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Abstract

Crude oil is one of the world's most important goods. It is used everywhere in the world daily and has many uses, the most common use being gasoline. In the short run, the supply of oil is inelastic; oil rigs can only produce so many barrels of oil per day, and companies will not be able to construct new rigs or implement new machinery. The demand for oil is also fairly price inelastic; consumers will consume large amounts of oil even at high prices due to its high necessity. Because of this high necessity and the inelasticity of demand and supply, it is important to understand the way different short and long run supply and demand shocks affect the market for both crude oil and gasoline, either within the examination of supply or demand.

Oil Spills and Futures Prices of Crude Oil and Gasoline: An Examination of the Effect of Precautionary Demand

Samantha Eads

I. Introduction

Crude oil is one of the world's most important goods. It is used everywhere in the world daily and has many uses, the most common use being gasoline. In the short run, the supply of oil is inelastic; oil rigs can only produce so many barrels of oil per day, and companies will not be able to construct new rigs or implement new machinery. The demand for oil is also fairly price inelastic; consumers will consume large amounts of oil even at high prices due to its high necessity. Because of this high necessity and the inelasticity of demand and supply, it is important to understand the way different short and long run supply and demand shocks affect the market for both crude oil and gasoline, either within the examination of supply or demand.

In the past, economists have disagreed on whether oil spills affect the supply or demand of crude oil more. Two economists speak of these differences in opinion concerning oil supply and demand, and thus prices, in response to the Gulf of Mexico oil spill (2010) as quoted in the Fort Worth Star-Telegram.

While "Bernard Weinstein, associate director of the Maguire Energy Institute at Southern Methodist University in Dallas states the oil spill will contribute to higher pump prices 'because of the uncertainty it creates,' especially in regard to its potential to curb domestic offshore drilling," Bill Day, communications director at oil refinery Valero Energy, said "the company doesn't expect any disruption to supply or production at any of its Gulf Coast refineries as a result of the spill. 'Given that, we don't expect any impact on prices'" (Smith, 2010). Weinstein appears to be focusing on the demand side of the price equilibrium, while Day focuses on the supply side. The question remains as to whether supply or demand plays a larger role in the pricing of oil and gasoline.

According to an article in the July 2010 issue of Businessweek, crude oil prices have decreased nearly 10 percent over the past three months, despite the occurrence of the worst oil spill in U.S. history (Gelman, 2010). The article continues, stating that this decrease in price is due to a weak global demand for oil. It also describes that if the moratorium on offshore drilling is reinstated, "U.S. crude output will be cut by an average of 26,000 barrels a day in the fourth quarter of this year and 70,000 barrels a day in 2011, according to the Energy Department--an amount equal to less than 1 percent of daily global oil production" (Gelman, 2010). Whether this could have

an impact on the future supply of oil, thereby affecting prices is not yet able to be determined. In contrast, an article in the Wall Street Journal discusses an increase in crude oil futures prices after a pipeline in Chicago ruptured (DiColo, 2010). Although it does not state, this increase in price could be due to either a supply shortage or an increase in precautionary demand as consumers purchase large quantities of crude oil in response to a fear of a future supply shortage.

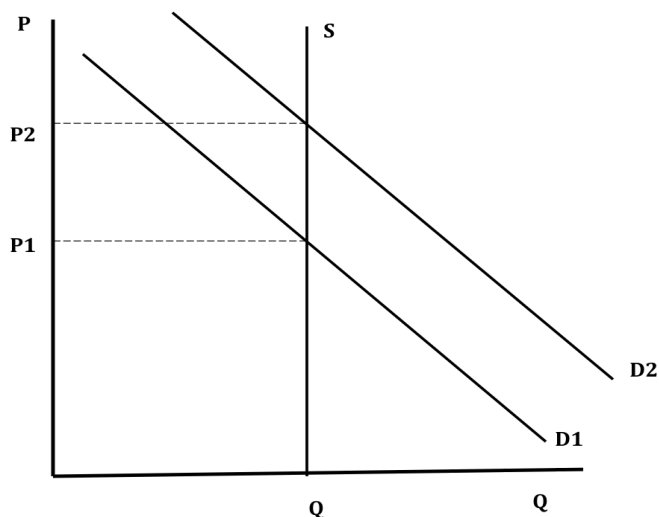
There are different types of supply and demand shocks that can affect the equilibrium price of oil and gasoline. Each type of shock has a different effect on the real price of oil. Kilian (2009) identifies three types of shocks: crude oil supply shocks, shocks to the demand for all industrial commodities, and demand shocks that are specific to the crude oil market. In a later study Kilian (2010) examines the latter of the three shocks in a more detailed context by composing a model that examines the precautionary demand for oil, which arises from the uncertainty about shortfalls of expected supply relative to expected demand (Kilian, 2010). This paper will observe Kilian's theory of precautionary demand by examining futures prices of both crude oil and gasoline over time. Futures prices are used instead of spot prices in order to capture the consumers' increase in precautionary demand after the oil spill occurs. Precautionary demand is examined rather than supply shocks because previous literature shows that since supply of crude oil is not significantly affected by oil spills supply changes should not affect the spot price. This paper hypothesizes that after an oil spill occurs, the precautionary demand of crude oil and gasoline will increase due to consumers' uncertainty of expected supply. This will cause futures prices to rise in the short run. In the long run, the futures prices will stabilize after the consumers realize supply has not been affected by the disaster.

II. Theory and Literature Review

The theory which envelopes this study is basic supply and demand. As previous literature dictates, supply is not significantly affected by oil spills. Supply is constant in the short run as firms are not able to change their production structure. According to Kilian (2009), when there is a decline in production in one region, another region will increase production, causing the global supply to stay constant. Thus, supply is constant in the long run, as well. This project will take supply as completely inelastic and focus solely on the demand for crude oil and gasoline, as indicated in Graph 1. This is due to the

insignificant effect oil spills have on the supply of crude oil, and is also assuming no public policy effect has taken place due to the oil spill, focusing solely on the direct effect of the oil spill rather than indirect effects such as a ban on offshore drilling, a decrease in the oil reserves, or increase in safety precautions. More specifically, precautionary demand, or the fear about shortfalls of expected, but not actual, supply relative to the observed demand of oil, will be examined.

Graph 1:



The demand for crude oil and gasoline will be examined by observing the impact oil spills have on the futures market of the two commodities. According to Arbatli (2008), “the key idea is that futures prices with different maturities reflect expectations of future spot prices at those maturities. When a shock hits, it shifts the entire term structure of futures prices, and the magnitude of the shift across different horizons reveals the expected dynamic of the shock.” The relative variances of contracts with short and long maturities reflect the relative variances of permanent and transitory shocks (Arbatli, 2008).

Futures markets are markets where participants trade contracts whose payoffs are tied to a future event, thereby yielding prices that can be interpreted as market-aggregated forecasts (Wolfers, 2008). This indicates that futures prices are what the traders (consumers) feel that the real price of the commodity will be in the future. Wolfers (2005) provides sufficient conditions under which futures market prices coincide with average beliefs among traders. Thus, since we know supply is constant in the short run, the change in futures prices depends solely on what the traders feel the demand for crude oil and gasoline will be in the future relative to the supply. This change in demand in the future may be dependent upon the sentiments consumers have towards the future supply of oil due to the oil spill, even though it is known through economic literature but not necessarily known by investors that spills have an insignificant effect on the supply of crude oil.

According to Kilian (2009), this fear about shortfalls of expected supply relative to expected demand of oil is known as precautionary demand. Even though supply will not change in the short run, precautionary demand can arise because of the fear over unexpected growth of demand, unexpected declines

of supply, or both. Kilian (2009) also found that the movements in the real price of oil induced by oil market-specific demand shocks are highly correlated with the precautionary demand component of the real price of oil based on futures prices (Alquist and Kilian, 2010). In the present study it can be said that due to an oil spill, consumers perceive supply to decrease so they increase demand due to fear of future shortfalls in supply.

In his empirical results, Kilian (2009) shows that a shock to the oil market triggers an increase in the real price of oil for about eight months which then reverts to the mean. The effect on real prices of oil of unanticipated oil market-specific demand increases is large, positive, and statistically significant. It is suggested that this is due to increases in precautionary demand. Kilian found that as shifts in precautionary demand are ultimately driven by expectations about future oil supply shortfalls, which can change almost instantaneously due to events such as oil spills, they tend to trigger an immediate and sharp increase in the real price of oil. He then focuses this idea by examining different political episodes that caused changes in precautionary demand of oil, such as the Iranian Revolution of 1979 and the Iran-Iraq war in the 1980s. The real price of oil was proven to have increased due to the precautionary demand of oil during these events (Kilian, 2009).

Asali (2004) found that crude oil prices are cyclical in nature; the prices follow the business cycle. When there is a recession, the prices will drop, and when there is an expansion, the prices will rise. This finding will help in this project to control for the affects of the business cycle on the time series data, ensuring that only precautionary demand will be captured in the model to be the factor of the change in futures prices.

Consistent with autoregressive behavior, crude oil prices are known to revert to the mean after the shock dies away (Arbatli, 2008; Asali, 2004; Bessembinder, 1995; Coppola, 2008; Kilian, 2009). According to Arbatli (2008), Bessembinder (1995) and Killian (2009), this reversion occurs approximately eight months after the shock initially occurs. Arbatli (2008) found that “transitory shocks have a half-life of approximately 8 months”, and Bessembinder (1995) found that “point estimates indicate that 44% of a typical spot oil price shock is expected to be reversed over the subsequent 8 months”. This means that immediately after the oil spill occurs, futures prices will increase due to the increase of precautionary demand of oil. Approximately eight months later, the price will revert to the mean price of crude oil. This provides an estimated time frame of eight months to be used in the current study of how oil spills affect precautionary demand and the futures price of oil.

While all of the studies discussed have examined the futures prices of crude oil over time, this project is different in the fact that it is examining both crude oil and gasoline futures prices to see if there is a difference in the variation over time. It is also examining specific time periods, looking at the futures price changes when there are oil spills to see if there is an effect of the spill on the futures price, rather than just fitting a model to the data and examining the behavior over time, as the studies in the past have done.

III. Empirical Model and Data

To test the hypothesis that the futures prices of oil will increase in the short run but stabilize in the long run, time-series analysis will be utilized instead of regression analysis. This will allow for the same series of data, futures prices of crude oil and gasoline, to be examined over time. It will require the examination of subsamples of the data along with the entire data set. This will allow for the analysis of the short run and long run effects of the individual oil spills on the futures price of oil and gasoline, and thus the precautionary demand.

The specific time-series model that will be used is the autoregressive moving average (ARMA) model. The futures prices of crude oil have autoregressive and moving average components. Autoregressive components indicate that the current value of y_t depends solely upon its previous values, plus a disturbance error term. Moving average models are used when y_t depends on the current and previous values of a disturbance error term. Since the futures price of crude oil contains components from both of these models, it can be fitted to the autoregressive-moving average model. The autoregressive-moving average (ARMA) model is a combination of the moving average model's random deviation from a constant mean, plus the autoregressive model's random deviation from past values of itself. The ARMA model is fitted to the futures price data using the Box-Jenkins methodology. The futures prices of crude oil have previously been fitted to an ARMA model by Arbatli (2008).

The Box-Jenkins methodology begins with the identification of the ARMA(p , q) model. The p and q orders are tested using information criterion, with p indicating the order of autoregressive components, and q indicating the order of moving-average components. The objective of the test is to minimize the criteria. Three information criteria tests will be used in this study, and are the Akaike (AIC), Schwarz, and Hannan-Quinn (HQ) information criterion.

The data will need to be manipulated, to control that only the shocks are being measured, before the ARMA model can be run. First, the data will need to be put into real terms to adjust for inflation. This will ensure that inflation is not the factor affecting price increases. I will do this using the CPI index with the base year as 1985. Second, stationarity needs to be ensured. If data is stationary, it has a constant mean and constant variance. Asali (2004) discusses stationarity by stating "mean-reverting and price shocks tend to have finite persistence, while a difference-stationary series has infinite persistence". A few tests are run to confirm stationarity. If the crude oil price-series has a unit root, innovations in prices have a permanent effect, hence are persistent. If the price-series is trend-stationary, innovations do not have a permanent effect and price fluctuations are purely cyclical in nature (Asali, 2004). The Augmented-Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics examine if there is a unit root in the data in levels. A unit root is present when the current value of y_t is equal to its past value plus a random deviation, and indicates non-stationarity. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test statistic examines if the data is stationary in levels. If the data is not stationary in levels, I will use the first-order difference of the data to ensure stationarity. Bessembinder (1995) found that there was non-stationarity in the futures prices of crude oil, so

the first differences of each data series was used in the time series analysis. It is estimated that the current project will yield similar results.

Seasonal components of the data are examined by graphing the averages of each month. By doing so, one can see which month(s) have a higher or lower crude oil price per month on average, showing the seasonal variations. In the summer, oil prices are theoretically higher due to the higher demand due to vacation travel than in the winter. This can be controlled after testing for these seasonal components. Kilian (2009) found that the supply of crude oil is not affected by seasonal components. When supply decreases in one region due to these components, it will increase in another region, thus the global supply stays constant. This indicates that seasonal components will only affect the demand for crude oil and gasoline.

Outliers will also have to be taken into account. If there are significantly large or small outlying prices, the ARMA model can become skewed. If there are large outliers that may affect the rest of the model's results, they may need to be left out of the data set. This could also be accomplished by taking the natural logarithms of the data to linearize and normalize the data set, removing the large impact of the outliers.

There are assumptions that need to be ensured when running an ordinary-least-squared (OLS) regression, such as an ARMA model. After I manipulate the data in the manners described above, I will ensure these following assumptions are satisfied to make sure the estimation results are reliable and meaningful. I will ensure the residuals of the model have a mean value of zero, a constant variance (homoskedastic), are unrelated over time (no autocorrelation), fixed in repeated samples (non-stochastic), and follow a normal distribution. Table 1 shows the tests used to check for these assumptions.

The data on the futures prices used will be collected from the Energy Information Administration (EIA) website, which compiles futures prices using the New York Mercantile Exchange (NYMEX). The EIA is a government agency created by Congress approximately 30 years ago. It is a statistical agency of the Department of Energy, and one of the 10 principle statistical government agencies. They adhere to the Office of Management and Budget, as well as the Department of Energy quality of information guidelines. They also state that their objective is to provide information in an "accurate, reliable, and unbiased, and the information is presented in an accurate, clear, complete, and unbiased manner" (EIA.doe.gov).

The data currently available are on the futures prices of crude oil from April 8, 1983 to October 1, 2010, and for gasoline from January 4, 1985 to December 29, 2006. The data is the official daily closing prices at 2:30 p.m. from the trading floor of NYMEX averaged for the week for a one month futures contract. The data is in dollars per barrel for crude oil and dollars per gallon for gasoline, and is in nominal terms. The data was adjusted for inflation using the CPI with the base year being 1985.

The shocks that this paper will examine will be eight major oil spills that occurred in the United States from 1989 to 2010. Oil

spills in the US were chosen over the top 8 largest oil spills in the world due to the expected decrease in supply of crude oil in the US because of these spills, possibly triggering supply reducing public policy or a fear induced increase in demand, thus affecting the precautionary demand. These oil spills will include the Exxon Valdez oil spill in Alaska in 1989, the Mega Borg off the coast of Texas in 1990, a spill caused by a collision of three ships off the coast of Tampa Bay, Florida in 1993, the Selendang Ayu in Alaska in 2004, a disruption in oil production caused by Katrina in Louisiana in 2004, a spill caused by a storm in the Calcasieu River, Louisiana in 2006, a collision between two ships in Louisiana in 2008, and the BP oil spill in the Gulf of Mexico in 2010.

Using time-series analysis to examine the effect oil spills have on the futures prices of oil and gasoline is useful because this paper is merely examining the effects on price (and no other variable). After manipulating the data in the way described above, and by using the ARMA model, thus controlling for the natural auto-regressive and moving-average components of the data series, I am able to examine solely the affects that the oil spill shocks have on the futures prices.

IV. Results

To begin the data manipulation to ensure proper results, I began by adjusting the nominal futures prices of crude oil and gasoline into real prices. I used the CPI from their website, with the base year of 1982-1984. I then plotted the descriptive statistics of both crude oil and gasoline futures prices to look for outliers and to check for normality. I did this by examining the skewness and kurtosis descriptive tests. As indicated in table 1, skewness should be near 0 and kurtosis should be near 3. With my original real futures prices of oil and gasoline, the skewness and kurtosis were 1.44 and 5.29, and 1.47 and 5.22 respectively, indicating non-normality in both sets of data. To normalize my data, I took the natural logarithms of the data. I then re-ran the descriptive statistics of my data and found the skewness and kurtosis of crude oil and gasoline to be 0.48 and 2.56, and 0.56 and 3.38, respectively, indicating normality. Thus, the natural logarithms of my data will be used to ensure the assumption of normality is accounted for.

After transforming my data into natural logarithms, I needed to check for unit roots to ensure stationarity in my data sets. To do this, I ran the Augmented-Dickey-Fuller (ADF) and Phillips-Perron (PP) to check for unit roots, and the KPSS test to check for stationarity. When running the tests, if the test statistic is greater than the critical values, we accept the null hypothesis of the data having a unit root, which indicates non-stationarity. With the KPSS test, if the test statistic is greater than the critical values, we reject the null hypothesis of stationarity. The results of the tests are below in table 2. With both the natural logarithms of the futures price of gasoline and crude oil, the tests indicated non-stationarity in levels. To correct for this and induce stationarity, I transformed my data into the first differences. After re-running the tests, I found that the data were stationary. For the rest of the paper, when referring to the data, I am referring to the differences of the natural logarithms of the futures prices of gasoline and crude oil.

With the now normal and stationary data, I fit the data to an ARMA(p,q) model. I did this by using the Box-Jenkins

methodology. I ran a program designed to produce the information criterion for the AIC, HQ, and Schwarz tests. The minimum of the criterion indicates the closest fitting ARMA model. Table 2 shows my results, which indicated that the futures prices of crude oil fits best to an ARMA(2,3) model, and the futures prices of gasoline fits best to an ARMA(0,1) model. The first number indicates the order of auto-regressive components and the second number indicates the order of moving-average components within the data. This data was used to run the OLS model to fit the subsamples of the data (each oil spill). The t-statistics, adjusted R2 and Durbin-Watson test results for the models for the entire data sets are shown in Table 2.

Even though the adjusted R2 of the entire data sets are low, it indicates that the data is more influenced by shocks rather than the auto-regressive and moving-average components. The adjusted R2 are higher for the subsamples, indicating a better fitting regression within these subsamples.

After running these regressions, I used the ARMA models to estimate what the futures prices of crude oil and gasoline should be, without taking into account the oil spill, to be compared to the actual prices. I then averaged the estimated prices and averaged the observed prices for each of the oil spills, starting on the initial day of the spill up to 8 months afterwards, as indicated by past literature. I then took the differences of the estimated prices minus the observed futures prices. This difference in prices shows if the actual prices are higher than the estimated prices, which do not take into account the oil spill shock, which is hypothesized to increase the price due to an increase in precautionary demand. To show that this hypothesis is correct, we want the difference to be negative and have a significant t-statistic. Table 3 shows the results. I did this test with each of the oil spills as well as with all of the spills averaged together for both the futures prices of crude oil and gasoline. The tests indicate that 5 out of the 8 oil spills caused an increase in the futures prices of crude oil, and 2 of the 6 oil spills caused an increase in the futures prices of gasoline, and thus an increase in the precautionary demand. When averaged together, the futures prices of crude oil was negative and significant, and gasoline was negative, but not significant.

There are a few reasons why the futures price of crude oil is more affected by oil spills than the futures prices of gasoline. One reason is that crude oil is what is actually being spilled. This would cause a higher precautionary demand, as the uncertainty of expected supply relative to expected demand decreases as people are able to see the supply diminish (although not significantly). Another reason why the futures prices of crude oil rather than the futures prices of gasoline is more significantly affected might be due to the fact that there is already a stockpile of crude oil in the refineries to make gasoline, thus the oil spill would not directly affect the amount of oil used to make gasoline in the short run, or at least until the stockpile at the refineries would run out. This would cause a more stable expectation of supply relative to demand of gasoline, thus not impacting the futures prices, which measure expectations, as much for gasoline.

V. Conclusions

This paper hypothesized that after an oil spill occurs, the

precautionary demand of crude oil and gasoline increases due to consumers' uncertainty of expected supply. This causes futures prices to rise in the short run. In the long run, the futures prices stabilize after the consumers realize supply has not been affected by the disaster. The results of the regression and tests indicate that this is true for crude oil futures prices, with 5 of the 8 spills indicating an increase in price and when averaging all the spills together there was a significant increase in price, but not true in the case of gasoline futures prices, with only two of the six spills indicating a significant increase in price, and when averaging all the spills together, there was an increase in price, although not a significant one.

This paper built upon previous studies by examining the futures prices of both crude oil and gasoline rather than just one or the other as past studies have done. It also fitted an ARMA model to the data rather than the other models used in the past, such as a VAR model and other time series models. This study examined the impact of oil spills on the futures prices of crude oil and gasoline rather than just examining futures prices over time. Past studies use time series techniques to examine the relationship between futures and spot prices of crude oil and gasoline, as well as attempt to forecast the prices. My project differs in the fact that it examines the effects of specific shocks on the prices, breaking the time series data into subsamples in order to better grasp the shocks' effects.

Just as Kilian (2009) found that a shock to the oil market triggers an increase in the real price of oil, this project found that a shock (an oil spill) causes an increase in the real futures price of crude oil. Kilian concluded this was due to an increase in the unanticipated oil market-specific demand, just as this paper concluded by using futures prices that the increase was due to an increase in precautionary demand. Kilian's research found statistically significant evidence that this is true during political changes, though, rather than oil spills.

Since it was found that there was a significant increase in the futures prices of crude oil after an oil spill, policy should be implicated to ensure that the investors in the futures market understand that the supply of oil does not change due to an oil spill. This study proved that precautionary demand increases when there is an oil spill due to the fear of a shortfall of supply relative to demand. The investors need to know there is no need for precautionary demand to increase if there is an oil spill without a coinciding public policy change, thus there is no need for the futures price to increase.

Future studies could examine the effects of public policy, such as a ban on offshore drilling or other supply regulations, on the futures prices of crude oil. It is probable that these implications will have a higher affect on the futures prices, as the actual supply of oil will decrease, rather than just the expected supply, when these regulations are put in place. In the future, economists could also improve on this study by inducing a lag of the number of months that are required for the maturity of the futures price to help capture the actual precautionary demand of the investor. Using the futures prices in the way in which this study used them examines the demand one month (the time of the maturity) before the actual oil spill, so a lag of one month should have been induced to capture the actual precautionary demand of the investors. Another way in which this study could

be improved is if the variances of the futures prices, rather than the average of the prices, were used, as suggested by Arbatli (2008). This helps indicate the extent of the variation of futures prices rather than the difference between what is estimated and what is observed.

References:

Alquist, R, and Lutz Kilian. (2010). "What Do We Learn from the Price of Crude Oil Futures?". *Journal of Applied Economics*, 25, 539-573

Alquist, R. and Elif Arbatli. (2010). "Crude Oil Futures: A Crystal Ball?". *Bank of Canada Review* (Spring, 2010)

Arbatli, E. (2008). "Futures Markets, Oil Prices and the Intertemporal Approach to the Current Account". *Bank of Canada* (48)

Asali, M. and Ahmad R. Jalali-Naini. (2004). "Cyclical Behaviour and Shock-Persistence: Crude Oil Prices". *Organization of the Petroleum Exporting Countries* (June)

Coppola, A. (2008). "Forecasting Oil Price Movements: Exploiting the Information in the Futures Market". *The Journal of Futures Markets* (28) 1, p. 34-58

DiColo Jerry A. (2010). Pipeline Break Drives Oil Over \$76. *Wall Street Journal* p. C.5.

Gelman, E. & Shenk, M. (2010). Oil Prices: Down and Heading Lower. *Bloomberg Businessweek*, (4186), 43-44.

Kilian, L. (2009). "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market." *American Economic Review*, 99(3), 1053-1069.

Narayan, P., Narayan, S., & Smyth, R. (2008). Are Oil Shocks Permanent or Temporary? Panel Data Evidence from Crude Oil and NGL Production in 60 Countries. *Energy Economics*, 30(3), 919-936.

Smith, J. (2010, May 4). Energy experts disagree on whether gulf oil spill will lead to higher gas prices. *Fort Worth Star-Telegram* (TX)

Wolfers, J. and Zitzewitz, E. 2005. Interpreting prediction market prices as probabilities. *Mimeo*, University of Pennsylvania.

Wolfers, Justin and Eric Zitzewitz. (2008) "prediction markets." *The New Palgrave Dictionary of Economics*. Palgrave Macmillan.

Table 1: Descriptive Tests

Test:	Null Hypothesis:	Reject:
White's Test:	Errors are homoskedastic	F- test <0.05
Durbin-Watson	No autocorrelation	Deviate from 2
Skewness	Normal distribution	different than 0
Kurtosis	Normal distribution	different than 3
Functional form	Linear model is appropriate	F-test <0.05
ADF	Unit root in levels	ADF statistic < critical values
Phillips-Perron	Unit root in levels	PP statistic < critical values
KPSS	Stationary in levels	KPSS < critical values

Table 2: Test Results

Test:	Used for:	Oil (logs):	Gas (logs):	Oil (1st dif)	Gas (1st dif)
Skewness	Normality	1.44 (original)	1.47 (original)	0.48 (logs)	0.56 (logs)
Kurtosis	Normality	5.29(original)	5.22 (original)	2.56 (logs)	3.38 (logs)
ADF test stat	Unit root	-1.90	-2.68	-33.99	-30.09
Crit. Value 1%		-3.43	-3.44	-3.43	-3.44
PP test stat	Unit root	-2.03	-2.69	-34.19	-29.96
Crit. Value 1%		-3.43	-3.44	-3.43	-3.44
KPSS test stat	Stationarity	1.39	0.87	0.16	0.09
Crit. Value 1%		0.74	0.74	0.74	0.74
AIC	Fitting ARMA			ARMA(2,3)	ARMA(0,3)
Schwarz	Fitting ARMA			ARMA(2,3)	ARMA(0,1)
HQ	Fitting ARMA			ARMA(0,1)	ARMA(0,1)
Adj. R ²	Fit			0.03	0.01
Durbin-Watson	Autocorre.			1.99	2.00
f-statistic	Functional			0.00	0.00

Table 3: Price Differences (t-statistics in parenthesis)

Spill	Avg. Oil Before	Avg. Oil During	Difference	Avg. Gas Before	Avg. Gas During	Difference
1	28.89	34.92	-6.03 (23.89)***	0.99	0.96	0.04 (-1.81)
2	34.98	44.30	-9.322 (5.05)***	0.94	1.17	-0.22 (6.01)***
3	31.82	23.14	8.68 (-18.50)	0.85	0.62	0.25 (-20.45)
4	31.20	57.66	-26.46 (27.44)***	0.86	1.65	-0.79 (18.10)***
5	66.32	69.06	-2.74 (4.60)***	1.79	1.78	0.01 (-0.12)
6	76.73	68.80	7.93 (-5.99)	2.11	1.78	0.32 (-5.55)
7	84.46	70.26	14.20 (-2.66)	—	—	—
8	71.77	76.75	-4.98 (6.68)***	—	—	—
Total	53.27	55.61	-2.34 (4.62)***	1.26	1.29	-0.02 (0.53)

*Significance at the .10 level

**Significance at the .01 level

***Significance at the .005 level

