University of Michigan

Buying High and Selling Low

Pipeline Ownership and the Price Gap between WTI and Brent Crude Oil

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Abstract

The 2011 price gap between the West Texas Intermediate and Brent crude oil benchmarks was caused primarily by the lack of pipeline infrastructure connecting the American Midcontinent to the Gulf Coast. An analysis of the profit-maximization function for a crude oil refiner with control of an inter-regional pipeline shows that by shipping crude oil from a high-price to a low-price region, a refiner can lower the cost of its inputs sufficiently to offset the trading loss on pipeline flows. This paper then explains how transporting crude oil to the low price region enabled the price gap to remain for most of 2011 and why the price gap ultimately shrank again.

1.   The Pipeline Paradox

The difference in crude oil spot prices between the Brent and West Texas Intermediate benchmarks grew to $19.84 per barrel on June 15, 2011. From February 1, 2011 until November 15, 2011 the price difference stayed above $10.00. Historically the price difference has been much smaller due to the similarity between the two crude oil benchmarks. The fact that the price gap remained for nearly 10 months is surprising and in the last decade unprecedented. This paper examines why the price gap persisted for so long.

ConocoPhillips, a major crude oil producer and refiner, had the capability to reduce the price gap considerably.   As owner of the only major pipeline between the American Midcontinent and the Gulf Coast, ConocoPhillips could decide the direction that oil flowed along the pipeline, either from north to south or from south to north. Despite the price gap of nearly $20 per barrel, ConocoPhillips kept sending oil from the high-price region in the south to the low-price region in the north. At first glance it appears that large rents could have been earned by ConocoPhillips if it had allowed some level of arbitrage to occur. Despite the potential benefits, ConocoPhillips waited until November 2011 to announce that Enbridge Inc. would buy a 50% stake in the pipeline and then reverse the flow (ConocoPhillips kept the remaining stake in the pipeline)[1]. Why did ConocoPhillips spend a year buying high and selling low before deciding to reverse the pipeline? What is at first surprising is found to be sensible once ConocoPhillips' situation is understood.

The oil industry is one of the largest sectors of the global economy. Nearly all of the world's crude oil is priced according to one of the two major benchmarks.   West Texas

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[1] http://online.wsj.com/article_email/SB10001424052970203699404577041901234224874-lMyQjAxMTAxMDEwNjExNDYyWj.html?mod=wsj_share_email

Intermediate (WTI) is priced in Cushing, OK and is the price of crude oil in most of the United States and Canada. Brent is the world's other major benchmark and is sourced in the North Sea. Changes in the price of crude oil could have important macroeconomic effects. James Hamilton says that it is likely that oil shocks "were a contributing factor in at least some of the U.S. recessions prior to 1972" (Hamilton 1983). Conversely Robert Barsky and Lutz Kilian conclude that "disturbances in the oil market are likely to matter less for U.S. macroeconomic performance than has commonly been thought" (Barsky and Kilian 2004). Excluding the possible macroeconomic effects of lower oil prices, most of the economic loss from the price divergence falls to crude oil producers in the United States, Canada, and Latin America who benchmark the price for their crude oil sales to the West Texas Intermediate price. The price divergence is beneficial for crude oil refiners, who are the primary consumers of crude oil in the United States.

The current price divergence also has theoretical implications. It shows that market efficiency for intermediate goods can be highly dependent on ownership of transportation networks. The fact that the price gap is caused largely by vertical integration between midstream and downstream operations is highly relevant to antitrust law and whether one company should be allowed to engage in both intermediate good refining and transportation.

The primary result is that when firms exhibit both monopolist power in the transportation of an intermediate good and engage in the refining of that intermediate good, they may have an incentive to transport the intermediate good from the high price region to the low price region. The surprise is that buying high and selling low is generally believed to be unprofitable. The model for this effect is then shown to be consistent with the present crude

oil price divergence. This leads to the conclusion that vertical integration of midstream and downstream operations can lead to deadweight loss in the market for the intermediate good.

This paper begins with the construction of a model for analyzing an inter-regional market for an intermediate good. It then models what would happen under different transportation ownership and monopsony power schemes. Finally it analyzes the regime that includes a firm having monopoly power over inter-regional transportation and oligopsony power in the purchasing of the intermediate good. This regime may result in an even greater deadweight loss than under autarky. The explanation of this finding concludes the theoretical section of the paper.

Following the exposition of the model is a section describing the recent history of the crude oil market. The empirical evidence section focuses on the status of ConocoPhillips' Seaway pipeline, the influx of crude oil from Canada, and the price differential between the regional crude oil benchmarks. An explanation of how the model applies to this market and the predictions it makes thereof follows. The section ends with an analysis of empirical data that supports the application of the model to the current price gap.

The paper concludes by presenting how the model is relevant to understanding the market for intermediate goods, specifically with respect to vertical integration and monopoly power in transportation networks, along with an analysis of the policy implications and a brief summary of the research findings.

2. Theory

Price Divergence Model

The cause of the price divergence in the crude oil market can be modeled by a two-region market under a few assumptions. The first assumption is that the good being bought and sold in the market is an intermediate good. Some examples of intermediate goods include crude oil, lumber, and steel. The intermediate good in this market will be referred to as crude oil although the model holds for any intermediate good.

The two regions are physically separated, but between the two regions exists a pipeline through which the crude oil can be transported. In each region are producers who produce the crude oil and refiners who buy the crude oil with the intent of refining it. The model will be presented using a few different market regimes. The first will be a monopsonist in one region and no inter-regional trade. This will act as a base scenario with which the others can be compared. The second regime will keep the monopsonist refiner assumption but give ownership of the pipeline to that monopsonist refiner. This regime is close to what is seen in the American crude oil market. The last regime to be examined will be the case of an oligopsonist that has ownership of the pipeline. By removing the assumption that the pipeline-owning refiner is a monopsonist, the model will more closely approximate reality. By showing that the results from the monopsonist regime still hold under weaker assumptions, I will expand the model's relevance to more situations. The model will illuminate why ConocoPhillips avoided directing the flow of its pipeline from the low to the high price region.

Model of a Monopsonist Refiner

The supply of crude oil is competitive and described by the supply function $Q_S(p_n)$. There is a single buyer of crude oil, a monopsonist refiner who chooses the quantity to refine Q_i, given the competitive supply. The monopsonist choice of Q_i will be profit maximizing and will therefore be smaller than would be seen under perfect competition. There are two regions, north and south, and the monopsonist refiner will be located in the north. The north represents the United States Midcontinent and the south represents the United States Gulf Coast. Assume that under autarky the equilibrium price in the north is lower than that in the south; therefore to cause the prices to converge some quantity must be shipped from north to south. This assumption is in line with the current situation in the crude oil market; prices in the American Midcontinent are significantly lower than along the Gulf Coast. The price of crude oil in the north in the general case will be a function of the amount Q_i, not total supply Q_S. The price in the south will be p_s and will be taken exogenously. Under autarky

$$Q_S = Q_i$$

We will later relax this restriction and allow Q_i to deviate from Q_S. The price the refiner receives for its refined good is P_R and the production function for refining the intermediate good into a refined good is f($\cdot$). From this we find the profit (π) maximization function to be

$$\begin{matrix} max \\ Q_i \end{matrix} \pi = P_R f(Q_i) - Q_i p_n(Q_i)$$

In order to find the profit-maximizing value for Q_i we take the derivative with respect to Q_i:

$$\begin{matrix} FOC \\ Q_i \end{matrix} : 0 = P_R f'(Q_i) - p_n(Q_i) - Q_i p_n{}'(Q_i)$$

$$P_R f'(Q_i) = p_n(Q_i) + Q_i p_n{}'(Q_i)$$

On the left-hand side of the above equation is the marginal revenue gained from selling the refined good. The right-hand side of the equation is then the marginal cost paid by the refiner. The marginal cost paid by the refiner has two components: the price of crude oil $p_n(Q_i)$ and the increase in the price of all barrels caused by the purchase of one extra barrel $Q_i p_n{}'(Q_i)$. The refiner will set quantity such that marginal revenue equals marginal cost and will set the price equal to supply at that quantity in order to maximize profit. In the next section the autarky assumption will be relaxed and replaced by giving the monopsonist refiner complete control of inter-regional trade.

Model of a Monopsonist Refiner with Monopoly Control of Inter-regional Trade

The next assumption to be made is that the monopsonist in the north will also have exclusive control of the pipeline. The refiner will choose what quantity Q_t it wishes to transfer to the south (note: transfers of crude oil to the north will be represented by Q_t being a negative value). Therefore it is possible for the monopsonist to change the price in the north by choosing whether to ship crude oil to the south. If the monopsonist does ship crude oil south, the price in the north will increase as expected by the price-supply function. Therefore the monopsonist must make two decisions: how much crude oil to ship south and how much crude oil to refine. For every barrel that is shipped south, the monopsonist can profit by selling it at the higher price. The drawback is that increasing shipments south will increase the price of crude oil in the north, which leads to higher input costs for the refiner.

In the real world it has been historically observed that the prices between the American Midcontinent and Gulf Coast are close to equal. The reason for this has been free trade between the two regions. Historically the price in the north would be higher under autarky

(since the United States is a net crude oil importer) and thus crude oil would be transported from the low-price south to the high-price north. When the price in the north fell below that in the south due to external supply shocks it was expected that crude oil would be allowed to be shipped from the north to south. The model of this specific regime will try to show what reasons the pipeline-owner would have for not changing the pipeline's direction.

Given the model detailed above, the refiner faces the following profit maximization function:

$$\underset{Q_i, Q_t}{max} \pi = P_R f(Q_i) - Q_i p_n(Q_i + Q_t) + Q_t(p_s - p_n(Q_i + Q_t))$$

Taking the first order conditions with respect to Q_i and Q_t yields

$$\underset{Q_i}{FOC} : 0 = P_R f'(Q_i) - p_n(Q_i + Q_t) - (Q_i + Q_t)p_n'(Q_i + Q_t)$$

$$\underset{Q_t}{FOC} : 0 = p_s - p_n(Q_i + Q_t) - (Q_i + Q_t)p_n'(Q_i + Q_t)$$

These equations can be reordered so as to be more easily analyzed:

$$P_R f'(Q_i) = p_n(Q_i + Q_t) + (Q_i + Q_t)p_n'(Q_i + Q_t)$$

$$p_s = p_n(Q_i + Q_t) + (Q_i + Q_t)p_n'(Q_i + Q_t)$$

The left side of the upper equation is the marginal revenue gained from selling one more barrel of oil $P_R f'(Q_i)$. The right side is the price of crude oil in the north $p_n(Q_i + Q_t)$ plus the increase in the price of all barrels caused by the purchase of one extra barrel $(Q_i + Q_t)p_n'(Q_i + Q_t)$. We see from the second equation that the marginal revenue is also equal to the price in the south. This makes intuitive sense. If the refiner refines more crude oil, then its marginal gain will fall below the price in the south; in this situation, it would make more sense to ship that crude oil to the south and sell it at the higher price in the south than to refine it. If

the refiner refined less crude oil, then it would be missing out on a profit by refining and selling that crude oil.

The quantity that will be shipped south by the refiner will be such that

$$p_s - p_n(Q_i + Q_t) = (Q_i + Q_t)p_n{'}(Q_i + Q_t)$$

The refiner will ship crude oil south until the price difference between the two, $p_s - p_n(Q_i + Q_t)$, equals the sum of the crude oil refined and the crude oil transported multiplied by the derivative of the price function. This is extremely surprising; the derivative of the price function is negative, and therefore Q_t must be negative. The profit-maximizing quantity transported is therefore from the high-price south to the low-price north.

Why would the refiner wish to buy expensive crude oil in the south and sell it at a loss in the north? The answer comes from looking at the refiner's input costs. For each barrel of crude that is brought from the south to the north, there are two effects. The first is the loss from buying high and selling low and the second is the fall in price of crude oil in the north. If that reduction in price is sufficiently high, as determined by the derivative of the price function, then the reduction in input costs outweighs the loss from buying high and selling low. Put another way, the transportation of one barrel of crude oil generates a loss from selling that one barrel but reduces the cost per barrel for every barrel used as an input in the refining process. This general result will be confirmed under the more realistic assumption that the refiner in the north is not a monopsonist but rather one of several large refiners.

Model of an Oligopsonist Refiner with Monopoly Control of Inter-regional Transportation

The final and most realistic assumption with respect to the crude oil market in the United States is that of an oligopsonist refiner in the north who owns the pipeline. This most

closely approximates the situation in the American Midcontinent. The number of firms involved in refining is small but greater than one. Under this regime there exist several other refiners in the north in addition to the one which controls the pipeline. The other refiners are unable to use the pipeline and therefore only choose how much they will refine. The refiner with control of the pipeline again has two choices; how much crude oil to refine and how much crude oil to ship from north to south (or if Q_t is negative, from south to north). The variable Q_{-i} will denote the total quantity refined by the other refiners and n will be the number of other refiners. It is assumed that the refiners are all equal except the one that controls the pipeline. Therefore the pipeline-owning refiner faces the following profit maximization function:

$$\begin{matrix} max \\ Q_i, Q_t \end{matrix} \pi = P_R f(Q_i) - Q_i p_n (Q_i + Q_{-i} + Q_t) + Q_t (p_s - p_n (Q_i + Q_{-i} + Q_t))$$

Each of the other refiners maximizes profit according to the following profit function:

$$\begin{matrix} max \\ Q_{-i} \end{matrix} \pi = P_R f \left(\frac{Q_{-i}}{n}\right) - \frac{Q_{-i}}{n} p_n (Q_i + Q_{-i} + Q_t)$$

The three first order conditions are then taken with respect to each of Q_i, Q_t, and Q_{-i} in the appropriate functions. This yields the profit maximizing values for each as a function of the others. Thus,

$$\begin{matrix} FOC \\ Q_i \end{matrix} : 0 = P_R f'(Q_i) - p_n (Q_i + Q_{-i} + Q_t) - (Q_i + Q_t) p_n' (Q_i + Q_{-i} + Q_t)$$

$$\begin{matrix} FOC \\ Q_t \end{matrix} : 0 = p_s - p_n (Q_i + Q_{-i} + Q_t) - (Q_i + Q_t) p_n' (Q_i + Q_{-i} + Q_t)$$

$$\begin{matrix} FOC \\ Q_{-i} \end{matrix} : 0 = P_R f' \left(\frac{Q_{-i}}{n}\right) - \frac{1}{n} p_n (Q_i + Q_{-i} + Q_t) - \frac{Q_{-i}}{n} p_n' (Q_i + Q_{-i} + Q_t)$$

Again the pipeline-owning refiner in the north will refine a quantity Q_i such that

$$P_R f'(Q_i) = p_s$$

The quantity that the refiner will wish to ship north will be the quantity that solves

$$p_s - p_n(Q_i + Q_{-i} + Q_t) = (Q_i + Q_t)p_n'(Q_i + Q_{-i} + Q_t)$$

That is the refiner will ship the quantity that makes the price difference equal the quantity

refined and shipped multiplied by the derivative of the price function. The main difference

between the quantity shipped under an oligopsony rather than a monopoly is that the price in

the north will be higher due to the additional demand for crude oil of the other refiners. The

quantity Q_{-i} that those refiners will want to refine is

$$P_R f'\left(\frac{Q_{-i}}{n}\right) = \frac{1}{n}p_n(Q_i + Q_{-i} + Q_t) + \frac{Q_{-i}}{n}p_n'(Q_i + Q_{-i} + Q_t)$$

This quantity will be non-zero and will therefore result in a higher price in the north than under

the monopsonist case, although the main results found in the monopsonist case still hold.

A Numerical Example

   This section will show a short, simplified example of how changing the quantity

transported affects the price of crude oil for a monopsonist refiner with monopolist control

over the connecting pipeline. The functional form for the production and price functions will be

as follows:

$$f(Q_i) = -\frac{1}{10,000}Q_i^2 + 200Q_i$$

$$p_n(Q_i) = \frac{1}{5,000}Q_i$$

   From this the marginal revenue and marginal cost functions may be derived. (P_R will be

set equal to $100):

$$MR = 100f'(Q_i)$$

$$MR = -\frac{1}{5,000} Q_i + 200$$

$$MC = Q_i p'_n(Q_i)$$

$$MC = \frac{1}{5,000} Q_i$$

When MR is set equal to MC, the equilibrium quantity is 500,000 barrels of crude oil.

Because the price is chosen by the monopsonist, it will be set according to the supply curve.

The supply curve will have one-half of the slope of the MC curve, that is:

$$p_{Supply\ Curve} = \frac{1}{10,000} Q_i$$

Plugging in 500,000 barrels yields a price of $50. That translates into a consumer

(monopsonist's) surplus of $50 million, calculated by taking the area between MR and

$p_{Supply\ Curve} = 50$ from 0 to 500,000 barrels.

If 200,000 barrels of crude oil are transported from the south to the north, the

equivalent of adding 200,000 to the Q_i in the MC equation, then the result when MR is set

equal to MC is Q_i = 400,000. Adding Q_i and the 200,000 barrels transported results in a total of

600,000 barrels of crude oil, but since Q_i and the supply curve determine the price the price is

only $40 per barrel. The consumer surplus is then a larger $60 million. See Fig. 1.
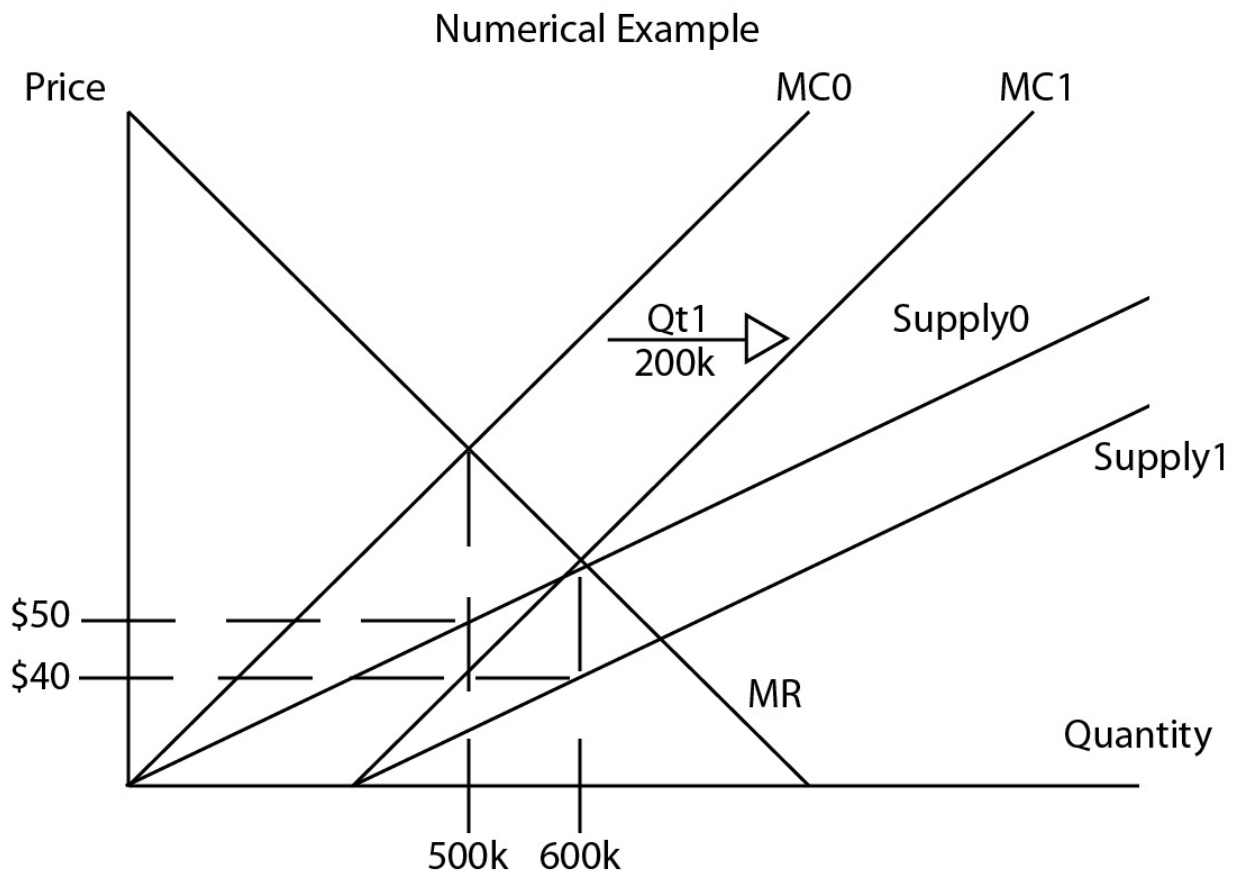
Numerical Example

Fig. 1

Recall that the price of crude oil is being held constant in the south; therefore the price difference between the two regions is $10 after crude oil is pumped from south to north.

Overview of Model

The model shows that a refiner can be induced to sell its crude oil in the low price region under certain scenarios if it is able to reduce input costs enough to make up for the loss per barrel from selling in the low price region. This would cause the price gap between the two regions to remain or widen. The next section will show how this model applies to what happened in the crude oil market during the period 2010-2011 and why the model is consistent with the observed behavior of the major actors in the market.

3.   Empirical Evidence

Analysis of Empirical Data

The model explains how a pipeline ownership structure that gives control of the connection between two regions to a refiner with market power could result in a divergence of regional prices of the intermediate good. I will now apply that model to the market for crude oil in the United States. This section starts with an explanation of the crude oil benchmarks, the major players in the crude oil market, and details of America's pipeline infrastructure. Next will be an explanation of what events have happened in the crude oil market in the past few years. These events are then explained in the context of the model. Empirical evidence from the past several years will be shown to be consistent with the presented model.

Crude Oil in the Gulf Coast and Midcontinent

There are a number of oil benchmarks which are used to price crude oil throughout the world. The two most widely cited benchmarks are West Texas Intermediate (WTI) and Brent Crude. WTI is priced in Cushing, Oklahoma, at the intersection of many of the United States' oil pipelines. Because the price for WTI is determined at Cushing, it is susceptible to the effects of localized changes in supply and demand. Brent Crude is priced from a blend of crude oils sourced in the North Sea. Brent crude is considered to be a lower quality crude, as determined by its sulfur content and specific gravity. The differences between the two benchmarks are slight however, in comparison to other regional benchmarks, such as Dubai Crude.

There are numerous refineries in the United States, but the majority of refining capacity east of the Rocky Mountains is located in the Midcontinent and along the Gulf Coast in Texas and Louisiana. The largest refiners of crude oil in the United States come from two groups. The

first are the supermajors: BP, Chevron, ExxonMobil, Royal Dutch Shell, Total, and ConocoPhillips. The others are large American refiners such as Valero and Marathon. ConocoPhillips in particular is the largest refiner of crude oil in the United States[2]. ConocoPhillips owns refineries throughout the country, as seen in Fig. 2. Data showing crude oil capacity at their refineries in the Midcontinent and along the Gulf Coast is given in Fig. 3. Note that the refining capacity along the Gulf Coast is larger than in the Midcontinent, but that much of the crude oil brought into coastal refineries was bought at WTI prices due to the contracts that ConocoPhillips had with crude oil producers. ConocoPhillips owns a pipeline known as the Seaway pipeline which connects the US Gulf Coast in Texas directly to Cushing. ConocoPhillips purchased the pipeline in 2005 and it is currently capable of carrying 350,000 barrels of crude oil per day but has recently transported much less than this, for example an average of 63,000 barrels per day in the first quarter of 2011[34]. Crude oil in the pipeline has been flowing from the Gulf Coast to Cushing since its construction.

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[2] http://www.conocophillips.com/EN/about/worldwide_ops/rm/Pages/index.aspx
[3] Reuters. *UPDATE 1 - Seaway pipeline has excess capacity: spokesman.* November 29, 2007.
    http://uk.reuters.com/article/2007/11/29/pipeline-seaway-capacity-idUKN2922963920071129 (accessed September 10, 2011).

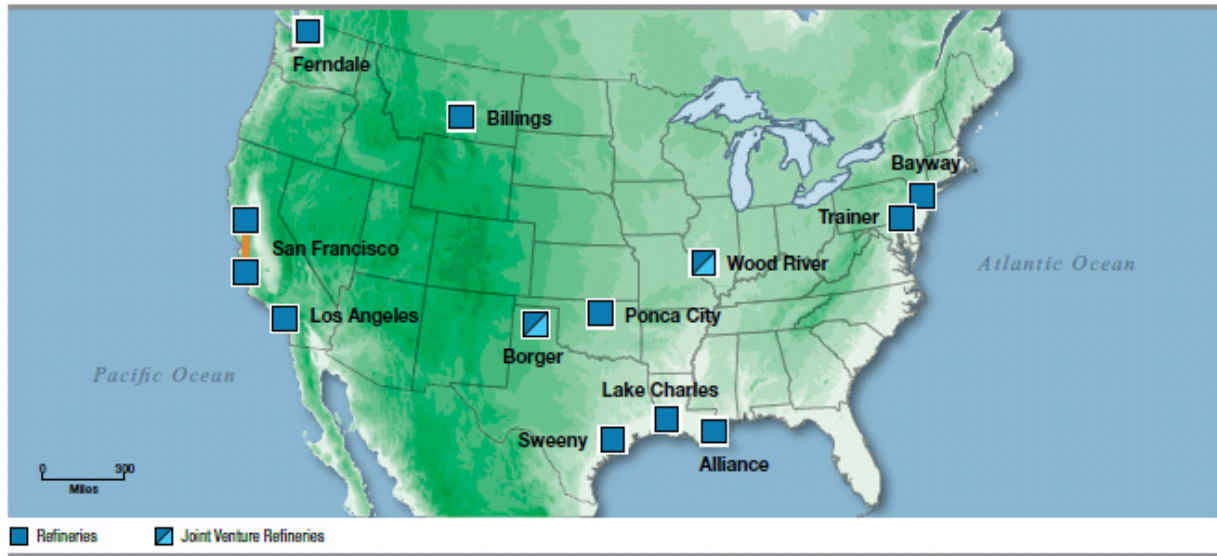[4] Federal Energy Regulatory Commission. *Annual/Quarterly Report of Oil Pipeline Companies.* 2008 - 2012.

Fig. 2[5]

Refinery Name	Crude Oil Capacity (MBD)
Total Midcontinent & Gulf Coast	1146
Midcontinent Total	413
Borger	73
Ponca City	187
Wood River	153
Gulf Coast Total	733
Sweeny	247
Lake Charles	239
Alliance	247

Fig. 3

The geography of the US oil industry can be roughly divided into two main regions: those purchasing crude oil inputs on the Cushing side of the Seaway pipeline and those purchasing on the Gulf Coast side. Refiners along the Gulf Coast, however, are able to buy most of their crude oil at the WTI price, despite the fact that the supply of crude oil there reflects Brent. The reason refiners are able to buy their crude oil at the WTI price is that their contracts

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with suppliers, especially American, Latin American, and Middle Eastern suppliers, are priced according to WTI (Fattouh 2011). This disconnect between crude oil supplies and the prices quoted in contracts has been a source of criticism of using WTI. Several suppliers, namely Saudi Aramco, Kuwait, and Iraq, have switched their crude oil contracts from being priced at WTI to being priced at the Argus Sour Crude Index (ASCI) benchmark. ASCI is priced according to supply and demand along the Gulf Coast and much more closely aligns with the Brent price of crude oil.

Changes in the Market for Crude Oil Since 2010

In the years before 2010 the prices of WTI and Brent oil were very close. During 2010 the prices began to diverge and in early 2011 the gap grew as large as $20/bbl. difference. It is important to see that the difference grew not only in absolute terms, but also in relative terms. Throughout most of the past decade WTI sold on average at about 4% higher than Brent, but in July 2011, Brent sold for a price 20% higher than WTI. See Fig. 4 and Fig. 5.
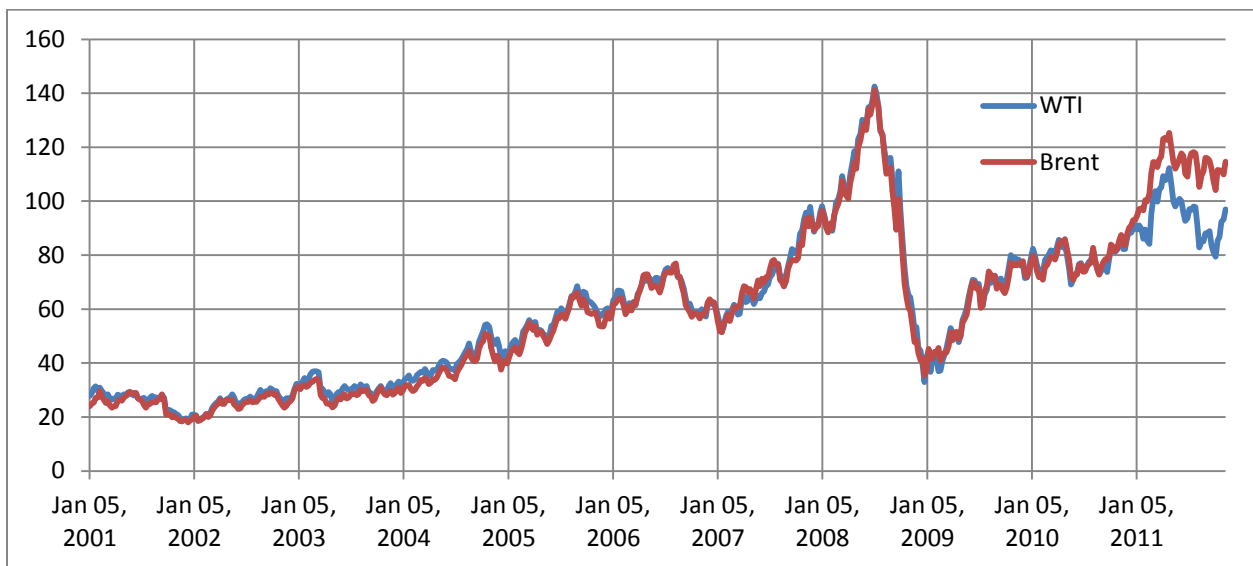

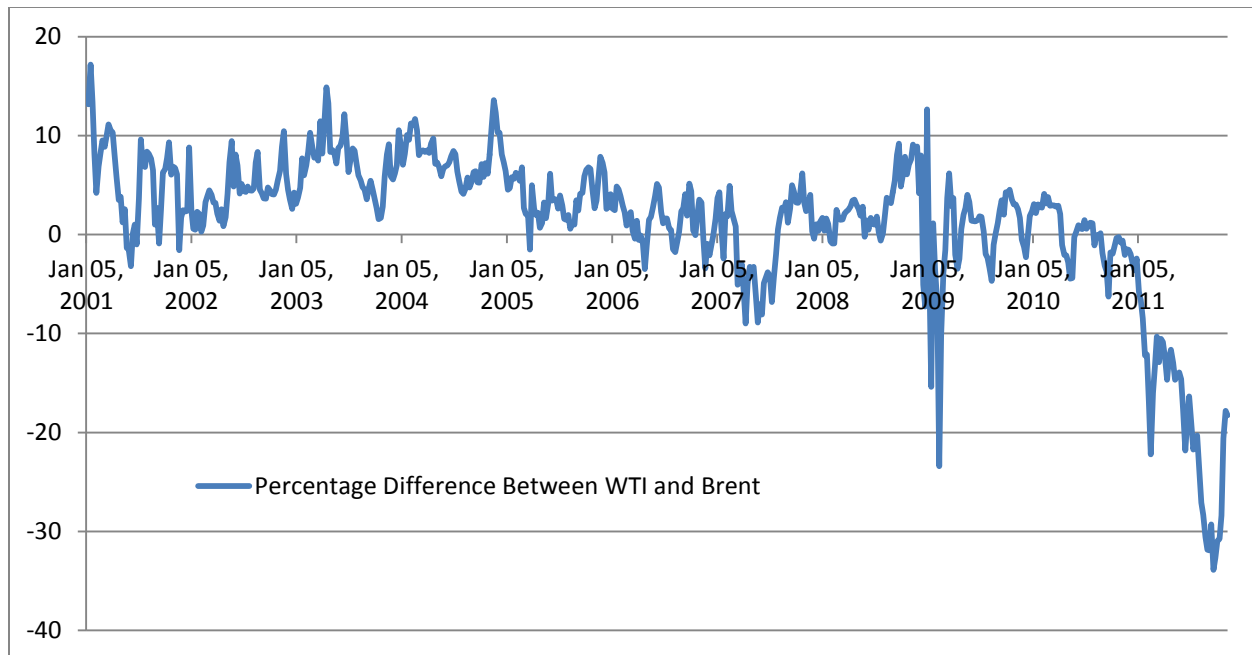Fig. 4 (U.S. Energy Information Administration. n.d. http://www.eia.gov)

Fig. 5 (U.S. Energy Information Administration. n.d. http://www.eia.gov)

The United States is the world's largest importer of crude oil and its largest source of crude oil imports is Canada. Production of crude oil in the Athabasca oil sands of Alberta has increased dramatically over the past decade. The dramatic increase in production led to increasing exports to the United States due to a lack of infrastructure in Canada for bringing Canadian crude oil to the coast. See Fig 6. Attempts to build pipelines to the Canadian Pacific Coast have been stalled by British Columbian First Nation peoples[6]. In response crude oil producers in Canada have sought other means to bring their crude oil to the international market. In the past few years they have begun transporting crude oil south through America to Cushing using TransCanada's Keystone pipeline. Of the roughly 1.5 million barrels of crude oil imported into the Midwest per day, about 1.4 million come from Canada. Canadian oil producers have transported the oil sands crude oil with a series of new pipelines, including the

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[6]http://www.vancouversun.com/business/First+nations+group+rejects+pipeline+ownership+offer/5374046/story.html

450,000 bbl. /day Alberta Clipper Pipeline owned by Enbridge[7] and the 550,000 bbl./day

Keystone Pipeline owned by TransCanada[8]. The Alberta Clipper Pipeline first opened in April

2010 and the Keystone Pipeline opened in two sections, the first connecting to Steele City,

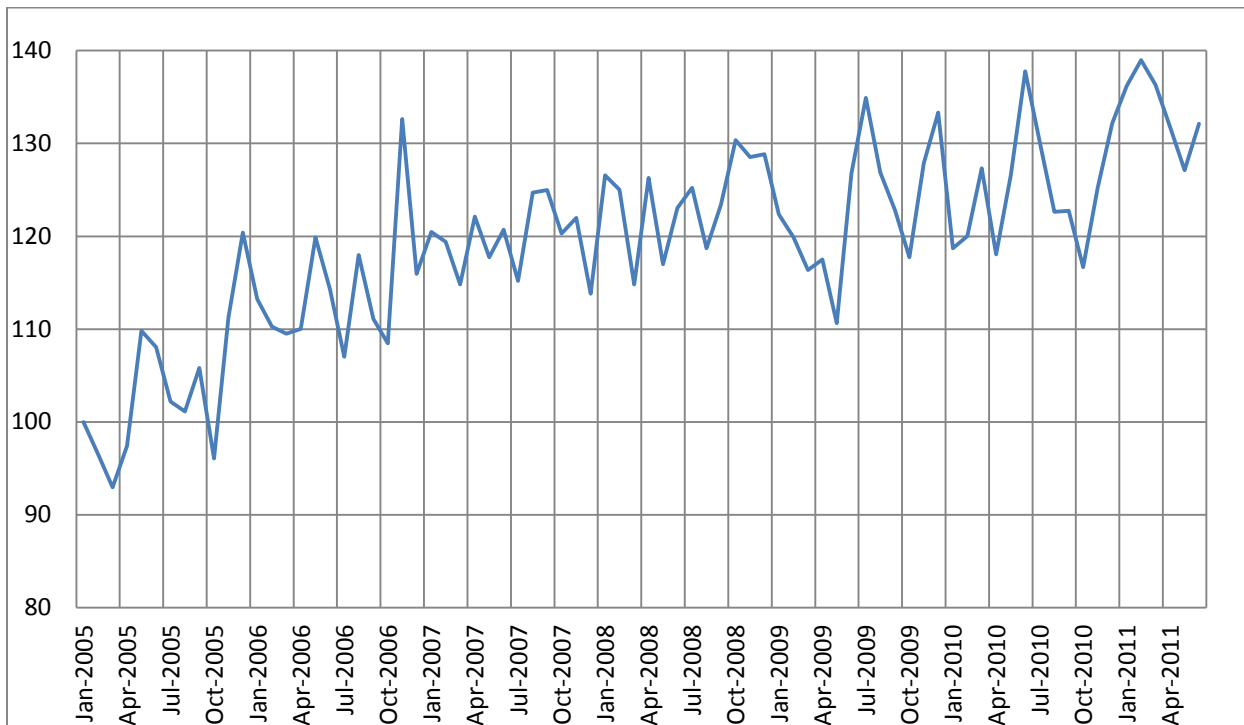Nebraska in June 2010 and the second connecting to Cushing in February 2011. See Fig. 7.

Fig. 6 (Imports of Canadian oil: Jan 2005=100) (U.S. Energy Information Administration. n.d.
        http://www.eia.gov.)

[7] Enbridge. *Alberta Clipper.* n.d. http://www.enbridge-expansion.com/expansion/main.aspx?id=1218
        (accessed September 10, 2011).
[8] TransCanada. *Project Information.* May 31, 2011.
http://www.transcanada.com/project_information.html (accessed September 10, 2011).

Fig. 7

Oil production has also increased in the state of North Dakota. The Bakken Shale formation in western North Dakota has been increasing production of crude oil since 2008. It now produces almost 350,000 barrels of oil per day. Most of the Bakken crude oil is shipped eastward towards Midwestern refineries using Enbridge's North Dakota Expansion pipeline and railroads[9].

Solving the Puzzle

There are two main questions with regard to the price divergence: why did it endure so long and why did the prices diverge when they did? ConocoPhillips seems to have had sufficient incentive to reverse the pipeline; potential gains from arbitrage would be on the

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[9]http://www.tulsaworld.com/business/article.aspx?subjectid=49&articleid=20110128_49_E3_CUTLIN848378&rss_lnk=5

order of millions of dollars per day. Examining ConocoPhillips' operating and financial statement[10] helps to explain the answer. ConocoPhillips' realized margin on refining in the United States more than doubled between 3rd Quarter 2010 and 3rd Quarter 2011, from 6.53 $/bbl. to 13.70 $/bbl. The increase in ConocoPhillips' realized margin coincides with the received difference in price between refined product outputs and crude oil inputs; this is known as the crack spread. ConocoPhillips' crack spread was more than triple in 3rd Quarter 2011 what it was in 3rd Quarter 2010 in both the Midcontinent and Gulf Coast regions, but not in international refining. The reason for the increase in the Gulf Coast is that ConocoPhillips has been able to buy crude oil on the Gulf Coast at the lower WTI price.

The large difference in revenue and input cost is consistent with the model. By not reversing the Seaway pipeline, ConocoPhillips was able to drive down its crude oil input costs and thereby increase profits. Although ConocoPhillips acts as a refiner in both regions, as long as it can pay the WTI price it will act like the pipeline-owning refiner presented in the model.

The next question is why the price divergence emerged in late 2010 and seemed to be closing in late 2011. As shown in Fig. 6, imports of Canadian crude oil steadily increased during the past five years. TransCanada's Keystone pipeline was completed in sections; first Alberta to Patoka, Illinois in June 2010 and later to Cushing, Oklahoma in February 2011. This resulted in a huge surplus of crude oil in the American Midcontinent and ultimately Cushing. The imported Canadian crude oil had no way of leaving the American Midcontinent due to a lack of major pipelines directed towards the coast. Therefore the increase in the quantity of crude oil in the

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[10] http://www.conocophillips.com/EN/investor/financial_reports/earnings_reports/Pages/index.aspx

American Midcontinent resulted in a relative decrease in the WTI price of crude oil as compared to Brent.

The difference in prices fell in November 2011 after ConocoPhillips announced that Enbridge Inc. would buy a 50% state in the Seaway pipeline and reverse it. There are a few reasons why ConocoPhillips likely chose to allow the reversal when it did. The first is that it would not be able to pay the WTI price for crude oil at its refineries on the Gulf Coast much longer. A number of foreign exporters, including Brazil's Petrobras, Saudi Arabia's Aramco, and Colombia switched their pricing to the Brent benchmark[11]. The change meant that the large refining margins ConocoPhillips was enjoying would shrink. The magnitude of the price gap grew before the pipeline deal, increasing from $17 per barrel in July to $26 per barrel in September. The increasing benefit of arbitrage combined with shrinking profit margins culminated in ConocoPhillips' decision to have the pipeline reversed.

Why didn't the price divergence occur until late 2010, considering Cushing must have experienced supply and demand shocks previously? Written more concretely, why didn't the prices diverge when the supply of crude oil in the American Midcontinent increased from domestic production? The reason is that before the opening of the Keystone pipeline, changes in supply and demand in Cushing could be alleviated by changing the quantity of crude oil brought in through the Seaway pipeline. If demand fell in Cushing, refiners would simply transport less crude oil in the Seaway pipeline. The reduction in the quantity transported to Cushing kept the WTI and Brent prices together. The Seaway pipeline was one-way, however, so when supplies increased dramatically at Cushing due to the Keystone pipeline, the flow of

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[11] http://www.reuters.com/article/2011/10/21/petrobras-pricing-idUSN1E79K1DE20111021

crude oil in the Seaway pipeline fell. Evidence of this can be found in the Federal Energy Regulatory Commission's (FERC) data for Seaway pipeline flows in 2010 and 2011 (see Fig. 8). Imports could not fall below zero (that is, crude oil could not leave Cushing via the Seaway pipeline) so the higher supply could not be alleviated. Thus the WTI price fell relative to the Brent price.
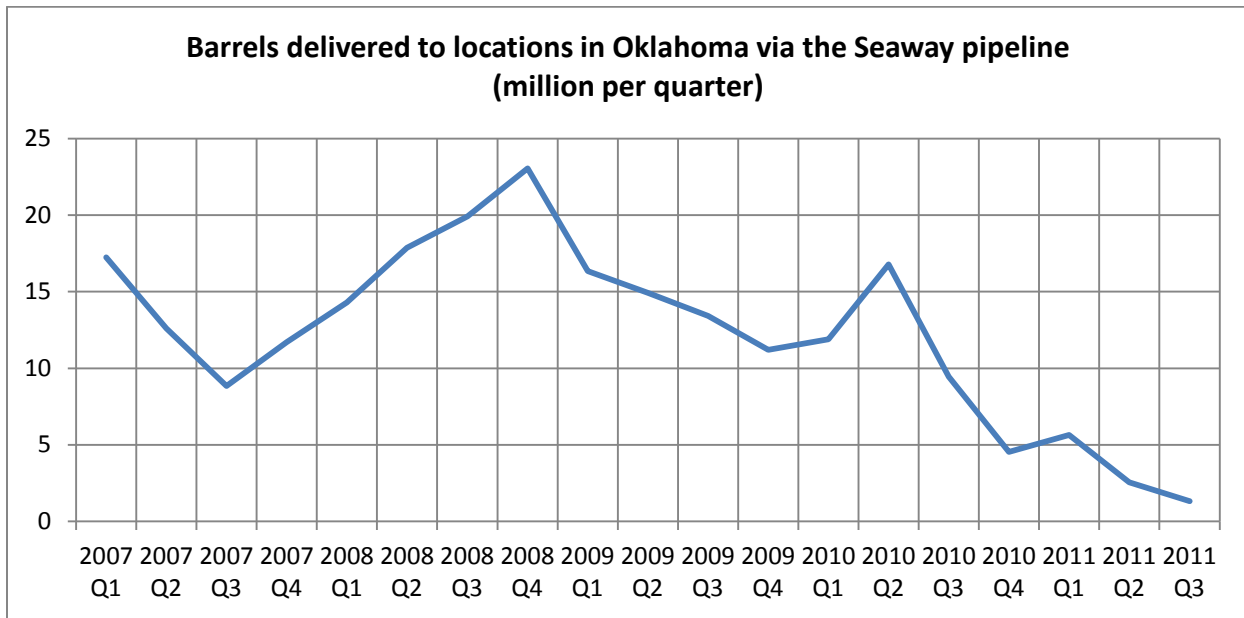

Fig. 8 (Federal Energy Regulatory Commission. *Annual/Quarterly Report of Oil Pipeline Companies.* 2008 - 2012.)

Empirical Evidence

In order to show that ConocoPhillips avoided reversing the pipeline in order to drive down input costs, it is useful to include some statistics that are consistent with that assertion. As shown in Fig. 9, crude oil stocks at Cushing increased. The increase in crude oil stocks is consistent with what would be expected; as supply increases at Cushing, low demand results in the suppliers of crude oil trying to store their oil for sale at a later date, when they hope it will

sell at a higher price. Because storage at Cushing is limited, incoming oil eventually had to be

sold to refiners, who increased their refineries' rate of crude oil utilization to handle the new
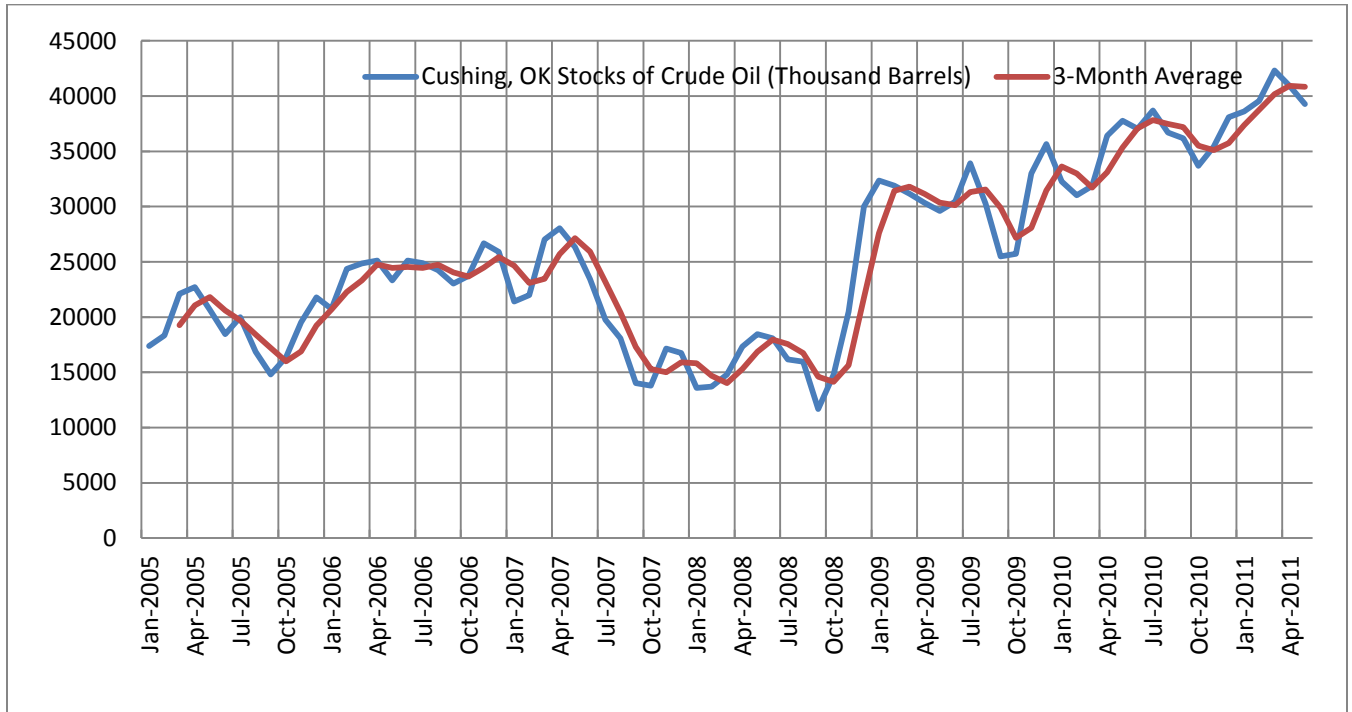
influx of cheap crude oil.

Fig. 9 (U.S. Energy Information Administration. n.d. http://www.eia.gov)

The utilization rate for refineries in relevant areas is plotted in Fig. 10. From the graph

we see that utilization in OK, KS, MO fell in September 2010 and on average has risen since.

Utilization on the Texas Gulf Coast fell on average from the summer of 2010 until about March

2011, after which it increased. Most refineries already run near capacity and changes in the

price of crude oil have only a minor effect on how much oil is processed. Because much of the

cost of buying the crude oil input can be passed onto the consumer of refined oil, oil refiners

have less incentive to decrease refining due to high prices (as along the Gulf Coast) and increase

refining due to low prices (as in the Midcontinent). Refining at an abnormal utilization rate is

assumedly costly (costs from refitting machines, changing plans for shipments into and out of a refinery, etc.) so it is logical to think that price of crude oil would have little effect on utilization.
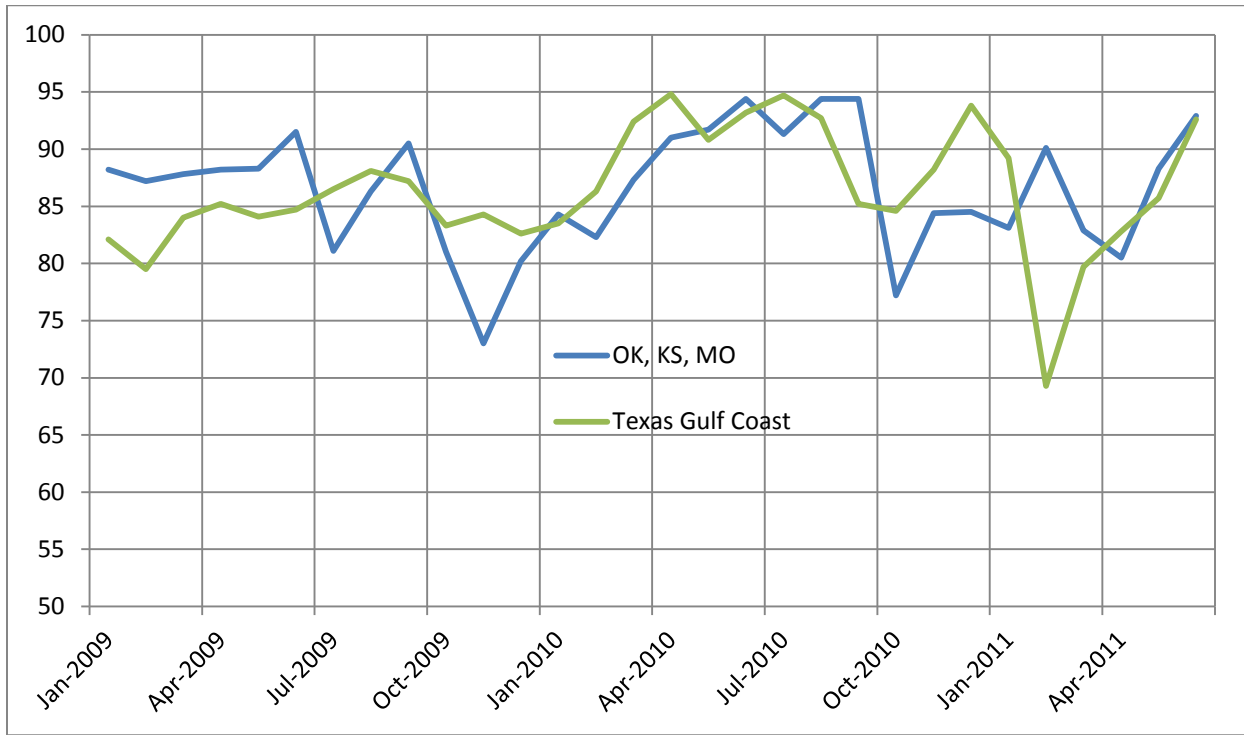

Fig. 10 Refinery Utilization Rate (U.S. Energy Information Administration. n.d. http://www.eia.gov)

A fall in shipments of oil between the Gulf Coast region and the Midwest is indicated by data from the Energy Information Agency, plotted in Fig. 11. It is important to note that the Gulf Coast includes inland Texas in these statistics, which is why the flow of oil from the Gulf Coast to the Midwest has slowed considerably but not stopped, as domestic producers of oil in northern and western Texas are still shipping their crude oil to Cushing. The model explains this change by showing that the new influx of Canadian crude lowered the price of WTI sufficiently to replace the need for crude coming in from the Gulf Coast, hence the fall in Gulf Coast to Cushing shipments.
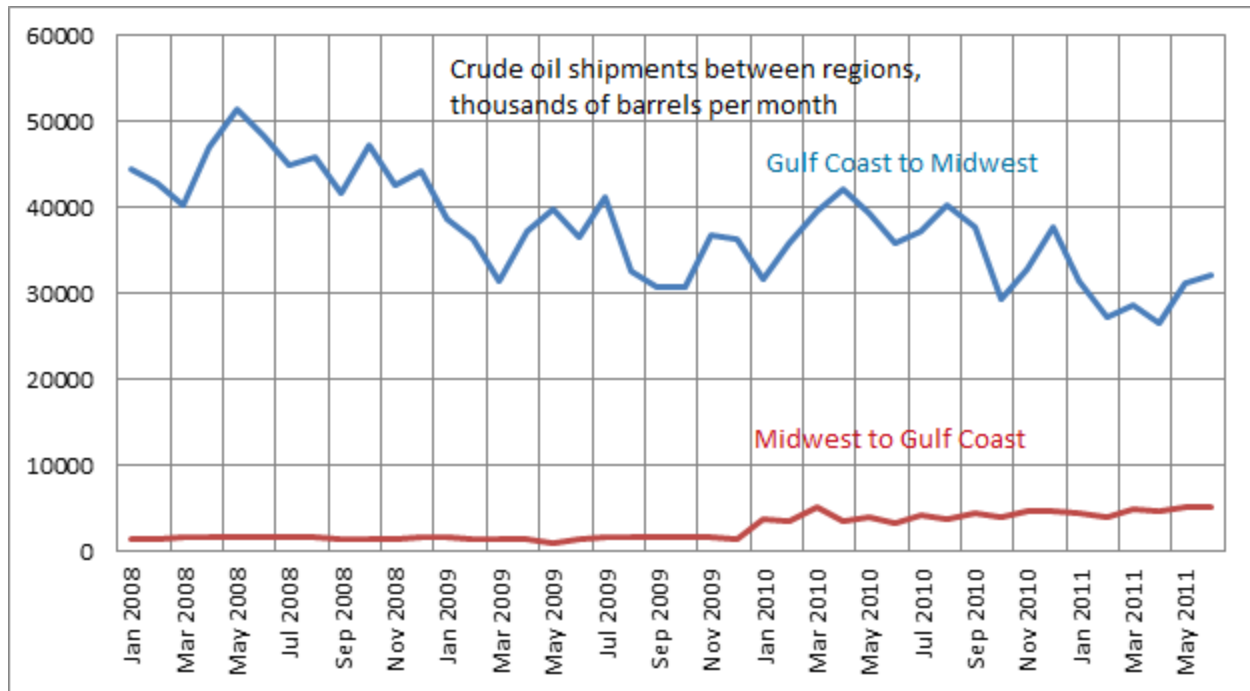
Fig. 11 (U.S. Energy Information Administration. n.d. http://www.eia.gov)

Recently a number of corporations have begun plans to construct new pipelines that would be capable of shipping crude oil from Cushing to the Gulf Coast. The most notable pipelines currently planned are being built by TransCanada[12], Enterprise Products Partners[13], and Plains All American Pipeline[14]. The model shows that companies without significant refining capacity in the Midwest can make a profit by selling cheap WTI crude at high prices along the Gulf Coast. In addition, some of these companies, namely Plains All American

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[12] TransCanada. *Project Information.* May 31, 2011.
http://www.transcanada.com/project_information.html (accessed September 10, 2011).
[13] Pipelines International. *Crude oil pipeline joint venture dissolves.* August 24, 2011.
http://pipelinesinternational.com/news/crude_oil_pipeline_joint_venture_dissolves/063248/
(accessed September 4, 2011).
[14] Pipelines International. *PAA proposes new Eagle Ford pipeline.* May 24, 2011.
http://pipelinesinternational.com/news/new_eagle_ford_pipeline_to_be_constructed_by_paa/
060958/# (accessed September 1, 2011).

Pipeline, own refining capacity along the Gulf Coast, and therefore are doubly interested in reducing the price of Brent crude oil.

4.   Policy

The two most interesting policy applications of the theory given in this paper are to the debate about TransCanada's Keystone XL pipeline and to the uncompetitive manipulation of the price of crude oil to the detriment of US crude oil producers. The Keystone Pipeline has gained much attention in the media due to its potentially negative environmental effects and its potential for job creation, but it could also be important for the price of crude oil. It is likely that Canadian crude oil production will continue to increase and therefore the quantity of crude oil shipped south to the United States will increase. Since the capacity of the Seaway pipeline is limited, it is possible that in the future there will again be a glut of crude oil in Cushing due to imports from Canada exceeding the capacity to ship crude oil to the coast. Therefore without increases in pipeline capacity, the prices will diverge again. If TransCanada builds the Keystone XL pipeline it will dramatically increase the capacity of Cushing to Gulf Coast crude oil transportation and could therefore prevent a price divergence. The benefit of building the pipeline would go primarily to Canadian and Midcontinent American crude oil producers; they will receive a higher price for their crude oil. The cost of the higher crude oil price will be borne by American crude oil refiners.

This paper has shown that it is possible for a refiner that owns the pipeline connecting two crude oil markets to induce a price divergence. The price divergence, although beneficial for the refiner, would be detrimental for crude oil producers in this case. By not reversing the Seaway pipeline, ConocoPhillips left the inter-regional price divergence, enabling them to profit

from lower input costs. American producers of crude oil however, such those in North Dakota and Texas, received a lower price for their crude oil than they would have if the price of WTI was at the global price.

There are several potential ways of preventing similar price divergences from happening again. One is to prevent important transportation assets from being monopolized by one entity. For example, this was the proposed solution by the FTC in the case of the BP and ARCO merger. The U.S. Federal Trade Commission (FTC) challenged the merger of BP and ARCO in 2000. The issue was that the newly formed company would control significant storage and pipeline capacity at Cushing and therefore be able to manipulate the price of WTI futures. Ultimately the merger was allowed, but they were forced to sell the Seaway pipeline, which was bought by ConocoPhillips. So although the FTC prevented BP from gaining a monopoly on pipeline and storage capacity at Cushing, because ConocoPhillips bought the pipeline, ConocoPhillips had a monopoly on pipeline capacity at Cushing. It is therefore very difficult to divide up transportation assets when the assets consist of only one property. Another potential solution is to prevent suppliers and demanders of a good from controlling important transportation lines. If the pipeline is owned by an independent company, then that company will direct the crude oil in whatever direction allows it to make the greatest profit by arbitrage and transportation fees. That direction would result in the excess crude oil being sold in the region with the higher price.

The best long run solution, however, would not require such strict regulation of ownership structures but would rather allow the free market to solve these transportation problems through the production of more pipelines. This is exactly what has been observed in

the crude oil market in the past several months. Numerous corporations have proposed and begun construction on new pipelines connecting Cushing to the Texas Gulf Coast. Ultimately the price divergence shrank significantly when the process of reversing the Seaway pipeline's flow began.

The main downside of this solution is that it is slow and results in long periods of inadequate allocation of resources before the market fixes itself. There is a considerable length of time for other corporations to build the necessary infrastructure to end a price divergence. Therefore it may be necessary to institute some level of regulation to prevent short term abuse.

5. Conclusion

This paper has shown that it is possible for refiners in the market for an intermediate good with monopoly control of inter-regional transportation to engage in unprofitable arbitrage in order to reduce input costs. The behavior appears paradoxical but, as shown in the case of ConocoPhillips, can result in large profit margins. We see that changes in the source of American crude oil imports explain why the price divergence occurred when it did. ConocoPhillips ultimately chose to reverse the pipeline in response to having to pay the Brent price for crude oil at its Gulf Coast refineries and increased potential gains from arbitrage. The price gap in the WTI and Brent prices of crude oil is thus explained by the profit-maximizing behavior of the refiner with control of the only major pipeline linking the American Midcontinent and Gulf Coast.

Bibliography

Barsky, Robert, and Lutz Kilian. "Oil and the Macroeconomy Since the 1970s." *Journal of Economic Perspectives*, 2004: 115-134.

Bloomberg. *ConocoPhillips Not Interested in Reversing Seaway Pipeline.* February 15, 2011. http://www.bloomberg.com/news/2011-02-15/conocophillips-not-interested-in-reversing-seaway-pipeline.html (accessed March 16, 2011).

Bunn, Derek, and Georg Zachmann. "Inefficient arbitrage in inter-regional electricity transmission." *Journal of Regulatory Economics*, Vol. 37 No 3, 3 July 2009: pp. 243 - 265.

Cooper, John C.B. "Price elasticity of demand for crude oil: estimates for 23 countries." *OPEC Review*, March 2003: 1-8.

Fattouh, Bassam. *An Anatomy of the Crude Oil Pricing System.* The Oxford Institute for Energy Studies, January 2011.

Federal Energy Regulatory Commission. *Annual/Quarterly Report of Oil Pipeline Companies.* 2008 - 2012.

Hamilton, James. "Oil and the Macroeconomy since World War II." *Journal of Political Economy* (University of Chicago Press), 1983: 228-248.

Joskow, Paul, and Jean Tirole. "Transmission Rights and Market Power on Electric Power Networks." *The RAND Journal of Economics*, Vol. 31, No. 3 (Autumn, 2000): pp. 450-487.

Sunoco Logistics. *Crude Oil Pipeline System.* 2009. http://www.sunocologistics.com/Customers/Business-Lines/Crude-Oil-Pipeline-System/55/ (accessed August 15, 2011).

U.S. Energy Information Administration. n.d. http://www.eia.gov.