operations inherently depend on jet fuel, which typically represents one of the largest parts of its operating expense, and, therefore, is impacted by changes in oil prices. The negative correlation between airline industries and oil prices is supported intuitively by the fact that a drop in oil prices boosts an airline's profitability.

Industry	Time Periods	β_0	p-value	γ
Chemical	2009/02 ~ 2009/12	0.037	0.07	0.87
	2010/01 ~ 2010/12	0.002	0.93	0.97
	2011/01 ~ 2011/12	**0.038**	0.05	1.02
	2012/01 ~ 2012/12	0.012	0.61	0.94
	2013/01 ~ 2014/07	0.013	0.58	0.88
	2014/08 ~ 2016/01	**0.070**	$< 10^{-2}$	1.01

Table 2. Regression of the chemical industry equity returns on oil prices.

Industry	Time Periods	β_0	p-value	γ
Airlines	2009/02 ~ 2009/12	**−0.142**	$< 10^{-2}$	1.41
	2010/01 ~ 2010/12	−0.014	0.82	1.13
	2011/01 ~ 2011/12	**−0.271**	$< 10^{-2}$	1.24
	2012/01 ~ 2012/12	**−0.327**	$< 10^{-2}$	1.12
	2013/01 ~ 2014/07	**−0.239**	$< 10^{-2}$	1.46
	2014/08 ~ 2016/01	**−0.264**	$< 10^{-2}$	1.36

Table 3. Regression of the airline industry equity returns on oil prices.

Another industry which is understood to be negatively impacted by oil prices is consumer products retailing. Low oil prices are probably beneficial to the consumer goods industry as a result of lower transportation and distribution costs. This intuitive understanding is supported by our regression analysis reported in Table 4.

Industry	Time Periods	β_0	p-value	γ
Consumer Retailing	2009/02 ~ 2009/12	−0.042	0.18	1.02
	2010/01 ~ 2010/12	**−0.088**	$< 10^{-2}$	1.08
	2011/01 ~ 2011/12	**−0.065**	0.01	0.94
	2012/01 ~ 2012/12	−0.051	0.07	1.02
	2013/01 ~ 2014/07	**−0.053**	$< 10^{-2}$	1.09
	2014/08 ~ 2016/01	**−0.034**	$< 10^{-2}$	1.0
Food & Staples Retailing	2009/02 ~ 2009/12	−0.029	0.15	0.53
	2010/01 ~ 2010/12	**−0.061**	0.03	0.66
	2011/01 ~ 2011/12	**−0.061**	$< 10^{-2}$	0.64
	2012/01 ~ 2012/12	−0.056	0.08	0.64
	2013/01 ~ 2014/07	**−0.052**	0.03	0.78
	2014/08 ~ 2016/01	**−0.067**	$< 10^{-2}$	0.85

Table 4. Regression of the consumer discretionary products retailing and food & staples retailing industry equity returns on oil prices.

According to a recent report from IHS Automotive, part of IHS, Inc, low oil prices will contribute to upside potential for the U.S. automotive market in the near term [6]. Fueled by cheaper gasoline, ownership of larger vehicles in the U.S. and Canada will be more affordable and U.S. consumers' confidence is expected to rise. This fact is supported by our regression analysis, for the time period after August 2014, the sensitivity of the automobile industry to oil prices manifests itself with a 5-day lag following the decline of oil prices. Before August 2014, the null hypothesis that the automobile industry is not strongly correlated with oil prices cannot be rejected.

Industry	Time Periods	β_5	p-value	γ
Auto-mobile	2009/02 ∼ 2009/12	−0.027	0.71	1.42
	2010/01 ∼ 2010/12	+0.003	0.95	1.48
	2011/01 ∼ 2011/12	+0.006	0.88	1.44
	2012/01 ∼ 2012/12	−0.013	0.67	1.29
	2013/01 ∼ 2014/07	+0.011	0.78	1.28
	2014/08 ∼ 2016/01	**−0.040**	$< 10^{-2}$	1.05

Table 5. Regression of the automobile industry equity returns on oil prices.

Banks have been lending to companies in the energy sector in the United States. Empirical observations indicate that during the decline phase of oil prices, banks and insurance companies are exposed to energy loans and suffer from the credit risks of energy sectors. The oil price effects on financial sectors are less obvious than those industries reported above as it may take some time for the crunch in the oil industry to translate into losses. Table 6 reports the sensitivities of financial industries to oil prices, measured by the leading significant β-coefficients with $4 \sim 5$ days of lag. An interesting pattern to observe is, similar to the case of automobile industries, the oil effect, which is typically statistically insignificant between 2009 and 2014, becomes significant since the decline of oil price around August 2014.

Industry	Time Periods	β_4	β_5
Commercial banks	2009/02 ∼ 2009/12	−0.006	+0.057
	2010/01 ∼ 2010/12	+0.015	−0.020
	2011/01 ∼ 2011/12	−0.016	−0.023
	2012/01 ∼ 2012/12	**+0.046**	−0.015
	2013/01 ∼ 2014/07	−0.034	−0.041
	2014/08 ∼ 2016/01	**+0.033**	**+0.028**
Investment Banks	2009/02 ∼ 2009/12	+0.045	+0.026
	2010/01 ∼ 2010/12	**+0.070**	+0.027
	2011/01 ∼ 2011/12	−0.044	−0.008
	2012/01 ∼ 2012/12	+0.069	−0.014
	2013/01 ∼ 2014/07	−0.024	−0.009
	2014/08 ∼ 2016/01	**+0.029**	**+0.038**

Table 6. Regression of the financial industry equity returns on oil prices.

In summary, based on the regression analysis reported above, our findings are consistent with conventional wisdom in which the effect of oil prices on stock returns varies due to the nature of the industry. We also observe that the industry co-movements and sensitivities to oil prices are more precisely estimated after August 2014, when the decline of oil prices set in. This suggests that the time period after August 2014 has a trend driven by the oil price plunge.

4.2 Granger Causality and Underreaction

In this section, we report the Granger causality test described in Section 3.2 for the selected list of industries reported in Section 4.1 for the time period from August 2014 to January 2016. Particular attention is paid to the maximum extent of lagging which generates a statistically significant p-value for the Granger causality F-test. More specifically, we start with choosing the maximum possible lag length $L = 30$ and estimating the model Equation 2-3. If the p-value for the F-test is less than 5% then L is chosen as the lag length; otherwise we decrease the lag length by one, and the above procedure is repeated until $L = 1$. The results are reported in Table 7, where only those industries Granger-caused by WTI spot price or 6-month forward are tabulated. It is observed that the oil returns Granger-cause returns in the oil and gas industry, the airline industry, and the consumer retailing industry, which is in agreement with the market structure of these industries. The typical lag length in units of days falls in the range $2 \sim 5$. We interpret the time lag in Granger causality tests as an under-reaction effects of industry returns to oil price movements, which are publicly available information and can be observed almost in real time without cost. The results in Table 7 show the evidence for oil price having a statistically significant effect on stock returns with lags for the tabulated industries.

	WTI Spot		WTI 6M	
Industry	Lag	p-value	Lag	p-value
Oil & Gas	2	0.048	5	0.046
Airlines	1	0.079	2	0.047
Consumer Retailing	2	0.133	2	0.034

Table 7. Granger causality tests for a selected list of industry stock index returns with respect to the returns of WTI spot prices and futures prices 6-months forward.

5. Response of Industries and Investors

5.1 Hedging Strategies of Industry Participants

One conventional measurement of hedge efficiency is based on price variations. The potential hedger holds a portfolio, $\mathbb{P}_t = P_t + \Delta \cdot Q_t$, consisting of a unit share of an industry index priced at P_t and a position Δ in the crude oil futures contract priced at Q_t. Minimizing the variance of the hedged portfolio, we get the hedge ratio and the minimized variance. The ratio of this hedged-variance to the unhedged variance is

$$\frac{\sigma^2(\mathbb{P}_t)}{\sigma^2(P_t)} = 1 - \frac{\text{cov}^2(P_t, Q_t)}{\sigma^2(P_t)\sigma^2(Q_t)} \triangleq 1 - r^2.$$

Defining hedging efficiency as the proportional reduction in variance compared to an unhedged position then gives the hedging effectiveness, as being equal to r^2. There are issues that arise from the use of such an approach to analyzing hedge efficiencies and constructing hedge ratios. For example, it concentrates on purely risk-minimizing agents which accept no trade-off between risk and return [7]. Regardless, this serves as a first-step estimation.

WTI and Brent are the two most frequently used benchmark crude oil contracts, Brent typically being more liquid because it is internationally traded. In Table 8, we report the hedging effectiveness estimated by the proportional reduction in variance compared to an unhedged position described above. Here we use Bloomberg WTI and Brent crude oil indexes six months forward, for the six industry groups reported in the previous sections based on the historical data since August 2014.

Industry	WTI 6M	Brent 6M
Oil&Gas	0.845	0.852
Chemical	0.144	0.150
Airlines	0.513	0.503
Consumer Discretionary Retailing	0.755	0.743
Food & Staples Retailing	0.420	0.399
Automobile	0.081	0.090
Commercial Banks	0.128	0.117
Investment Banks	0.018	0.013

Table 8. Hedging effectiveness of a selected list of industries using crude oil futures contracts 6 months forward.

Questions might be raised regarding why airlines would use crude oil futures contracts to hedge against oil price risk given that what aircraft really consume is jet fuel. The key to this issue is liquidity, measured by trading volume or open interest. Since jet fuel is not as frequently traded on an organized futures exchange as crude oil or heating oil contracts, there are limited opportunities to hedge directly in jet fuel for time horizons more than one year forward into the future. As a result, companies in the airline industry often use financial derivative instruments in refined products such as heating oil and unleaded gasoline to decrease their exposure to jet fuel price volatility. In the case of looking many years forward where heating oil trading is again insufficiently liquid, airline companies have to resort to even more liquid contracts of crude oil, typically WTI or Brent. Specifically, companies have used financial derivative instruments for both short-term and long-term time frames and primarily use a mixture of purchased call options, collar structures, call spread, and fixed price swap agreements in its portfolio. Table 9 from Form-10Q filed by Southwest Airlines Co. in the last quarter of 2015 provides information about the company's volume of fuel hedging for the years 2016 through 2018 on an economic basis. However, as a powerful tool to protect a company's profitability against oil price risk, hedging strategies using derivatives can be beneficial or detrimental. The experience of Southwest Airlines in 2008 is an example of the latter. According to Forbes, Southwest hedge against higher fuel prices and purchased long-term contracts to buy most of its fuel at \$51 a barrel through 2009. The value of these hedges climbed as oil price continued to increase throughout 2006 and 2007. However, in 2008, oil prices dramatically decreased to \$40 a barrel. Consequently, Southwest lost \$56 million, or 8 cents per share in the fourth quarter of 2008 [8].

For the oil and gas industry, revenue is highly positively correlated to oil price. The easiest way oil companies can protect themselves against falling oil prices is by cutting production. Although cutting production in a falling oil-price environment would further suppress revenues, production cuts can help restore supply and demand balance, eventually leading to increasing prices. This strategy works if the entire industry is cutting production to restore trade balance, which has not happened as oil prices have been falling for more than a year. Alternatively, crude oil producers can hedge against falling crude oil prices by taking up a position in the crude oil futures market. Contrary to the airline industry, oil and gas companies can employ what is known as a short hedge, a put option for example, to lock in a future selling price for an ongoing production of crude oil that is only ready for sale sometime in the future. Table 10 from Form-10Q filed by Linn Energy, LLC, an independent oil and natural gas company based in Houston, Texas, in the last quarter of 2015 provides information about the company's derivative positions in oil for the periods indicated as of September 30, 2015. On the other hand, higher oil prices usually lead to product innovations and the development of substitutes for oil-consuming products.

Period (year)	Fuel hedged as of September 30, 2015 (gallons in millions)	Derivative underlying commodity
2016	1,188	Brent crude oil Heating Oil Gulf Coast jet fuel
2017	1,294	WTI crude oil Brent crude Oil
2018	466	Brent crude oil

Table 9. Information from Form-10Q filed by Southwest Airlines Co. in the last quarter of 2015.

Period (year)	Hedged Volume as of September 30, 2015 (MMMBtu)	Derivative Type
Oct 1 to Dec 31, 2015	3,890 276 864	Fixed price swaps Three-way collars Put options
2016	11,465 3,271	Fixed price swaps Put options
2017	4,755 384	Fixed price swaps Put options

Table 10. Information from Form-10Q filed by Linn Energy, LLC., in the last quarter of 2015.

Similarly, the chemical industry's business is inherently exposed to price changes for several commodities, including feedstocks for ethylene production, natural gas, and oil. Some exposures can be hedged effectively through financial instruments traded on an exchange, and when feasible, over-the-counter instruments can also be used to hedge these risks.

The price of gasoline is directly affected by crude oil because it is a petroleum-based product. Depressed fuel prices make driving much cheaper, and consequently, vehicle ownership becomes much more attractive. While American automobile manufacturers are benefiting from the current decline in oil prices, concerns exist that they could face penalties from regulators in the future. As a matter of fact, consumers' interest and resource investment gravitates toward electric and hybrid vehicles when the oil price is high. Currently, hybrid car technology is viewed as the next big profit generator in the automobile industry and the U.S. is the largest hybrid car market in the world, with sales accounting for 60-70% of global hybrid sales. In this regard, higher oil prices provide more investment opportunities for the manufacturing sector. It would be wise for automobile manufacturers to strategically invest the excess earnings in improving the fuel-efficiency of their vehicles in order to comply with greener standards while the oil prices are low. On the other hand, commodity price risk exposure could be mitigated by entering into derivative instruments such as forward and option contracts. For example, according to the Form-10Q filed by Ford Motor Co. in 2008 during the oil price spike, the net value of commodity forward and option contracts as of March 31, 2008 was $612 million, compared to $353 million as of December 31, 2007.

Regarding the retailing industry and distributors of foodservice products and consumer goods, high gasoline costs have always struck the core of these businesses and have been largely responsible for bringing their profits down. For example, although oil prices have fallen, Sysco Corporation hedged 60% of its 2009 fuel needs in late July and August, when oil was still above $120.

5.2 Portfolio Rebalancing of Institutional Investors

Institutional investors can include banks, pension funds, endowment funds, insurance companies, governments etc. Faced with a decline in the price of oil, institutional investors have to decrease their exposure to industries adversely impacted by the fall in oil prices, such as the energy sector, and increase exposure to industries benefiting from low prices of crude oil, such as transportation. This is, in fact, what institutional investors have been doing since 2014. Table 11 reports the aggregated 13F filings of portfolio allocation in all level-1 industry sectors categorized under GICS for pension funds, endowment funds, banks, and government in the past two years.

A first pattern to be observed is the consistent decrease in the percentage allocation in the energy sector until the end of 2015 for all four institutional investors reported in Table 11, which is graphically represented in Figure 3. This decrease in portfolio allocation started in the third quarter of 2014 and reflects investment manager's allocation shifts away from the oil and gas industry, which was adversely impacted by the falling price of oil.

As consumer products, retailing, distributors, and transportation industries are benefiting from the low price of crude oil (see Section 4), a noticeable portfolio rebalancing in favor of Consumer Discretionary and Consumer Staples sectors can be observed for pension funds and banks in Figure 4. This pattern is less obvious in endowment funds' and government's portfolio allocation changes.

During the same period of time, the percentage portfolio

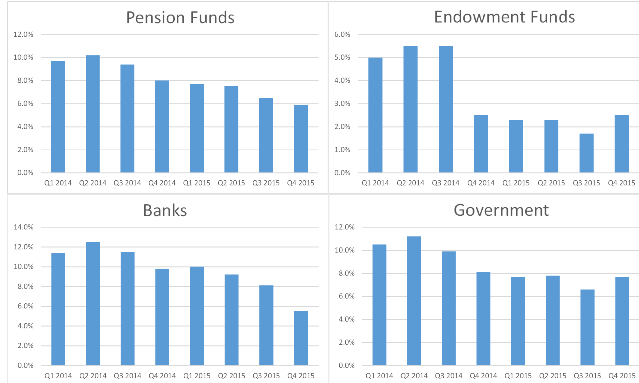

Figure 3. Percentage allocation in the energy sector (GICS) by pension funds, endowment funds, banks, and government according to 13F filings in the calendar years 2014-2015.

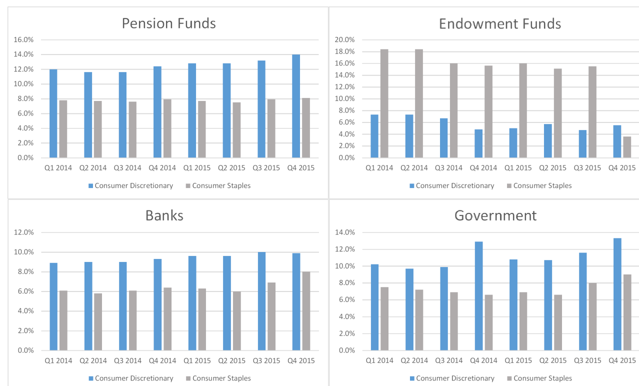

Figure 4. Percentage allocation in consumer discretionary and consumer staples sectors (GICS) of pension funds, endowment funds, banks, and government according to 13F filings in the calendar years 2014-2015.

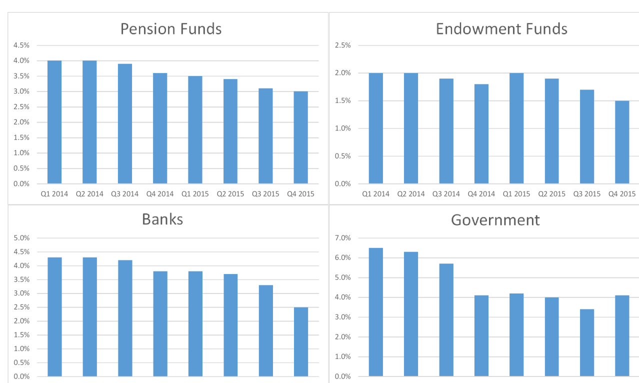

Figure 5. Percentage allocation in the materials industry sector (GICS) of pension funds, endowment funds, banks, and government according to 13F filings in the calendar years 2014-2015.

allocation in the materials industry has been decreasing, as shown in Figure 5, consistent with the observation that the materials sector, including chemical industries, are adversely impacted by falling oil prices.

On the other hand, while institutional investors have already decreased their exposure to the energy sector to a certain level by the end of 2015, they should actively monitor the price of oil in the near future to estimate the transition point for oil to reach its bottom. In fact, the fourth quarter of 2015 witnessed a slight increase in energy sector allocation within endowment funds and government investments. The agreement of Saudi Arabia, Russia, Qatar, and Venezuela to freeze their oil output may be followed by other oil producing countries. Consequently, the price of oil is expected to recover in the coming years.

In summary, since the third quarter of 2014, institutional investors have been hedging against oil price exposure by rebalancing their portfolios in favor of the industry groups which benefit from lower oil prices. At the same time, they have been reducing allocation in the energy and materials industries, which are susceptible to falling oil prices. In the mean time, institutional investors will carefully watch oil market trends in anticipation of potential profiting opportunities accompanying the expected recovery of oil prices.

5.3 Sovereign Wealth Funds Depreciation

Downward movements in oil prices adversely affect oil-related revenues and put fiscal pressure on the government budgets of oil-exporting countries, part of which can be mitigated by drawing funds from sovereign wealth funds or reserve assets. Signs of depreciation or even liquidation of sovereign wealth funds or reserve assets emerged after the oil price decline set in, as shown in Figure 6. A consequence of sovereign wealth depreciation is the weakening of a country's currency. Figure 7 depicts the Saudi Arabia foreign exchange rate, spot, and 12-month forward, measured by the price of 1 USD in SAR. During the period before mid-2014, the exchange rates were largely stable and the spreads between the spot and 12-month forward exchange rates were typically small. An interesting phenomenon can be observed that a noticeable volatility in the exchange rate appeared in the second half of 2014. While effort has been made to maintain the spot exchange rate at the level of 3.75, the forward rate, which manifests the market expectation, grew well above 3.80 rapidly. For those oil exporting countries, such as Libya and the Republic of Yemen, which do not possess enough financial buffers, a continued decline of oil prices entails substantial challenge for fiscal adjustment and local political stability.

On the other hand, the sovereign wealth funds' liquidation of oil exporting countries is not expected to exert a dramatic impact on the U.S. market. We find no significant change in oil price β by adding an explanatory variable corresponding to the growth rate of sovereign wealth funds in the linear regression analysis. This is an indication of the limited dependency of the U.S. economy on the involvement of sovereign wealth funds.

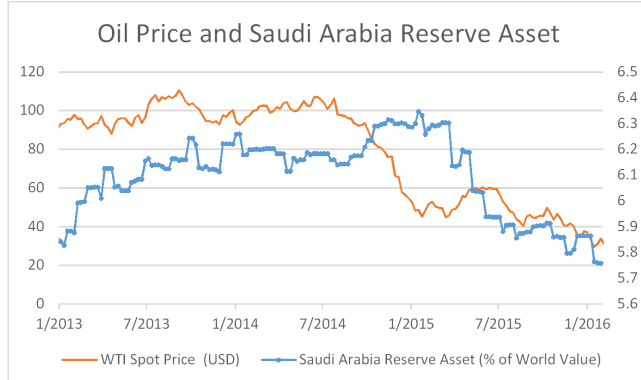

Figure 6. Co-movements of WTI crude oil spot price and the reserve assets, excluding gold, of Saudi Arabia as a percentage of world value. It is observed that the depreciation or potential liquidation of Saudi Arabia's reserve assets started about 6-8 months after the decline of oil prices set in.

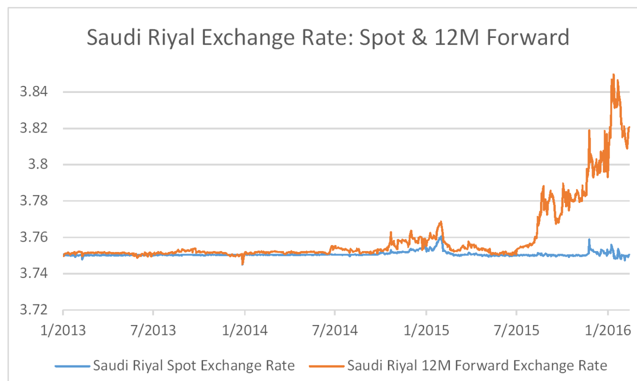

Figure 7. Saudi Arabia foreign exchange rate, spot, and 12-month forward, measured by the price of 1 USD in SAR. The weakening of Saudi Riyal is indicated by an increasing volatility and rapid increase of the forward rate after August 2014, when the decline of oil prices set in.

5.4 Wealth Redistribution and Global Impact

The downward trend in oil prices is also accompanied by a wealth redistribution across countries in the world and across states within the United States. While the adverse impact on oil exporting countries can be felt immediately and aggravated by market pressure, the benefit for oil importing countries could take some time to materialize and has so far been limited [9].

In this section, we use the *current account balance* as a percentage of GDP, the sum of net exports of goods and services, net primary income, and net secondary income, to measure the international wealth redistributive flow. Table 12 reports the current account balance as a percentage of GDP for a variety of regional aggregations in the past five years. It's

Institution	Periods	COND	CONS	ENRS	FINL	HLTH	INDU	INFT	MATR	TELS	UTIL
Pension Funds	Q1 2014	12.0%	7.8%	9.7%	21.6%	12.0%	10.9%	17.1%	4.0%	2.1%	2.8%
	Q2 2014	11.6%	7.7%	10.2%	21.3%	12.1%	10.6%	17.5%	4.0%	2.1%	2.9%
	Q3 2014	11.6%	7.6%	9.4%	21.5%	12.6%	10.3%	18.1%	3.9%	2.2%	2.7%
	Q4 2014	12.4%	7.9%	8.0%	21.9%	12.9%	10.3%	18.1%	3.6%	1.9%	2.8%
	Q1 2015	12.8%	7.7%	7.7%	21.3%	13.6%	10.3%	18.5%	3.5%	1.9%	2.7%
	Q2 2015	12.8%	7.5%	7.5%	22.0%	14.0%	10.0%	18.4%	3.4%	1.9%	2.4%
	Q3 2015	13.2%	7.9%	6.5%	22.9%	13.5%	9.8%	18.2%	3.1%	2.1%	2.8%
	Q4 2015	14.0%	8.1%	5.9%	18.9%	14.4%	10.4%	20.2%	3.0%	2.1%	2.9%
Endowment Funds	Q1 2014	7.3%	18.4%	5.0%	28.9%	23.3%	9.9%	3.9%	2.0%	0.5%	0.7%
	Q2 2014	7.3%	18.4%	5.5%	27.2%	23.8%	10.4%	4.0%	2.0%	0.5%	0.7%
	Q3 2014	6.7%	16.0%	5.5%	31.2%	23.6%	10.0%	3.9%	1.9%	0.5%	0.7%
	Q4 2014	4.8%	15.6%	2.5%	32.3%	25.8%	11.6%	4.4%	1.8%	0.4%	0.8%
	Q1 2015	5.0%	16.0%	2.3%	30.2%	27.7%	11.5%	4.1%	2.0%	0.4%	0.7%
	Q2 2015	5.7%	15.1%	2.3%	27.9%	30.9%	11.3%	3.9%	1.9%	0.5%	0.7%
	Q3 2015	4.7%	15.5%	1.7%	30.7%	30.5%	10.4%	3.7%	1.7%	0.4%	0.7%
	Q4 2015	5.5%	3.6%	2.5%	8.7%	62.7%	4.8%	8.4%	1.5%	0.8%	1.4%
Banks	Q1 2014	8.9%	6.1%	11.4%	33.9%	9.3%	8.0%	12.5%	4.3%	3.1%	2.3%
	Q2 2014	9.0%	5.8%	12.5%	31.9%	9.3%	8.2%	13.3%	4.3%	3.2%	2.3%
	Q3 2014	9.0%	6.1%	11.5%	31.7%	10.0%	8.1%	13.8%	4.2%	3.1%	2.3%
	Q4 2014	9.3%	6.4%	9.8%	31.5%	10.6%	8.2%	14.3%	3.8%	3.3%	2.6%
	Q1 2015	9.6%	6.3%	10.0%	32.1%	10.9%	7.9%	13.7%	3.8%	3.3%	2.2%
	Q2 2015	9.6%	6.0%	9.2%	32.2%	11.6%	7.6%	14.8%	3.7%	3.2%	2.0%
	Q3 2015	10.0%	6.9%	8.1%	32.3%	11.2%	8.0%	14.4%	3.3%	3.4%	2.3%
	Q4 2015	9.9%	8.0%	5.5%	32.7%	12.1%	8.3%	16.0%	2.5%	2.1%	2.2%
Government	Q1 2014	10.2%	7.5%	10.5%	16.8%	13.4%	9.4%	15.0%	6.5%	8.0%	2.8%
	Q2 2014	9.7%	7.2%	11.2%	17.1%	13.0%	8.9%	15.3%	6.3%	8.3%	2.9%
	Q3 2014	9.9%	6.9%	9.9%	18.0%	13.2%	8.4%	16.8%	5.7%	8.5%	2.7%
	Q4 2014	12.9%	6.6%	8.1%	20.3%	13.6%	9.5%	17.9%	4.1%	4.2%	2.9%
	Q1 2015	10.8%	6.9%	7.7%	16.3%	15.1%	8.2%	19.4%	4.2%	8.8%	2.5%
	Q2 2015	10.7%	6.6%	7.8%	16.3%	16.0%	8.3%	19.7%	4.0%	8.5%	2.3%
	Q3 2015	11.6%	8.0%	6.6%	17.5%	15.1%	8.9%	20.5%	3.4%	5.5%	2.8%
	Q4 2015	13.3%	9.0%	7.7%	16.7%	14.1%	9.6%	19.5%	4.1%	2.8%	3.2%

Table 11. Institutional investors' portfolio percentage allocation in 2014 and 2015: COND (consumer discretionary), CONS (consumer staples), ENRS (energy), FINL (financials), HLTH (health); INDU (industrials), INFT (information technology), MATR (materials), TELS (telecommunication services), UTIL (utilities).

observed that the current account balance of the countries of the Gulf Cooperation decreased rapidly in 2014 and fell below zero in 2015. The same pattern occurs for Africa, in which Angola and Nigeria are oil exporters. On the other hand, the year 2015 witnessed a significant increase in the current account balance for BRICS members and Asian countries excluding Japan, representative of emerging economies. The current account balance for developed nations in G8 remained stable in the past five years. We conclude that internationally, wealth redistribution from oil exporters to emerging economies was triggered after the decline of oil prices.

Region	2011	2012	2013	2014	2015
GCC	23.6	25.0	21.6	14.8	−0.2
BRICS	0.5	0.6	0.2	0.8	2.8
G8	−0.6	−0.8	−0.6	−0.5	−0.4
Africa	−0.7	−0.8	−1.2	−3	−3.9
Asia ex-Japan	1.9	1.9	1.8	2.5	3.9

Table 12. The current account balance as a percentage of GDP for a variety of regional aggregations. GCC: Gulf Cooperation Council; BRICS: Brazil, Russia, India, China, and South Africa. Source: Bloomberg.

Within the United States, we choose unemployment rate as an indication of economic activity and wealth. We choose North Dakota, Oklahoma, and New Mexico to exemplify the states whose economies are dependent on oil production. On the other hand, we choose Florida, Illinois, and Georgia to exemplify states with sizable economies but limited oil production. Figure 8 depicts changes of the unemployment rates of the chosen states over time since September 2014. We observe that the oil-producing states endure a stiffer employment situation than the other group of states, signifying the challenge of bolstering the local economies during a phase of declining oil prices.

Generally speaking, a decline in oil prices would be associated with an increase in global GDP [10]. The expected positive impact on the global economy is an aggregated consequence of the benefits of lower oil prices on the world's largest economies. The European Union and Japan are net beneficiaries from lower oil prices as imports of crude oil and its refined products amount to 3-4% of their GDPs. A net positive effect is also expected on the United States economy. However, this upward effect is likely to have an upper bound due to the existence of a substantial share of energy production domestically in the U.S. The impact of low oil prices on the growth of China's economy is expected to boost its economic activity modestly, because the majority of the energy consumption in China is accounted for by coal. Similarly, in the other members of the BRICS countries, the fall in oil prices is beneficial for reducing the current account deficits and lowering inflation, while the precise effect depends on the intensity of oil consumption in the individual economy. Despite the expected benefits, historically, the weakening global oil demand has also been associated with periods of financial stress in world economies. The overall impact of a continued declining oil price gives rise to a wide divergence of growth paths in world economy [11].

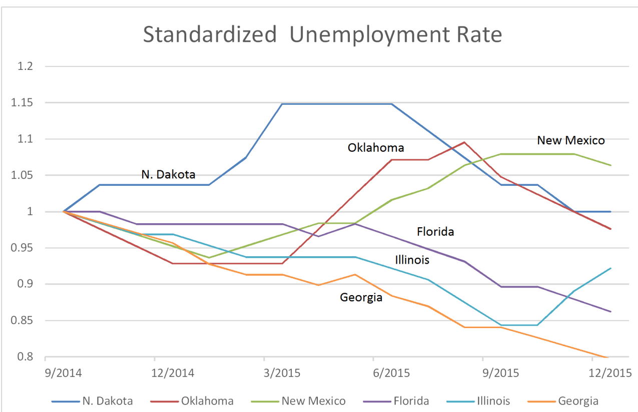

Figure 8. Standardized unemployment rates of a selected list of states in the United States since September 2014. ND, OK, and NM are chosen as representative oil-producing states, and FL, IL, and GA as state economies not dependent on oil production.

6. Conclusions

This paper sets out to investigate the differential impact of falling oil prices on stocks in various industries and how industries and investors respond in different ways to changes in oil prices after the 2007-2008 financial crisis. According to our regression analysis, the oil & gas and the chemical industries are adversely impacted by the oil price decline. Since the energy sector has a large footprint in the U.S. capital market, the profit of financial industries has also been dampened during this phase. On the other hand, the airline, consumer goods, and automobile industries are benefiting from the falling oil prices as a result of lowered costs and stronger consumer' confidence. We have shown strong evidence for Granger causality between the oil returns and the stock returns in the oil & gas, airline, and consumer goods industries.

Following the investigation of oil price impact, the response of U.S. industries and investors to oil price decline is examined through the quarterly 10-Q and 13-F report filings for a selected list of companies and institutional investors, respectively. The effectiveness of hedging strategies and portfolio allocation against oil price risk are described and assessed in detail. A transfer of funds from the energy and materials sectors to transportation and consumer goods sectors is a feasible portfolio allocation for investment managers faced with the continued oil price decline. The consequence of the sovereign wealth funds and reserve asset depreciation is described using Saudi Arabia as an example.

In the context of declining oil prices, we explored the issue related to the wealth redistributive effects across countries and across states within the United States. The current account balance as a percentage of national GDP is used to measure the wealth redistribution effects from oil exporting countries to emerging economies, while unemployment rates are used to indicate the magnitude of economic activities within the United States. Finally, we summarized the net macroeconomic impact of declining oil prices on global growth.

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